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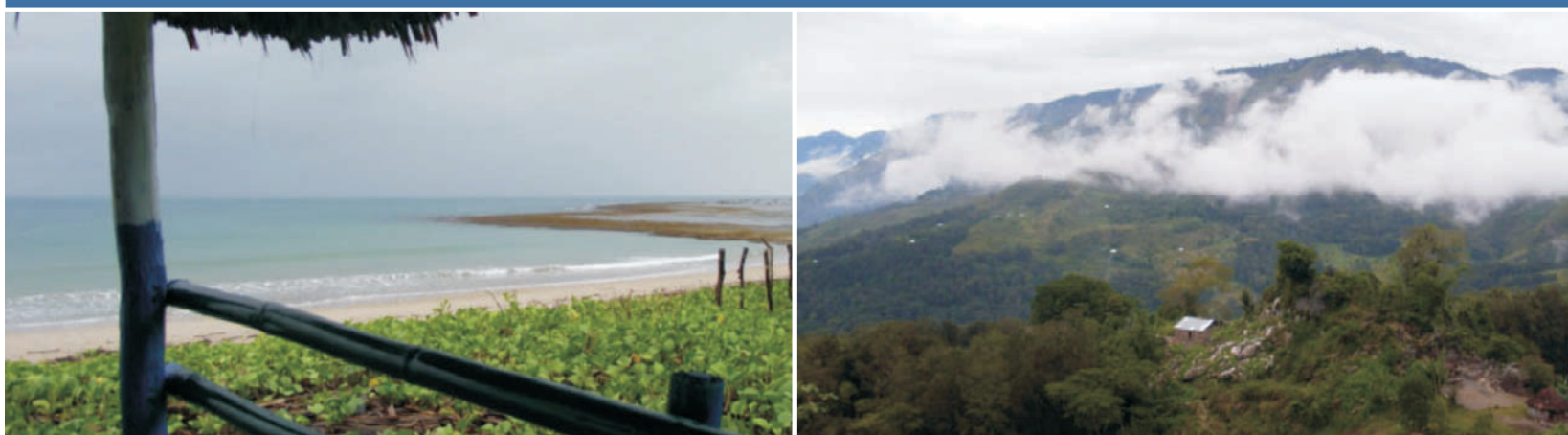
REPÚBLICA DEMOCRÁTICA DE TIMOR-LESTE  
SECRETARIA DE ESTADO DOS RECURSOS NATURAIS

# Tasi Mane Project - Betano Petroleum Refinery and Beaco LNG Plant Strategic Environmental Impact Statement

Final Report

June 2012

## Volume 1 - Main Report Part A



301012-01504-EN-REP-0005



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**The Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant Strategic Environmental Impact Assessment (Final Report) is made up of four separate volumes:**

**VOLUME 1 of 4: Betano Petroleum Refinery and Beaco LNG Plant Strategic Environmental Impact Assessment Main Report Part A (Chapters 1 to 6)**

**VOLUME 2 of 4: Betano Petroleum Refinery and Beaco LNG Plant Strategic Environmental Impact Assessment Main Report Part B (Chapters 7 to 10)**

**VOLUME 3 of 4: Betano Petroleum Refinery and Beaco LNG Plant Strategic Environmental Impact Assessment Main Report Part C (Appendices)**

**VOLUME 4 of 4: Betano Petroleum Refinery and Beaco LNG Plant Strategic Environmental Impact Assessment (Attachments)**

**Terrestrial Flora and Fauna Final Technical Report  
Marine Environment Final Technical Report**



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# STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

## Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

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## Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

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# STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

## Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

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# STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

## Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

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# STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

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# Strategic Environmental Impact Assessment

## Betano Petroleum Refinery and Beaco LNG Plant

### FINAL REPORT

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**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

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ATTACHMENT 2	MARINE ECOLOGY AND FISHERIES ASSESSMENT



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

## GLOSSARY

### Units

µg/m <sup>3</sup>	micrograms per cubic metre
cfu	colony-forming units
dB	decibels
g/m <sup>2</sup> /month	grams per square metre per month
ha	hectare
hPa	hectopascals
kL	kilolitres
km	kilometre
kV	kilovolts
L/min	litres per minute
L/s	litres per second
m	metre
mbgs	metres below ground surface
mcm	million cubic metres
mg/kg	milligrams per kilogram
MJ/m <sup>2</sup>	megajoules per square metre
ML	megalitre (one million litres)
mm	millimetre
m/s	metres per second
MT	million tonnes
Mtpa	million tonnes per annum
MW	megawatt
nm	nautical miles
ppb	parts per billion
ppm	parts per million
sqm	square metres



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

#### Abbreviations

<b>A</b>	
AACTL	Civil Aviation Authority of Timor-Leste
AADT	annual average daily traffic
ADB	Asian Development Bank
AGWR	annual groundwater resource
ANP	National Petroleum Authority
ANZECC	Australian and New Zealand Environment Conservation Council
APORTIL	Port Authority of Timor-Leste
ARCOM	Communications Regulatory Authority
AQIS	Australian Quarantine Inspection Services
AS/NZS	Australian/New Zealand standard
ASS	acid sulphate soils
AWS	automated weather station
<b>B</b>	
BGL	below ground level
BOD	biological oxygen demand
BPD	barrels per day
<b>C</b>	
CBO	community-based organisation
CEDAW	Committee on the Elimination of Discrimination against Women
CEO	chief executive officer
CITES	Convention on International Trade in Endangered Species
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
<b>D</b>	
DCP	dynamic cone penetrometer
DNSAS	Direcção Nacional Serviço de Água e Saneamento
DNSMA	National Directorate of Environmental Service
<b>E</b>	
EC	electrical conductivity
EIA	environmental impact assessment
EIS	environmental impact statement
EMP	environmental management plan
ENSO	El Niño Southern Oscillation
<b>F</b>	
FEED	front-end engineering and design



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

#### Abbreviations (cont'd)

<b>G</b>	
GIS	geographic information system
GDE	groundwater-dependent ecosystems
GMP	groundwater monitoring plan
GoTL	Government of Timor-Leste
GTZ	Gesellschaft für technische Zusammenarbeit
<b>H</b>	
HH	household
HIV	human immunodeficiency virus
HSE	health, safety and environment
<b>I</b>	
IADE	Instituto de Apoio ao Desenvolvimento Empresarial
IAP	interested and affected party
IBA	impacts and benefits agreement
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
IHT	Institute of Highway Engineers
ISO	International Standards Organisation
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
<b>J, K</b>	
KSI	Kadalak Sulimutuk Institute
<b>L</b>	
LI	Landscape Institute
LNG	liquefied natural gas
LTA	Land Transport Authority
<b>M</b>	
MAFF	Ministry of Agriculture, Forestry and Fisheries
MPW	Ministry of Public Works
MSDS	material safety data sheet
<b>N</b>	
NATA	National Association of Testing Authorities
NDSMA	National Directorate of Environmental Service
NEPC	National Environment Protection Council (Australia)
NEPM	National Environment Protection Measures



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

#### Abbreviations (cont'd)

NGO	non-governmental agency
NPI EETM	National Pollutant Inventory Emission Estimation Technique Manuals (Australia)
NO	nitric oxide
NO <sub>2</sub>	nitrogen dioxide
N <sub>2</sub> O	nitrous oxide
NO <sub>x</sub>	oxides of nitrogen
NTU	nephelometric turbidity units
<b>O</b>	
O <sub>3</sub>	ozone
OCHA	the United Nations Office for the Coordination of Humanitarian Affairs
<b>P</b>	
Pb	lead
PM <sub>10</sub>	particulate matter less than 10 micrometres in aerodynamic diameter
<b>Q, R</b>	
RAP	resettlement action plan
RDTL	Democratic Republic of Timor-Leste
RO	reverse osmosis
<b>S</b>	
SDP	Strategic Development Plan
SEIA	strategic environmental impact assessment
SEFOPE	Secretariat of State for Professional Training and Employment
SERN	Secretaria de Estado dos Recursos Naturais
SISCa	Servisu Integradu da Saúde Comunitária (English translation 'Integrated Community Health Services')
SO <sub>2</sub>	sulphur dioxide
SO <sub>x</sub>	oxides of sulphur
SOI	Southern Oscillation Index
<b>T</b>	
TB	tuberculosis
TBT	tributyltin
TDS	total dissolved solids
TEOM	tapered element oscillating microbalance
TKN	total Kjeldahl nitrogen
TPLNG	test pit LNG plant
TPNB	test pit Nova Betano





### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

#### Abbreviations (cont'd)

TPNC	test pit Nova Beaco
TPNV	test pit Nova Viqueque
TPRB	test pit refinery Betano
TSS	total suspended solids
<b>U</b>	
UNTAET	United Nations Transitional Administration in East Timor
US EPA	United States Environmental Protection Agency
USAID	United States Agency for International Development
<b>V</b>	
VOC	volatile organic compound
<b>W, X, Y, Z</b>	
WA	Western Australia
WHO	World Health Organisation

#### Report Conventions

kangkung	An Asian leaf vegetable, known in English as water spinach
slickenside	A polished, striated rock surface caused by one rock mass sliding over another in a fault plane.
the Beaco development	the four components of the project proposed at Beaco i.e., the LNG plant, Nova Beaco, Nova Viqueque and the upgrade to the existing Viqueque Airstrip
the Beaco development area	the boundaries of the four components of the Beaco development
the Betano development	the two components of the project proposed at Betano i.e., the refinery and petrochemical facility and Nova Betano
the Betano development area	the boundaries of the two components of the Betano development
the project	The Tasi Mane – Betano Refinery and Beaco LNG Plant project. <i>(NB. the wider Tasi Mane project includes the proposed Suai supply base and associated developments, which are not part of this study)</i>
the proponent	Secretaria de Estado dos Recursos Naturais (SERN)
the study area	the Betano development area, the Beaco development area and any buffer areas defined in the individual environmental specialists studies
Timor-Leste	The Democratic Republic of Timor-Leste
waste	Any substance or solid, liquid, gaseous or radioactive matter from the activities of individuals, public or private institutions which causes change when discharged into the environment.



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# Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

## Strategic Environmental Impact Assessment

### EXECUTIVE SUMMARY



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

---

## EXECUTIVE SUMMARY

### Overview

The Government of the Democratic Republic of Timor-Leste (GoTL), through the Secretaria de Estado dos Recursos Naturais (SERN) has commissioned a study to assess the likely environmental and social impacts of the possible development of a petroleum refinery and petrochemicals complex near the town of Betano, and an LNG Plant near the town of Beaco; both located on the south coast of Timor-Leste.

This proposed development forms part of the strategic vision for the nation and is central to securing new commercial and industrial activities that can contribute to sustainable social and economic growth for Timor-Leste (Strategic Development Plan (SDP) 2011-2030).

The implementation of this vision starts with the Tasi Mane project - a collection of three, shore-based petroleum-related facilities that are of strategic importance to the GoTL. The SDP identifies the careful management of the petroleum sector as a key source of the nation's future development:

*'This sector is critical not only to our economic growth and strength, but also to our future progress as a successful, stable nation. While developing the sector, we must ensure that Timor-Leste's natural resource wealth is used to build our nation and support our people.'*  
(SDP, 2011).

The Tasi Mane project is intended to facilitate the onshore processing of gas and condensate reserves in the Timor Sea and comprises (Figure ES-1):

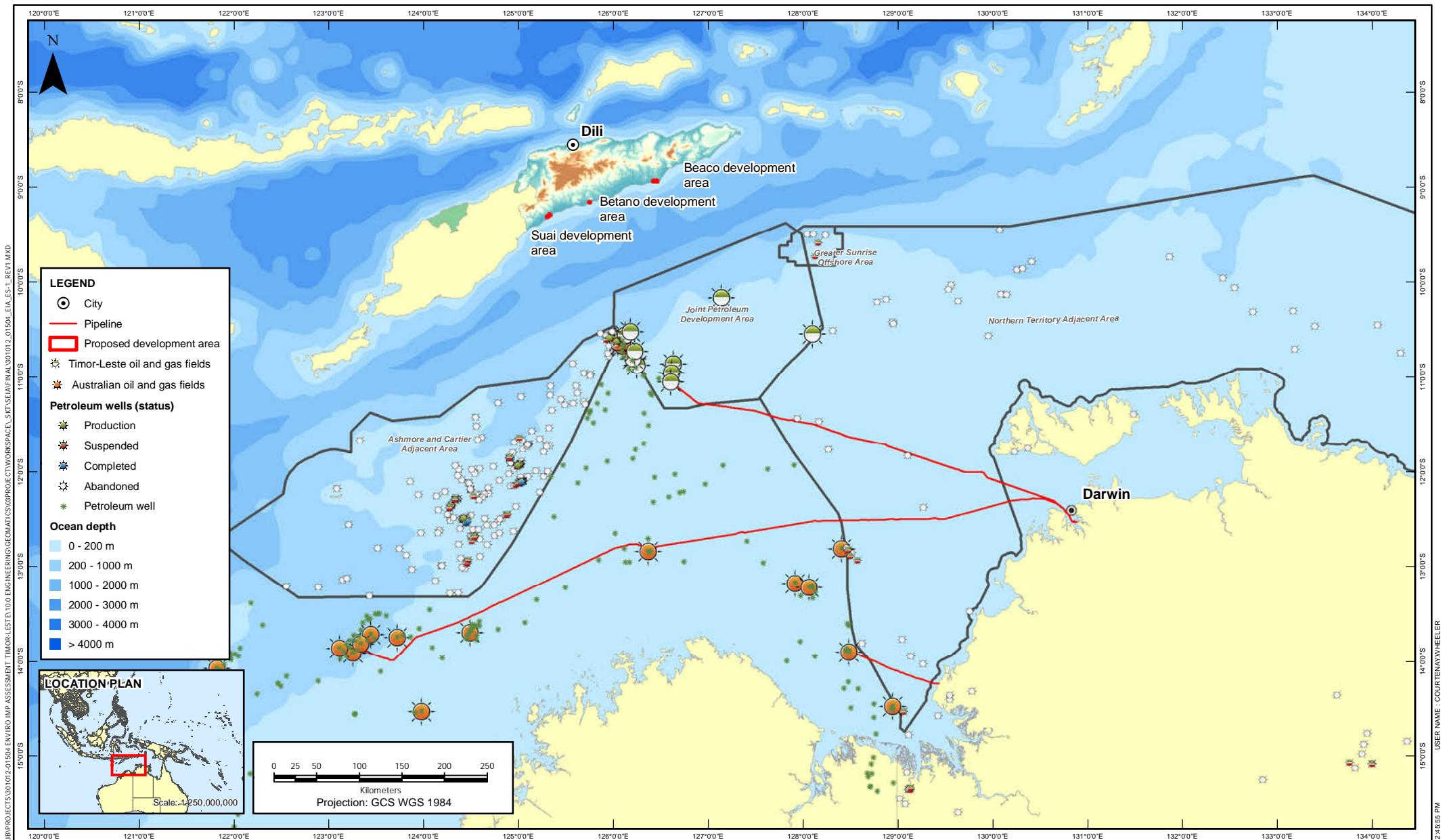
- Suai Supply Base.
- Betano Petroleum Refinery and Petrochemicals Complex.
- Beaco LNG Plant.

For each site, there are additional facilities planned including new towns to accommodate the workforce and some relocated local residents and, upgrades of existing airstrips.

This document relates to the planned development of the Betano Petroleum Refinery and Petrochemicals Complex and the Beaco LNG Plant. A separate environmental impact statement has been prepared for the Suai Supply Base.

For clarity, the executive summary has been divided into three sections:

- Common sections that apply equally to all sites such as the introduction, the role of government, stakeholder consultation and the environmental management framework.
- A summary of the study of the Betano development area.
- A summary of the study of the Beaco development area.



NOTES:  
 This map consists of:  
 1. DEM: SRTM (2011)  
 2. Petroleum wells: Department of Mines and Petroleum, Western Australia

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TASI MANE PROJECT - BETANO AND BEACO  
 STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

**Figure ES-1**  
 Petroleum developments in the Timor Sea

LOCATION: \\PERIODIC\IT\INFOTRUB\PROJECTS\301012-01504\ENV\RO-IMP-ASSESSMENT\TIMOR-LESTE\100-ENGINEERING\GEM\TAS\TASI\USE\FINAL\301012-01504\_EIA\_ES-1\_REV1.MXD  
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**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
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## **This Strategic Environmental Impact Statement**

This strategic environmental impact statement is based on engineering design studies that are, in part, conceptual in nature or entirely absent hence, as detailed design proceeds, much of the project description on which the predicted impacts are based could change. In some instances, generic information has been used to guide field studies and to inform the discussion to at least provide an indication of the scale and type of development that may eventually occur when the projects do proceed.

*As a result, this strategic environmental impact assessment statement should be regarded as preliminary in nature as it is expected that, as detailed design proceeds, further studies and consultation with the affected communities will be required and some of the conclusions reported herein, will also change.*

Nevertheless, we can state with confidence that the majority of the *types* of environmental and social impacts are reasonably predictable although, some variances in the quantum and location of these predictions are inevitable subject to:

- The provision of information relating to the key infrastructure proposed, scale and production technology.
- The inclusion of additional, project-related works such as quarries, laydown areas, temporary accommodation camps, dredging areas and dredge spoil dumps.
- The accumulation of seasonally-based or long-term data.
- The passage of time.
- Probable changes in the actual plant design or product mix compared to those that form the basis of the study.

What is most likely to vary is the actual scale and location of those impacts and, for this reason, a quantitative assessment could not be undertaken. For example, the amount of groundwater consumed, actual area of vegetation clearance, estimated emissions of noise, dust or greenhouse gases or, changes to the number of vehicles on the local road system.

*It is expected that, once commercial arrangements have been finalised and the project design progressed sufficiently, a separate environmental impact assessment will be carried out.*

## **The Role of Government**

Unlike the Suai Supply Base, where the GoTL is the project proponent, it is expected that development of the petroleum refinery and LNG plant will be commercial ventures operated by private companies. At this stage, neither the proponent nor the development timetables have been confirmed.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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There are two principal laws governing the development of the Betano and Beaco sites; one relating to the environmental impact assessment and the other relating to licensing of the downstream petroleum industry:

- Environmental Decree Law No.5/2011. Under Part V, Annex 1, Category A projects defined by the decree law require an environmental impact assessment. For the Betano and Beaco sites, this law has been triggered by:
  - Port and port facilities are of a scale > 500 gross tons.
  - Storage sites for oil, natural gas, petrochemicals or chemicals  $\geq 1,000,000$  L.
  - Oil and gas refineries.
- Decree Law 1/2012 on the downstream sector. Under this law, it is anticipated that a single licence application will be made to cover the Betano petroleum refinery and petrochemical complex, and the Beaco LNG plant and jetty.

In addition, port licences will need to be granted under Decree Law 3/2003 prior to the commencement of construction and other sundry approvals may be required.

### Stakeholder Consultation

In the two project areas, the stakeholder consultation process has commenced with district, subdistrict and local village leaders; however, to date, there has been little more widespread engagement with the affected communities within the project area and their understanding of the proposals is limited.

Stakeholder consultation is no less important at these sites as it is at Suai and the amount of consultative effort applied to Suai simply reflects the immediate priorities of development of the three sites. Effective stakeholder consultation is a crucial component of work on the project to ensure that the proposed works are understood and any concerns addressed. It is expected that the consultation program in the Betano and Beaco development areas will be expanded as part of the future EIA once commercial arrangements are at a more advanced stage.

The limited stakeholder consultation for Betano and Beaco that has been conducted to date has been led by SERN and has largely been aimed at informing community leaders about the nature and location of the planned development. The involvement of senior members of the GoTL, including the Prime Minister, in stakeholder consultation undertaken to date provides an indication of the importance placed on the project by the government. It is recognised that the consultation process for the Betano and Beaco sites has not been as thorough as what has been undertaken at Suai due to the project's construction timeline, with both the Betano Petrochemical Complex and the Beaco LNG Plant to be built after the Suai Supply Base.

Feedback from the consultation program to date reflects some community support for the project, particularly, the potential for jobs for local residents. However, it was also clear that very little was known about what was planned at either site which has heightened concern about who would be affected.





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### Betano Petroleum Refinery and Petrochemicals Complex

#### Project Description

Located on the coast in the Manufahi District, approximately 70 km south of Dili and 5 km to the east of the Rio Caraulun, the proposed Betano Petroleum Refinery is expected to produce approximately 30,000 BPD of petroleum products from petroleum condensate piped to site from gas fields in the Timor Sea (see Figure ES-2).

The refinery and petrochemical complex will convert condensate to a range of fuels and other products; however, the actual product range and expected rate of production across that range has not been confirmed.

Development of the refinery will be supported by construction of a new town, Nova Betano which will house up 14,500 staff, contractors and their families and cover an area of approximately 1,065 ha. The town area will include schools, hotels, commercial areas, recreation facilities and ancillaries such as water, waste, sewage and power plants. The existing Betano airstrip will be upgraded to the status of regional airport with a new runway and terminal facilities.

Nova Betano is located approximately 7 km inland of the sea adjacent to Rio Caraulun (see also Figure ES-2).

#### Existing Environment

##### Climate and Meteorology

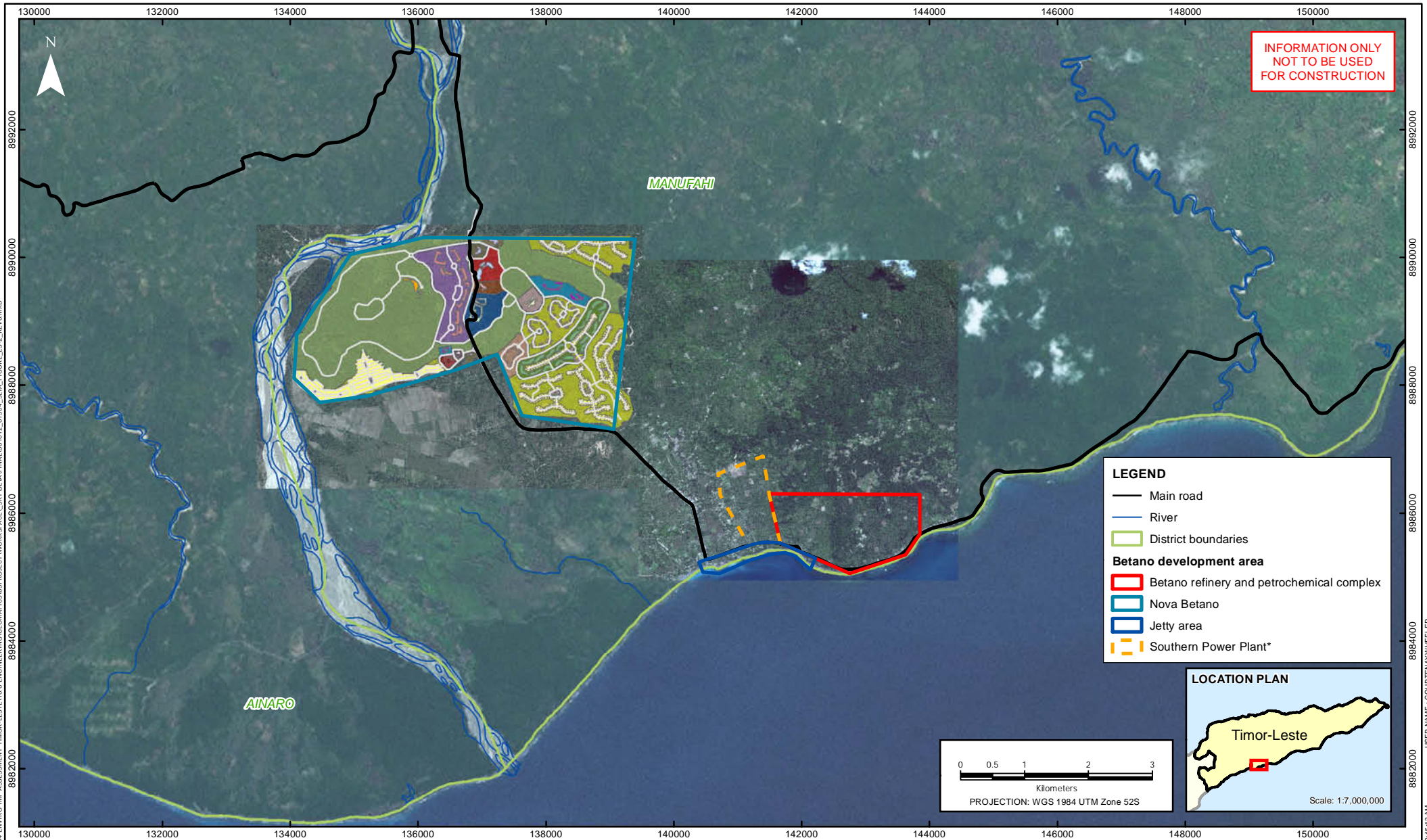
The project area has a typical tropical monsoonal climate with distinct wet and dry seasons. Seasonal variation in temperature is minimal, with the diurnal temperature variation often greater than the seasonal variation. Daytime temperatures are typically in the low to mid 30's and night-time temperatures are in the mid 20's. Humidity is consistently high, typically above 75% and ranging up to 85% while mean annual rainfall in the area is 1,387 mm with the lowest monthly rainfall occurring during the months from August to November. Long-term multi-year rainfall trends are generally dictated by El Niño / La Niña effects; however, shorter-term annual rainfall patterns are monsoonal in nature experiencing a 7 to 9 month wet season with two peak months, December and May (CSIRO, 2010).

Little historic wind speed and wind direction information was available therefore, generalised trends cannot be determined at this time. Since 1920, two cyclone events have been reported to be within 100 km of the Betano study area and an additional nine cyclone events within 200 km.

##### Land Use and Visual Amenity

The project area comprises a mosaic of rural subsistence farms serviced by a small network of roads and tracks. In some hilly areas, the farmland has been terraced. Where they occur, villages and towns are clustered around the inter-regional roads while scattered housing is also prevalent. A variety of animals (chickens, pigs, cattle and goats) and food crops (corn, cassava, peanuts, long beans, papaya, watermelon and bananas) are raised. Trees such as mango, coconut, teak, kapok, sago and banana are also farmed and artisanal fishing in the sea is common.





NOTES:  
This map consists of:  
1. Imagery: DigitalGlobe (2008-2011)  
2. Imagery: Google Earth (2010)  
3. Rivers: Geographic Information Group TimorLeste (2010)  
4. Roads: DivaGIS (2010)  
5. Town layouts: RDTL (2011)

\*Not part of this scope  
\*\*Detailed layouts are included in Figures 4-1 and 4-2

0	30/05/2012	FINAL FOR ISSUE	CW	MW	CS	-	GH		A4 SHEET	SCALE 1:80,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
										Copyright © WorleyParsons Services Pty Ltd

TASI MANE PROJECT - BETANO AND BEACO  
STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

**Figure ES-2**  
Betano development area

USER NAME: COURTNEY WHEELER  
PLOT DATE & TIME: 30 MAY 2012, 8:45:12 AM



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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The change from the current land use to that proposed for the refinery and the associated works is profound as the only comparable works in Timor-Leste are parts of the urbanized areas of Dili. The new industrial and urban land use planned will replace some current farm and village areas; however, this change is consistent with the objectives of the SDP.

The expected increase in population associated with the Betano development may result in pressure on existing land uses and potentially increase the rate of land degradation (forest clearance, erosion, water harvesting). Management measures to reduce any potentially adverse impacts will require further consideration during the detailed design stage of the project.

Due to the relatively flat topography and the open coastal location, the refinery and petrochemical complex is likely to be highly visible from both higher vantage points and some lower areas (e.g., local roads and settlements) in the immediate vicinity although, the existing vegetation and topography may offer some screening.

The assessment of visual amenity was based on a combination of visual sensitivity, visual impact significance and visual exposure and considered the known attributes of the plant, the current environment and the scale of the development. The significance of the impact of the refinery and petrochemical complex on nearby land users is likely to be significant due to the scale and nature of the proposal, the likely visibility from sensitive receptors. The significance of the impact of Nova Betano is likely to be 'moderately adverse' for local residents and nearby land users.

### **Topography, Geology and Soils**

The geology of Timor-Leste comprises predominantly limestone and metamorphosed sediments overlying ancient Proterozoic basement rocks. Topographically, the project area slopes southwards towards the Timor Sea and merges with a wide, flat, coastal plain on which most project-related facilities are located. The refinery and petrochemical site stretches from the high water mark above the beach, inland along the narrow coastal plain, before intersecting a few low hills which occupy the northern part of the site.

In contrast, Nova Betano (located approximately 5 km northwest of the refinery site) is draped over a pair of prominent hills, bisected by the road to Viqueque and separated by a prominent valley into two sections; Nova Betano East and Nova Betano West. Gradients in Nova Betano are generally moderate to fairly steep.

The refinery and petrochemical site is underlain by the Suai Formation which is comprised of unconsolidated sediments ranging from silts to conglomerates. Construction on the refinery site will need to consider the potential effects of soil shrinkage and swelling on foundation design due to the presence of some clayey horizons. The central core of Nova Betano East is underlain by the Baucau Limestone Formation while the central core of Nova Betano West is underlain by the Bobonaro Scaly Clay Formation. Due to the high proportion of montmorillonite (bentonite) in this formation it is unstable even when vegetated. When covering vegetation is cleared, it is prone to severe erosion. The Nova Betano West site is likely to be experience ongoing problems with slope stability and an alternate site has been recommended.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### Air Quality

The existing air quality in the project area has been sampled and, in the absence of Timor-Leste standards, has been compared against World Health Organisation, US EPA or Australia's National Environment Protection Council (Ambient Air Quality) standards.

The assessment shows that most existing sources of air pollutants (dust particles as PM<sub>2.5</sub> and PM<sub>10</sub> and gases such as nitrogen dioxide, sulfur dioxide and carbon monoxide) originate mainly from human activities such as burning of the vegetation, vehicular traffic and, to a lesser extent, power generation exhausts although, aspects such as total suspended particulates are likely to vary widely during the year due to seasonal effects. Naturally occurring sources of pollutants such as methane emissions from cattle are unlikely to be a significant influence on air quality. Current air quality indicators are, with the exception of Freon 12 (a refrigerant gas), all below the limit of reporting or the assessment criteria set in the standards.

During construction, the exposure of large areas of soil accompanied by vehicular traffic will cause localised increases in airborne dust particles. During operations, the potential impacts of emissions of gaseous pollutants will need to be assessed (including BTEX, VOCs, and NO<sub>x</sub>).

### Noise

The main existing sources of anthropogenic (i.e., caused by human activity) noise in the project area are talking, the play of children, use of power tools, music and electrical generators. Non-anthropogenic sources include the weather (wind, thunder and rain) and animals such as chickens and dogs also contribute to the current noise environment.

Project-specific noise limits have been developed based on the Western Australian Environmental Protection (Noise) Regulations 1997. These limits recognise the need to have varying permissible noise levels depending on the time of day (e.g., to protect sleeping patterns) and the sensitivity of the affected premises (residence, commercial premises or industrial site). Based on the existing background noise levels, the calculated allowable noise levels range from 45 to 57 dB(A)<sub>L<sub>A1</sub></sub> for noise-sensitive sites such as residences to 75 dB(A)<sub>L<sub>A1</sub></sub> for commercial premises and 80 dB(A)<sub>L<sub>A1</sub></sub> for industrial and utility premises.

Computer-based predictions of actual noise emissions from project-related activities at any of these sites are not possible at this point due to the unknown plant design although, the character of the noise will change between construction and operational phases. For example, construction is likely to include impulsive sounds such as pile-driving and will largely be confined to daylight hours.

Operational noise will be continuous and largely unchanging throughout the day except during periodic shutdowns for maintenance.

### Hydrology, Drainage and Water Quality

The refinery site itself is situated within the Clere and Belulic Hydrologic Unit and is situated 5 km east of the largest river in the catchment, the Rio Caraulun, which has a catchment of approximately 554 km<sup>2</sup>. Within the Rio Caraulun catchment, the mean annual streamflow is 385,000 ML while mean annual irrigation demand- the main source of water consumption- is only 33,000 ML.





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Estimated peak flows on the Rio Caraulun are expected to have 10-year average recurrence intervals (ARI) rates of 800 m<sup>3</sup>/s and 1,502 m<sup>3</sup>/s for a 100-year ARI.

Surface waters are suitable for human consumption; however, water quality varies widely during the year due to changes arising from sometimes intense seasonal rainfall.

### Hydrogeology

In the project area, at a regional scale, groundwater recharge occurs in the Ramelau mountain range to the north and generally flows southwards towards the Timor Sea where it discharges through the unconsolidated sediments of the Suai and Dilor formations.

Groundwater is the principal source of drinking water in Timor-Leste and natural groundwater springs are the dominant sources of water supply in rural areas, supplying potable water to approximately 60% of the population (ADB, 2001). Shallow wells (2 to 10 m) are used extensively in villages such as Betano and other rural areas; especially those near the sea or on river plains.

The Clere and Belulic hydrological region is estimated to have a total AGWR budget of 26 million m<sup>3</sup> while estimated groundwater withdrawals per capita within the Clere and Belulic area were 57 m<sup>3</sup> per year, less than 0.5% of the total water resources per capita (12,486 m<sup>3</sup>; ADB, 2004) in an average year. However, during a dry (1 in 5 low flow) year, groundwater withdrawals can account for up to 1% of total water resources due to limited water availability (7,863 m<sup>3</sup> per year). Within that same hydrologic region, a total sustainable yield of 25.5 M m<sup>3</sup>/year (809 L/s) and a total storage of 6,800 M m<sup>3</sup> were calculated based on an average aquifer extent of 340 km<sup>2</sup> and 100 m in thickness. These values indicate an abundance of groundwater within the region; however, they should be considered very approximate estimates of deep (>100 m) aquifers.

Groundwater samples were analyzed for total dissolved solids (TDS), salinity and turbidity. Results for TDS are all below WHO drinking water guidelines while half of the samples were at, or above, WHO guidelines for turbidity. Turbidity values reported above the WHO guideline value indicate the presence of silt, sand, mud, bacteria and/or chemical precipitates, which may adversely affect water treatment systems, such as sedimentors or gravel filters. It is also important to control turbidity in drinking water supplies for both health and aesthetic reasons (WHO 2011).

### Terrestrial Biodiversity

The coastal plain of southern Timor-Leste has largely been cleared in association with swidden ('slash and burn') agriculture, sandalwood harvesting, plantation estates and timber plantations. Remnant native vegetation exists as highly fragmented and secondary communities. Most of the understory within remnant vegetation and agricultural land is dominated by invasive species, particularly Siam weed (*Chromolaena odorata*) and cogon grass (*Imperata cylindrica*). Grasses are actively farmed by the local communities by grazing cattle, water buffalo, pigs and goats.

Nova Betano is located within an extensive area of secondary moist deciduous forest and a proportion of the western area of the Nova Betano site is relatively undisturbed dense forest although, the majority of the central and eastern area is secondary open forest.

Nova Betano is also adjacent to a government-operated irrigation channel that comprises undisturbed forest in good condition and according to local guides, this area is 'lulik' (sacred). This undisturbed



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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site has a canopy cover of 50% and a well-developed understory. Orchids and stag horn ferns (*Platyserium* sp.) were observed high in the canopy.

A total of 201 species were identified, two of which are listed on the IUCN Red List as Vulnerable; aina (its Tetum name) *Pterocarpus indicus* and sandalwood (*Santalum album*). There are nine major weed species present including Siam weed and cogon grass both of which are recognised as major weeds across all of Timor-Leste. Seven species of reptiles and 40 species of birds were noted, of which, the two most common families were the *Columbidae* (pigeons and doves) and the *Meliphagidae* (honeyeaters). There are also 13 species of mammal and 5 species of bat including Canut's horseshoe bat (*Rhinolophus canuti*) which is listed as Vulnerable on the IUCN Red List, and the little long-fingered bat (*Miniopterus australis*) which is listed as being of Least Concern.

The best means of protecting both commercially valuable species and conservation-significant native species is to situate project facilities in previously cleared land.

### Marine Biodiversity

The southern Timor-Leste coastline consists of a combination of sandy beaches and limestone rock ledges that extend from the shoreline as intertidal reef flat areas that then slope steeply downwards. In some places along the southern coastline, water depths of 200 m can be found less than 1 km offshore.

The sandy beaches at Betano consist of medium to fine sand with silt. During heavy rains, sediments are mobilised from the surrounding catchment and enter the ocean causing large sediment plumes. Related to this phenomenon, the benthic habitat within the study area is dominated by sediment although, some corals and algae in various forms are also present. The greatest diversity of corals was generally found within 3 to 8 m of the surface.

Bottom sediments show little in the way of any contaminants compared to ANZECC/ARMCANZ (2000) criteria. Concentrations of total nitrogen and phosphorus were relatively high in coastal sediments and have been interpreted as being of organic origin.

With respect to water quality, results collected during the field investigation indicate that marine water quality conditions at Betano are generally typical of a tropical marine ecosystem at that time of the year (Kirono, 2010). Few trends in water quality parameters were apparent across sites or between offshore and inshore sites; indicative of well-mixed waters and a relatively constant water quality.

Concentrations of nutrients and metals (total and dissolved) in water samples were generally below levels prescribed in ANZECC/ARMCANZ (2000) although, there were some elevated results for ammonia at all sites and, in several instances, copper.

Construction will unavoidably disturb and alter habitats in some areas of the site. The consequence of these changes are likely to be confined to the jetty footprint and can be minimised by locating the development site in an area where habitats are likely to have a relatively high tolerance to turbidity and disturbance and, lower conservation value.

Operation of the desalination plant is not expected to have any noticeable impacts, provided discharge of brine occurs in deeper waters away from shore. Similarly, suitable treatment of



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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wastewater generated by the refinery should be undertaken prior to any discharge into the marine environment if adverse impacts are to be avoided.

The risks of spills, antifoulant contamination and marine pest incursions can be greatly reduced through the implementation of specific management plans as part of an environmental management system.

### Land Transport

The current poor condition of the existing road network in the project area at both Betano and Beaco reflects the heavy rainfall, low maintenance budgets and the geological conditions on which the roads are built. Within the project area, the major means of transport are buses, trucks, motorcycles and horses. Pedestrian traffic on roadsides and informal tracks is also widespread while cars are relatively uncommon.

A brief transport study has shown that the existing road network will be challenged by the likely increase in heavy vehicle traffic during the construction phase and both light vehicle (predominantly) and heavy vehicles during operations. The current road system will require substantial investment to upgrade existing roads and divert and maintain new roads away from town centres. Drainage management will be a key aspect.

Once construction has been completed, it is thought that the most frequent vehicle trips will be between the new towns and the workplace (i.e., petroleum refinery) and the majority of workers will travel by bus.

### Socio-economic

Socio-economically, if it proceeds, the project will have a profound impact on both the local community and the whole country. With a population of 5,151, the nearest village- Betano- is typical of many south coast villages in that households typically have around 5 members, 41% are aged between 0 to 14 years, they rely on subsistence farming, 60% own a mobile telephone and 34% own bicycles while only 15% owned a motorcycle. Cars are quite rare; only 2% of households owned one. Most people relied on one of the 100 wells in Betano for their drinking water and 94% cooked over a wood fire. Nearly half of the population (47%) aged 5 or older does not have any formal education and less than 1% had a tertiary education. Malaria is common.

The community is generally looking forward to the job creation afforded by the new facilities; however, they have some concern about the influx of outsiders and what the project may bring in terms of competition for jobs, disturbance to sacred sites, loss of agricultural land, changes to transport linkages, communicable disease and competition for available services. All of these aspects will need proactive management in order to minimise any adverse effects.

The likely large-scale relocation of local residents represents the most significant social challenge to both the GOTL and the affected communities.

Economically, the local impacts include financial benefits of a scale unprecedented in the area.



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SECRETARIA DE ESTADO DOS RECURSOS NATURAIS

**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

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**Waste Management**

With the exception of sewage from Nova Betano, the predominant source of all wastes will be gaseous, solid and liquid wastes from the petroleum refinery and petrochemicals plant. These wastes will largely be contaminated by hydrocarbons but, will include inorganic wastes such as mercury, incinerator ash and gaseous wastes emitted to the atmosphere from vehicle exhausts and stationary plants sources such as gas turbines.

The exact volume and inventory of wastes will not be known until the actual plant design of both the refinery and the petrochemicals complex has been confirmed.

A waste management plan should be implemented in accordance with the waste hierarchy of reduce, reuse and recycle.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### Beaco LNG Plant

#### Project Description

The proposed development site is located near the coastal village of Maluru in the Viqueque District approximately 100 km southeast of Dili and will be comprised of four distinct developments (see also Figure ES-3):

- LNG plant and jetty. A single gas train with a capacity of 5 Mtpa.
- Nova Beaco. A new town on approximately 100 ha that can accommodate up to 1,900 residents.
- Nova Viqueque. A new town on a 216 ha site that can accommodate up to 6,400 residents.
- Viqueque Airstrip upgrade.

Each of the new towns will have a commercial centre, recreation facilities, schools and civil infrastructure such as water, waste, power and sewage plants while the currently abandoned Viqueque airstrip will be upgraded to the status of regional airport with a new runway and terminal facilities.

The LNG plant is expected to be expanded with the addition of successive 5 Mtpa trains to a total capacity of 20 Mtpa at some point in the future.

#### Existing Environment

##### Climate and Meteorology

The climate at Beaco is broadly similar to Betano; however, the Beaco/Viqueque region often receives far more rainfall than other lower-lying regions on the southern coast, including torrential rain events. Mean annual rainfall is 1,879 mm and, on average, six months of the year it receives more than 100 mm of rain per month.

A more extensive (range of parameters and duration) meteorological data set will be beneficial to future mathematical modelling of air quality and noise emissions.

##### Land Use and Visual Amenity

Currently, Maluru village and various scattered houses are situated within the proposed area of the LNG plant while land use within the areas proposed for Nova Beaco and Nova Viqueque comprises grazing land, plantations and scattered farm houses. These houses and towns are connected by a small network of roads and tracks. Where they occur, villages and towns are clustered around the inter-regional roads and farming in the area typically involves a variety of animals (chickens, pigs, cattle and goats) and food crops (corn, rice, cassava, coconuts and bananas). Trees such as teak, rosewood and sandalwood are also farmed and artisanal fishing is common.

The change in land use will be profound and permanent as there is no comparable type of development anywhere in the region. Some ameliorative work could be used to soften the change in viewsheds (e.g., screen planting) nevertheless, the rising ground to the north and the size of the likely developments means that the developments will be readily visible from many vantage points.







## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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The significance of the impact of the LNG plant on nearby land users is likely to be significant due to the scale and nature of the proposal. The significance of the impact of Nova Beaco and Nova Viqueque is likely to have been 'moderately adverse' on nearby land users.

### Topography, Geology and Soils

The topography of the project area slopes southwards towards the Timor Sea and merges with a wide, flat, coastal plain on which most project-related facilities are located. The LNG plant site stretches from the high water mark above the beach, inland (northwards) along the coastal plain, before intersecting a few low hills which occupy the central and northern parts of the site. These low hills, with gentle to moderate gradients, coincide with a change in the geology. Nova Beaco, located about 1 km to the east of the LNG Plant site, occupies a comparable position in the landscape.

In contrast, Nova Viqueque (located approximately 6 km north-west of the LNG Plant site) is draped over a prominent set of ridges dissected by incised valleys. Gradients in this area range from moderate to steep, with many landslips in evidence.

At the LNG Plant site and Nova Beaco, the coastal plain is underlain by the Suai Formation, with the hills emerging to the north comprising the Baucau Limestone Formation. The limestone is; however, generally overlain by clay washed down from the higher-lying Bobonaro Scaly Clay Formation to the north.

The eastern two-thirds of Nova Viqueque are underlain by the Bobonaro Scaly Clay Formation, whilst most of the western third is underlain by the Viqueque Formation. The lower south-western corner of this site extends onto the coastal plain, which is underlain by the Suai Formation. Gradients at Nova Viqueque are typically fairly steep and, as a result of this and the Bobonaro Scaly Clay Formation, this site will, in all likelihood, be permanently plagued by geotechnical problems and development of this site should be reconsidered. Nova Viqueque, as well as the upper reaches of Nova Beaco and the LNG site, are potentially vulnerable to soil erosion.

The soil test results from the LNG plant site and Nova Beaco indicate consistently alkaline pH values and very low moisture, electrical conductivity and nutrients including total organic carbon in all samples. These results are consistent with coarse-textured, non-saline, low productivity soil developed on calcareous parent materials. Soils from Nova Viqueque are similar but, have a higher moisture content.

Additional challenging soils may also be present as acid sulphate soils and karstic limestones are also present and will need further investigation. No evidence of soil contamination was found.

### Air Quality

The existing air quality in the project area has been sampled using the same study methods at Betano and showed that all measured indicators were well below the referenced air quality benchmarks. Across the study area, particularly around Viqueque, most pollutants originate from vehicular traffic and, to a lesser extent, smoke produced from refuse disposal.

During construction, the exposure of large areas of soil accompanied by vehicular traffic will cause localised increases in airborne dust particles. During the operational phase, dust emissions will



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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diminish and the emission of pollutant gases arising from fixed or mobile plant and equipment (power generation and vehicles) will take on a greater significance.

#### Noise

The main existing sources of anthropogenic noise in the project area are motor vehicles. Using the same study methods as at Betano and based on the existing background noise levels, the calculated allowable noise levels range from 45 to 49 dB(A) $L_{A1}$  for noise-sensitive sites such as residences to 75 dB(A) $L_{A1}$  for commercial premises and 80 dB(A) $L_{A1}$  for industrial and utility premises.

Computer-based predictions of actual noise emissions from project-related activities at any of these sites are not possible at this point due to the unknown plant design although, the character of the noise will change between construction and operational phases.

#### Hydrology, Drainage and Water Quality

The proposed site for the Beaco LNG Plant is located within the Irabere Hydrologic Unit and approximately 2 km to the east of the Rio Cuha. It is traversed by three minor waterways (Ribeira Buaran, Ribeira Benaro and Ribeira Beaco). Nova Viqueque is located approximately 10 km inland on the banks of Rio Cuha, which has a catchment area of 268 km<sup>2</sup>.

Within the catchment, the mean annual streamflow is 198,000 ML while mean annual irrigation demand- the main source of water consumption- is only 12,000 ML.

Estimated peak flows on the Rio Cuha are expected to have 10-year average recurrence intervals (ARI) rates of 750 m<sup>3</sup>/s and 1,370 m<sup>3</sup>/s for a 100-year ARI.

Surface waters are suitable for human consumption; however, water quality varies widely during the year due to changes arising from sometimes intense seasonal rainfall. Water sampling indicated elevated levels of nutrients, biological oxygen demand and pathogens and has been attributed to agriculture and human occupation.

Due to the low-lying nature of the terrain, the Beaco study area is defined to be in a high flood risk region.

#### Hydrogeology

At a regional level, the circumstances of Betano and Beaco project areas are very similar in that groundwater resources are generally abundant and are used by the local populace as a source of potable water. Estimates of groundwater withdrawals per capita within the Clere and Belulic area were 57 m<sup>3</sup> per year, less than 0.5% of the total water resources per capita (12,486 m<sup>3</sup>; ADB, 2004) in an average year.

Groundwater samples were analyzed for total dissolved solids (TDS), salinity and turbidity. Results for TDS are all below WHO drinking water guidelines while the majority of samples were at, or above, WHO guidelines for turbidity. Turbidity values reported above the WHO guideline value indicate the presence of silt, sand, mud, bacteria and/or chemical precipitates, which may adversely affect water treatment systems, such as sedimentors or gravel filters. It is also important to control turbidity in drinking water supplies for both health and aesthetic reasons (WHO 2011).





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### Terrestrial Biodiversity

The proposed site of the Beaco LNG plant lies on a coastal plain largely cleared for grazing, agriculture, teak and coconut plantations. The low lying coastal plain area is often inundated during the wet season. Remnant vegetation in this area exists as a narrow strip of coastal vegetation and small areas of coastal mangroves, riparian mangroves and remnant moist deciduous forest along the eastern boundary. Remnant moist deciduous forest comprises the western portion of the Nova Beaco site.

Nova Viqueque is situated on rolling hills with some limestone outcropping visible. Vegetation is largely cleared for agriculture and grazing and remnant vegetation exists as patches of very open secondary vegetation or scattered trees on hill tops and along drainage lines.

In the Beaco LNG Plant area a single coastal mangrove community was recorded as well as two areas of riparian mangrove communities on estuarine rivers. In addition to this, secondary vegetation there is characterised by very open 'regrowth' forest, over grassland and introduced weed communities. This community is common in the area and results from repeated cycles of swidden agriculture. Most trees are deciduous at the end of the wet season. Dominant trees include *Borassus flabellifer*, *Corypha utan*, *Schleichera oleosa* and *Ziziphus mauritiana*.

Two Vulnerable listed flora species were recorded in the Beaco development areas, *Pterocarpus indicus* and *Santalum album*. Thirteen species were identified in the Beaco development area as having local and economic importance and nine major weed species. Siam weed (*Chromolaena odorata*) is the most widespread.

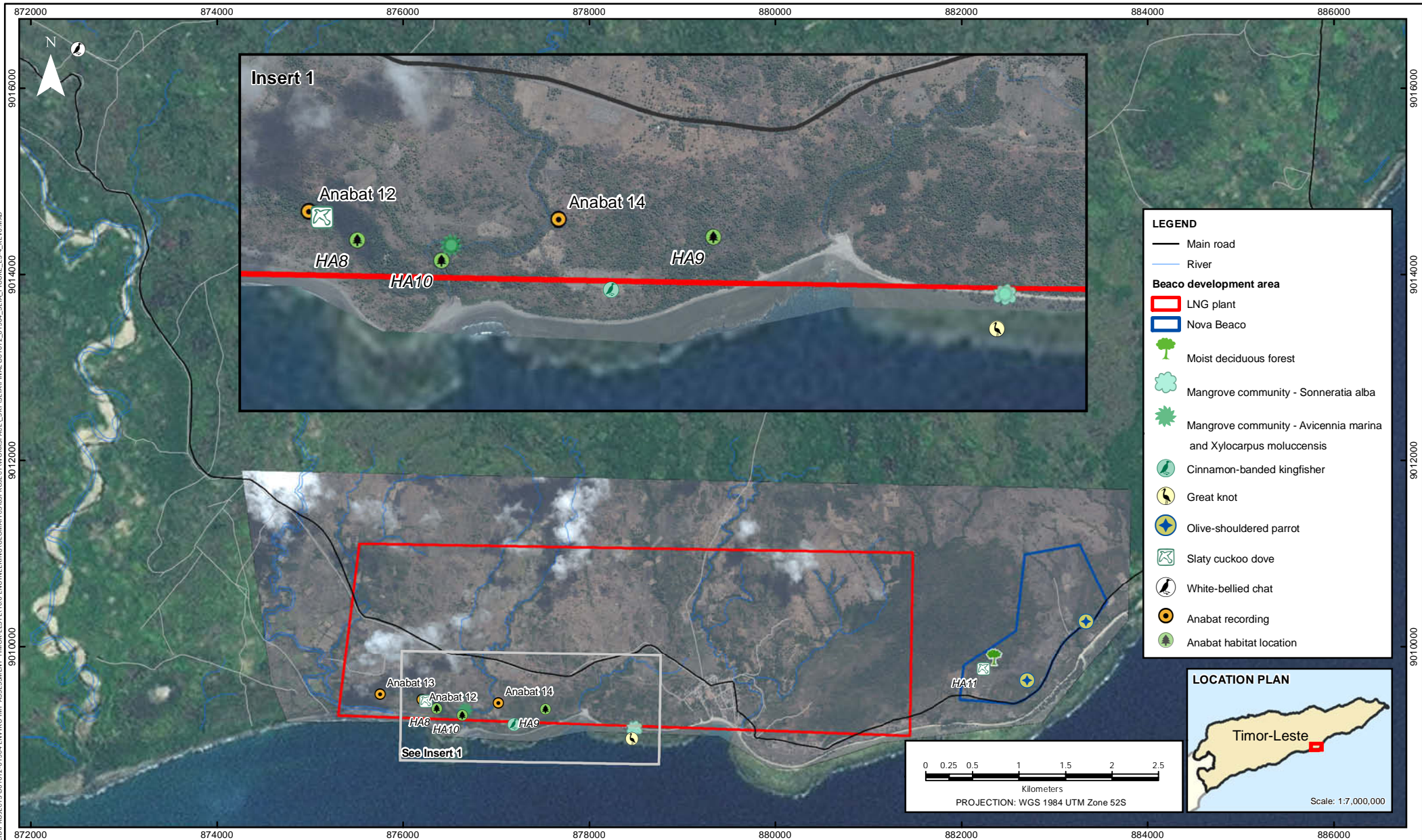
Within the Beaco development area, a total of 80 vertebrate fauna species were recorded, including 2 species of amphibians, 9 species of reptiles, 59 species of birds and 10 species of mammals. Of the 10 mammal species, five species were bats, including Canut's horseshoe bat (*Rhinolophus canuti*) which is listed as Vulnerable on the IUCN Red List. Six species of conservation significance were recorded in the Beaco development area, while 29 other species that either had the potential to occur, or had been previously recorded, in Timor-Leste were noted as either being 'Likely', 'Possible' or 'Unlikely' to occur in the development area (Figure ES-4).

### Marine Biodiversity

Within the Beaco study area, algae, coral and invertebrates made up the biotic benthic community, which were primarily associated with hard substrate. The fringing reef identified adjacent to the Beaco study area is typical of the fringing reef systems found in South East Asia (Burke et al. 2002). The reef generally consisted of a low diversity reef flat which falls steeply into deep water. The greatest coral diversity was generally found within 5 to 8 m of the surface.

Similar to Betano, water quality sampling at Beaco indicates well-mixed water and relatively constant water quality. Ammonia and copper are again elevated compared to ANZECC/ARMCANZ (2000) standards whereas all other indicators are below them.

Sedimentary metal concentrations were generally below the ANZECC/ARMCANZ (2000) sediment quality guidelines with the exception of nickel which was just above the guideline value. Hydrocarbon levels in sediments were very low.



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NOTES:

This map consists of:

1. Imagery: Digital Globe (2008-2011)
2. Rivers: Geographic Information Group TimorLeste (2010)
3. Roads: DivaGIS (2010)
4. Vegetation communities: WorleyParsons (2012)

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**Figure ES-4**  
Beaco study area biodiversity key sites



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Similar to Betano, it is not possible at this point to quantify the impacts associated with development of either the onshore facilities via marine discharges or direct impacts associated with establishment of the materials offloading facility (MOF).

### Socio-economic

Overall, the expected socio-economic impacts arising from the development of the LNG plant are as profound for Beaco and Viqueque as the petroleum refinery is to the area around Betano.

The two villages that will be most affected by the developments are Uma-Uain Craik (population 2,787) and Maluru (population 678) (Census 2010). The number of households present in Uma-Uain Craik is approximately three times greater than that of Maluru although both had average household sizes of just over five persons.

As for Betano, over 40% of the population in each village is aged between 0 to 14 years and relied on subsistence farming, the majority of households owned a mobile telephone, around 10% owned a motorcycle while car ownership remained a rarity (3%). Unusually, only 27% of households in Uma-Uain Craik grew crops.

Between 40% and 60% of the total population were literate in the two villages (RDTL, 2010).

The most common diseases present in Maluru and Uma-Uain Craik are malaria, tuberculosis, diarrhoea and leprosy

### Waste Management

The predominant source of all wastes will be gaseous, solid and liquid wastes from the LNG plant. These wastes will largely be contaminated by hydrocarbons but, will include inorganic wastes such as mercury, incinerator ash and gaseous wastes emitted to the atmosphere from vehicle exhausts and stationary plants sources such as gas turbines and the acid gas removal unit. Significant volumes of sewage will also be generated from the new towns.

A waste management plan should be implemented in accordance with the waste hierarchy of reduce, reuse and recycle.

### Environmental Management Framework

Integral to the SEIA process has been the identification of the likely adverse impacts on the existing environment and community and specific measures to avoid, manage and mitigate those impacts. This assessment has been limited to the consideration of generic impacts associated with a petroleum refinery and LNG plant of a similar size and hence, the framework has been developed commensurate with the current level of knowledge. When the final EIA is prepared, this framework will be further refined and specific management measures, in the form of an environmental and social policy, environmental management plans, work instructions and monitoring programs will be developed.

Implementation of the management framework will see a regular program of monitoring against defined standards, auditing to confirm compliance and opportunities for improvement and, reporting to GoTL regulators and community stakeholders. A key component of the framework will be the preparation of a range of environmental management plans that will include diverse topics such as air





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quality management, groundwater management, chemical management, employment and training, stakeholder engagement, traffic management and, water (both surface and groundwater). These plans will be the key management mechanism to ensure that the issues identified during the environmental impact assessment process are managed effectively into the future.

For both the Betano refinery and the Beaco LNG plant the likely program of monitoring would include: dust particulates, air quality, noise, community attitudes, water quality (surface and groundwater) and biodiversity.





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# Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

## Strategic Environmental Impact Assessment

### CHAPTER 1 INTRODUCTION



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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## 1. INTRODUCTION

### 1.1 Context

The Government of Timor-Leste (GoTL), through the Secretaria de Estado dos Recursos Naturais (SERN), proposes to facilitate development of oil and gas resources in the Timor Sea. This proposed development forms part of the strategic vision for the nation and is central to securing new commercial and industrial activities that can contribute to sustainable social and economic growth for Timor-Leste (Strategic Development Plan (SDP) 2011-2030).

The implementation of this vision starts with the Tasi Mane project - a collection of three, shore-based petroleum-related facilities on the south coast of Timor-Leste. The SDP identifies the careful management of the petroleum sector as a key source of the nation's future development: *'This sector is critical not only to our economic growth and strength, but also to our future progress as a successful, stable nation. While developing the sector, we must ensure that Timor-Leste's natural resource wealth is used to build our nation and support our people.'* (SDP, 2011).

The Tasi Mane project will establish industry 'clusters' at three locations shown in Figure 1-1:

1. A supply base industry at Suai;
2. A refinery and petrochemical complex at Betano; and
3. A liquefied natural gas (LNG) plant at Beaco.

The Suai component does not form part of this study and has been assessed separately.

### 1.2 Project Outline

The scope for this study is the Betano and Beaco components of the Tasi Mane project, herein referred to as the Tasi Mane – Betano and Beaco Project (the project):

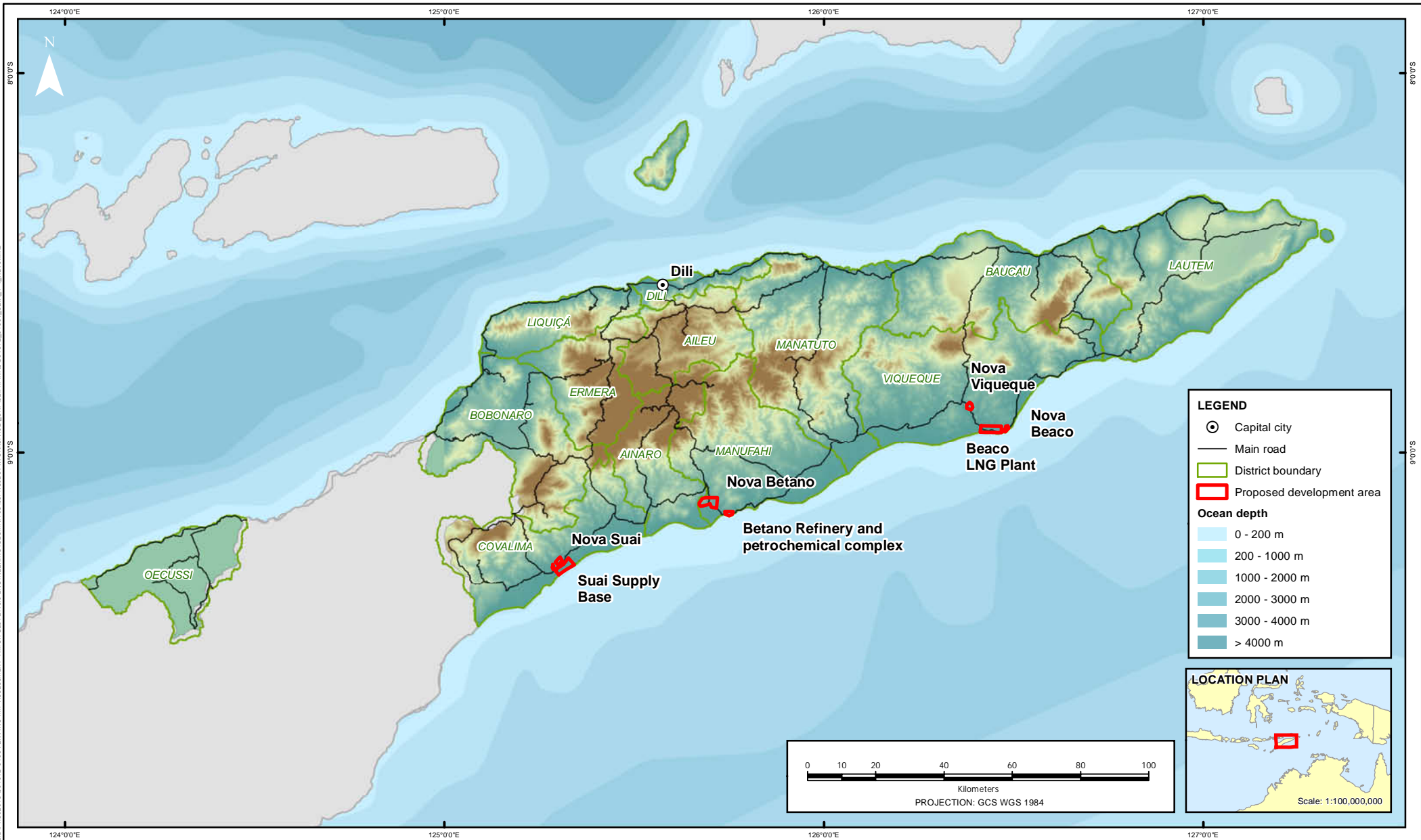
**Betano** (the Betano development area):

- A petroleum refinery and petrochemical complex.
- A new town, Nova Betano, to accommodate the workforce and some relocated local residents.

**Beaco** (the Beaco development area):

- An LNG plant and jetty.
- A new town, Nova Viqueque, to accommodate the workforce of the LNG plant.
- A new town, Nova Beaco, to accommodate the workforce of the LNG plant.
- Upgrade to the existing Viqueque Airport.

The proposed aspects at the Betano and Beaco development areas are shown in Figure 1-2 and Figure 1-3 (respectively), and outlined further in Chapter 4 (Project Description).



NOTES:  
 This map consists of:  
 1. Digital Elevation Model: SRTM (2011)  
 2. District boundary's: Geographic Information Group TimorLeste (2010)  
 3. Rivers: Grogaphic Information Group TimorLeste (2010)  
 4. Roads: DivaGIS (2101)

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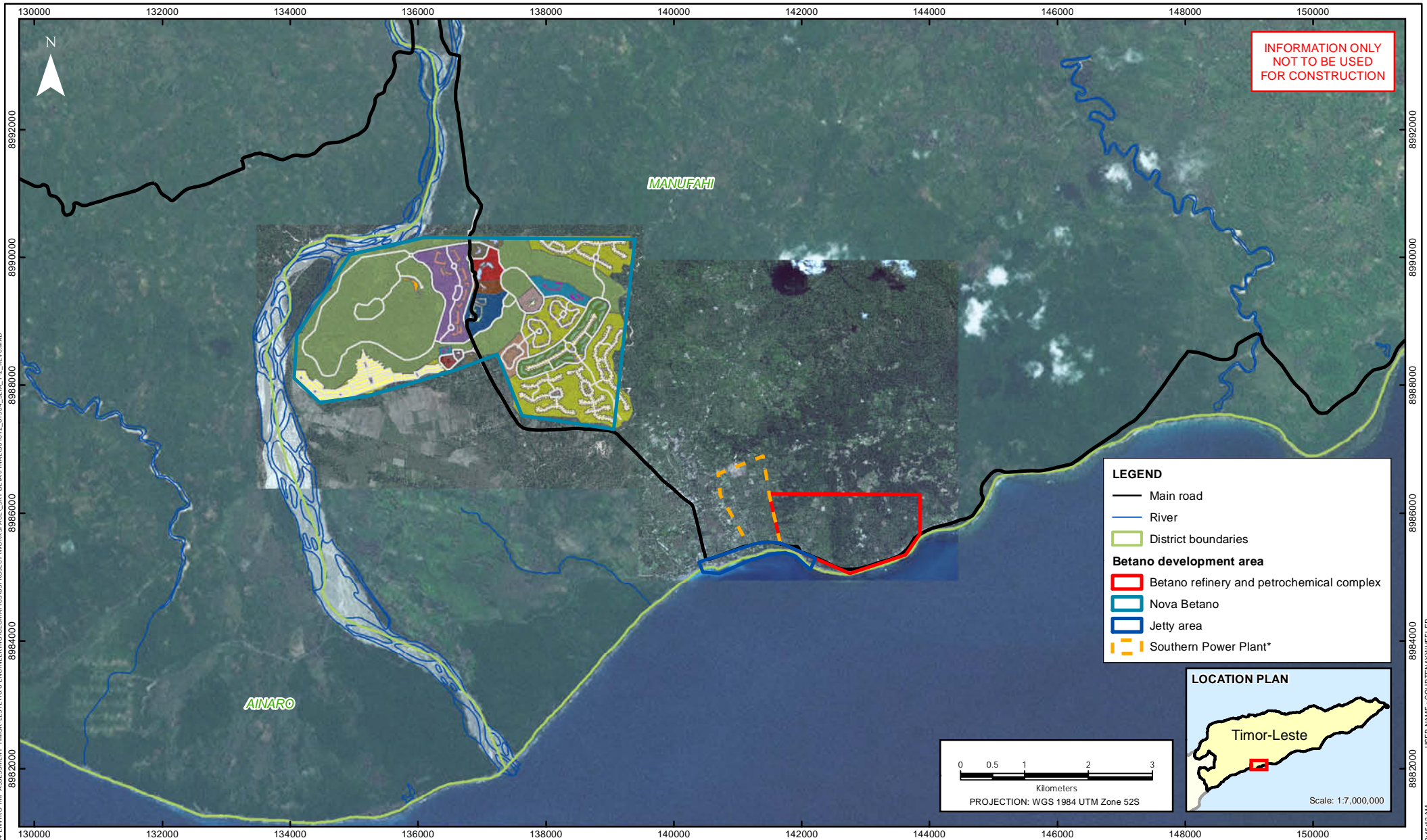
TASI MANE PROJECT - BETANO AND BEACO  
 STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

**Figure 1-1**  
 Tasi Mane Project overview

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NOTES:  
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 1. Imagery: DigitalGlobe (2008-2011)  
 2. Imagery: Google Earth (2010)  
 3. Rivers: Geographic Information Group TimorLeste (2010)  
 4. Roads: DivaGIS (2010)  
 5. Town layouts: RDTL (2011)

\*Not part of this scope  
 \*\*Detailed layouts are included in Figures 4-1 and 4-2

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**Figure 1-2**  
 Betano development area

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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 1.3 This Document

This Strategic Environmental Impact Assessment (SEIA) has been prepared under the Democratic Republic of Timor-Leste (RDTL) Government Decree Law 5/2011 – the legal framework for regulating the environmental impacts of significant projects in Timor-Leste. Section 2.2.1 sets out the regulatory framework and EIA process.

The purpose of this document is to:

- Identify the likely environmental and social impacts associated with the construction and operation of the project (as defined in Section 1.2).
- Inform the detailed design stage.
- Determine the baseline conditions for the physical, biological and social environment at the Beaco and Betano development areas.
- Identify areas or aspects requiring further investigation.

The proposed facilities at Betano and Beaco that are the subject of this report have been assessed by means of a strategic environmental impact assessment (SEIA). The difference in the type of assessment originates in the differences in the amount of available data on the individual project designs at each site, and the nascent state of environmental impact assessment and regulation in Timor-Leste.

SEA extends the aims and principles of EIA to the higher levels of decision-making when major alternatives are still open and there is far greater scope than at the project level to integrate environmental considerations into development goals and objectives. This SEIA study identifies the social, economic and major environmental impacts that are likely to arise from the construction and operation of the project (as far as possible), assesses qualitative environmental impacts of the project on sensitive receptors including communities, and proposes measures for management and mitigation to minimise likely adverse impacts. Where relevant, further work has been identified by each environmental specialist for studies required at the detailed design stage.

### 1.4 Scope

The original commission from SERN was for the preparation of an environmental impact assessment (EIA) to describe the likely environmental and social impacts associated with the Tasi Mane project as a whole. Upon commencement of the study, a detailed review of the available project information revealed that more project information was available for the Suai development than for the Betano and Beaco aspects and it was agreed that differing levels of assessment were necessary.

SERN elected to continue with an EIA for the Suai component; however, took a new approach for the proposed Betano and Beaco developments to assess them separately as a SEIA to reflect the lower level of certainty surrounding the project design and the level of stakeholder consultation undertaken to date.





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Therefore, this document relates to the Betano and Beaco aspects of the Tasi Mane project, as outlined in Section 1.2 above. A copy of the original terms of reference for tender ID ICB/016/MNR-2011 is in Appendix A.

### 1.5 Document Structure

This document has been structured to describe the new, project-related facilities and their likely impacts-positive, neutral or negative-on the existing environment (including the community, the natural environment and local cultural heritage) in the context of prevailing government policies and law. Chapters 2 to 4 provide the context and a description of the new facilities while Chapters 5 to 7 describe the various specialist studies that have informed preparation of the document, the environmental management framework and overall recommendations for further work. Recommendations for further work are also included within each of the Chapters from 5 to 7.

The rest of this document is divided into the following chapters:

**Chapter 2: Regulatory Context** - describes the relevant environmental policies, legislation and international conventions to regulate the project, and acknowledges that these policies represent the aspirations of the GoTL and what it aims to achieve for the people of Timor-Leste should the project proceed.

**Chapter 3: Project Setting** - summarises the existing environment of the development areas, which are presented in detail in Chapters 6 and 7.

**Chapter 4: Project Description** - provides a description of the project including infrastructure, their location and an outline of likely construction activities.

**Chapter 5: Stakeholder Consultation** – addresses the requirements for undertaking public consultation under the of Timor-Leste Decree Law No. 5/2011, and sets out the stakeholders and consultation activities that were undertaken for this stage of the project.

#### Chapter 6: Betano Refinery

**6.1 Climate and Meteorology** – provides a baseline (i.e., prior to disturbance by any project-related activity) description of the general climate and meteorological profile of the region in which the project will be located, and determines the general climate and meteorological trends relevant to the project.

**6.2 Land Use and Visual Amenity** – provides a preliminary land use and visual amenity assessment of the project, including a discussion of the local landscape, and a description of the likely land use impact.

**6.3 Topography, Geology and Soils** - provides a preliminary geological assessment including a description of the prevailing topography and geological and soil conditions within the Betano development area.

**6.4 Air Quality** – provides a baseline description of the general air quality in the study area, based on the ambient concentrations of particulates and gas pollutants against the assessment criteria.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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**6.5 Noise** – provides a baseline description of the noise profile for the project, by identifying noise sensitive receptor locations in proximity to the project and conducting baseline monitoring of ambient levels.

**6.6 Hydrology, Drainage and River Water Quality** – outlines the hydrological impact assessment undertaken for the project, including an assessment of the available water resources information, an estimation of the design flows for the streams adjacent to the site, and overview comments on potential water quality impacts and mitigation measures.

**6.7 Hydrogeology** – describes the regional hydrogeology, assesses potential impacts of the project, and possible avoidance, management and mitigation measures.

**6.8 Terrestrial Biodiversity** – outlines the findings of the flora and vegetation assessment, and a vertebrate fauna assessment prepared as part of this study. The full report is presented as Attachment AT01.

**6.9 Marine Ecology** – outlines the findings of the marine ecology assessment, including water and sediment quality, prepared as part of this study. The full report is presented as Attachment AT02.

**6.10 Social and Economic Values** – identifies the social and economic impacts that are likely to result from the project, and considers the residual impacts following recommended management and mitigation measures.

**6.11 Land Transport** – outlines the assessment undertaken to determine the potential impacts on existing land transport links arising from the project including the establishment of the baseline conditions and understanding the way in which anticipated traffic from the development will distribute and affect road transport in the study area.

**6.12 Waste Management** – describes the typical waste management strategies that could be employed for the project, which will generally rely on the development of new facilities and waste management areas.

### Chapter 7: Beaco LNG plant

As for the Betano development area.

**Chapter 8: Environmental Management Framework** – outlines the environmental and social management framework for the project that will be applied throughout construction, commissioning and operation of the project.

**Chapter 9: Conclusions and Recommendations** – provides the overarching conclusions, and recommendations for further environmental studies upon completion of the detailed design stage.

## 1.6 Study Limitations

The RDTL is one of the world's newest countries, officially gaining independence from Indonesia in May 2002. A significant amount of the country's infrastructure was damaged or destroyed during the 1999 conflict that preceded this independence and the reestablishment of government policies, legislation, regulations and regulatory standards is still at an early stage. Redevelopment of key



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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infrastructure (including health, education, drinking water supply, electricity and highways) has commenced under the government's guidance; however, much of this is also at an early stage of development. Similarly, the availability of social, economic and environmental data taken for granted in most western democracies is fragmented, in development, or simply not available. As an example of this, many of the criteria used to assess the significance of project-related impacts are from other jurisdictions.

As a result of these many factors, a number of assumptions have been required in undertaking this study. They are:

- Short timeframe commissioned for the study period;
- Absence of key baseline environmental information and infrastructure details; and
- Early stage of engineering design for the proposed facilities.

Chapter 9 sets out the recommendations for further environmental studies upon completion of the detailed design stage of the project.

### 1.7 Alternatives

The 'Alternatives' section of a SEIA would typically describe the sequential process that was followed to develop, appraise, and eliminate reasonable alternative options for siting and design, and how each compares to meeting environmental standards and minimising harm.

SERN has confirmed that no other suitable alternative locations were identified for siting the proposed Betano Refinery and Petrochemical complex, Nova Betano, or the Beaco LNG Plant and accommodation facilities at Nova Viqueque and Nova Beaco.

### 1.8 Page Numbering

All page numbering of this report uses the following format:

- Chapter–page number e.g., the thirty-second page of Chapter 8 is shown as 8–32.
- Page numbers are located on the left, at the bottom of each page.



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# Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

## Strategic Environmental Impact Assessment

## CHAPTER 2

# REGULATORY CONTEXT



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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## 2. REGULATORY CONTEXT

This chapter describes the government policies, laws and international conventions that are applicable to the project and includes an outline of the country's national guiding principle contained in its constitution, the laws and regulations of the Democratic Republic of Timor-Leste (RDTL) and the relevant international conventions and agreements to which RDTL is a signatory. These policies are important as they represent the aspirations of the Government of Timor-Leste (GoTL) and what it aims to achieve for the people of Timor-Leste should this development proceed, while the laws represent legal constraints for the assessment, operation and administration of the project.

The RDTL is one of the world's newest countries, gaining independence from Indonesia in 2002 and as a result, development of a comprehensive environmental management framework in terms of legislation, regulation and adequately resourced institutions (World Bank, 2009) is in its early stages and continuing.

### 2.1 Constitution of the Republic of Timor-Leste

Timor-Leste's environment and its valuable natural resources (notably oil and gas), represent a potential source of wealth that may support economic growth and community development (RDTL, 2011b). However, the GoTL recognises the need to develop these resources in a sustainable way and still provide a better quality of life for its citizens. The GoTL and the constitution recognise the importance of environmental protection as a fundamental task of the government and as a fundamental right of its citizens. The constitution of Timor-Leste provides the guiding principle for environmental protection in the country. Article 61 of the constitution states:

- Everyone has the right to a humane, healthy and ecologically balanced environment and the duty to protect it and improve it for the benefit of the future generations.
- The State shall recognise the need to preserve and rationalise natural resources.
- The State should promote actions aimed at protecting the environment and safeguarding the sustainable development of the economy.

Furthermore, the constitution states 'the exploitation of the natural resources shall preserve the ecological balance and prevent destruction of ecosystems'.

### 2.2 National Legislation

There is a collection of legislation promulgated by the Indonesian Government, United Nations Transitional Administration in East Timor (UNTAET) and RDTL that applies in Timor-Leste. Of the enacted legislation, there are a number of approvals required before construction and operation of the Betano and Beaco projects can commence. These approvals are outlined below.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 2.2.1 Environmental Law

The legal framework that addresses the constitutional imperative of environmental protection and compliance with international responsibilities is outlined in two laws. The first is a draft base law on environment and the second is a decree law on environmental licensing.

#### **Base Law**

In accordance with the unofficial translation of the draft base law on environment, the purpose of the law is to provide an overarching environmental framework that defines environment policy, guiding principles for environmental protection and conservation and sustainable use of natural resources in order to ensure the quality of life of its citizens.

The draft law requires a strategic environmental assessment before adoption of any policy, legislation, program, plan or project that has the potential to cause impacts on the environment. The strategic environmental assessment must identify, describe and assess the significant environmental effects and ensure integration of environmental values in decision-making procedures. The environmental effects should be avoided, minimised or compensated. The draft law provides no statutory timeframes for submission and assessment of the strategic environmental assessment.

This strategic environmental impact statement (SEIA) has been prepared based on the terms of reference prepared by SERN and in accordance with the draft base law on environment.

#### **Environmental Licensing Law**

The RDTL Government Decree Law 5/2011 on environmental licensing (environmental licensing law) establishes the licensing procedures to be followed to prevent negative impacts on the environment. This is achieved by conducting an environmental assessment and requires the preparation of an environmental impact statement (EIS) and environmental management plan (EMP).

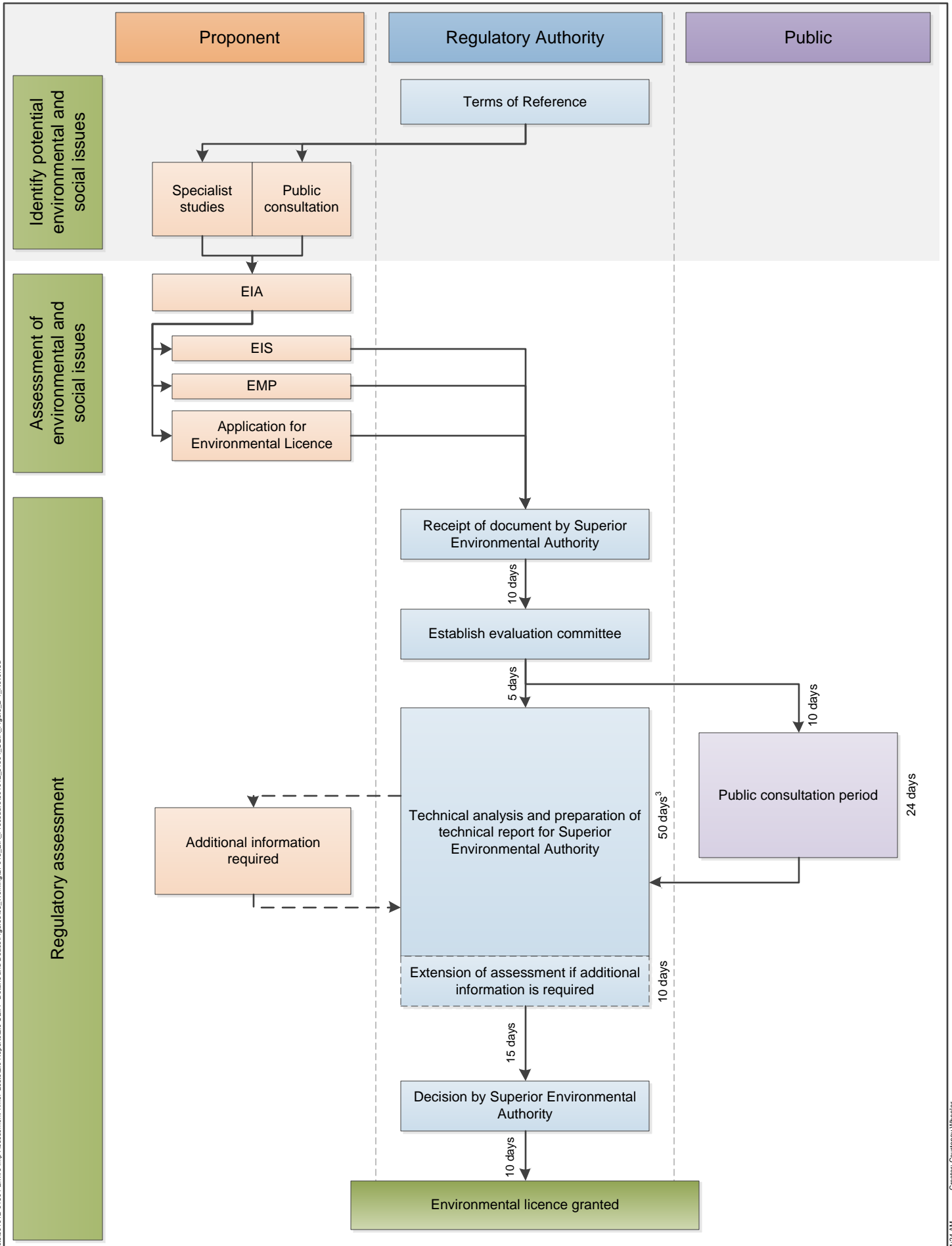
The decree is administered by the Direcção Nacional dos Serviços do Meio Ambiente or National Directorate of Environmental Service (DNSMA). Annex I of the decree specifies triggers for Category A projects – projects that may potentially cause significant environmental impacts. Category A projects require an EIA, and the grant of an environmental licence. The Betano and Beaco projects trigger Category A as they are petroleum projects.

Figure 2-1 shows the EIA process stipulated by the environmental licensing law. In summary, there are four key procedural steps in the grant of an environmental licence:

1. Presentation of the project for evaluation and application for environmental licence.
2. Public consultation.
3. Technical analysis and opinion by the evaluation committee.
4. Decision on the procedure of EIA and allocation of the environmental licence.

The EIS and EMP form the documentation to be presented for evaluation to the environment authority.





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**NOTES:**  
 1 Figure based on an unofficial English translation of Timor-Leste decree law 5/2011 on environmental licencing.  
 2 All time measured in working days.  
 3 A pause will occur in the technical analysis if the proponent is required to provide additional information.

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**Figure 2-1**  
 Timor-Leste environmental impact assessment process for Category A projects

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Within ten days of receipt of the project information, the superior environment authority must establish an evaluation committee whose role will be to manage the public consultation process – a period of 24 days – and subsequently provide technical analysis of the EIS and EMPs. The evaluation committee will formulate their recommendation in a final technical report, for final consideration and decision by the superior environmental authority.

### **EIA Process**

In accordance with international standards, an EIA is defined as the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made (IAIA, 1999). The EIA will determine the positive and negative changes produced in the environmental and social parameters resulting from the project, and analysing this against the existing conditions or the possibility that if the project was not implemented. DNSMA, as the decision maker, will consider the predicted environmental impacts when deciding whether to allow the project to proceed. If the net impact of the project is deemed to be acceptable, the grant of the environmental licence as the legal instrument and written decision gives the proponent the right to proceed with the project.

It is understood the SEIA will be the first step in identifying, describing and assessing high level and significant environmental effects for the Betano and Beaco projects. Given that much of the technical description of the proposed work at Betano and Beaco is either preliminary or simply indicative – from an unrelated project – it is not appropriate or prudent to use this document as the basis of project approvals by the GoTL and has instead, been described as a strategic environmental impact assessment. Only after a detailed project description is provided can a detailed EIS and EMP be produced to support the application for an environmental licence.

The superior environmental authority will either approve or not approve the project and the decision must be published in an official gazette. If the project is approved, the environment licence can then be granted, following submission of a fee. The duration of a licence is two years and can potentially be renewed for another two years.

In addition, the environmental licensing law requires an Impacts and Benefits Agreement (IBA) be developed with the communities located around or near the proposed development whose traditional land use, customs or traditional rights are potentially affected. The IBA is to be negotiated following the approval of the environmental licence.

### **2.2.2 Downstream Sector Law**

Based on the unofficial translation, the Decree Law 1/2012 on the downstream sector regulates activities associated with the supply, processing, transportation, storage, trading and marketing of petroleum, petroleum products and similar products. The Autoridade Nacional do Petróleo or National Petroleum Authority (ANP) is responsible for regulating and supervising downstream activities in Timor-Leste. The decree law requires a licence to be obtained prior to commencing downstream activities. The proponent does not need multiple licences when undertaking more than one downstream activity; a single licence can be obtained for the main commercial activity and can include the authorisation of the remaining ancillary and support activities. A downstream licence is required for the Betano petroleum refinery and petrochemical complex, and the Beaco LNG plant and



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jetty. In accordance with the decree law, a licence can be granted for a maximum period of 30 years and renewal is discretionary depending on the activity. A fee applies to the licence application, as determined by ANP, and once granted, the licence must be published in the *Jornal da República*.

### 2.2.3 Port Law

The Decree Law 3/2003 on the establishment of the Port Authority and on the approval of the bylaws thereof details the structure, nature and responsibilities of the Administração dos Portos de Timor-Leste or Port Authority of Timor-Leste (APORTIL). The annex to this law requires APORTIL to grant licences for works carried out within their jurisdiction. The marine facilities associated with the project will require the issuing of a port licence from APORTIL prior to commencement of construction.

### 2.2.4 Civil Aviation Law

The Decree Law 1/2003 on the basic law on civil aviation governs the activities associated with airfields. The law requires permission to be sought from the Autoridade da Aviação Civil de Timor-Leste or Civil Aviation Authority of Timor-Leste (AACTL) prior to the construction of an airfield or associated facilities. This is applicable to the air facilities associated with the Beaco project cluster.

### 2.2.5 Road Transport Law

The Decree Law 2/2003 on the basic law on the road transport system establishes the technical standards for regulating passenger and cargo transport by road in Timor-Leste. The Ministry of Infrastructure is responsible for the Autoridade Reguladora dos Transportes e Comunicações or Regulatory Authority for Transport and Communications and this decree law.

The development of road infrastructure is governed by the law on the national road plan. The national road plan will define the rules that shall govern the technical specifications of national, district and local roads, taking into consideration traffic nature and volume.

The decree law specifies the construction, maintenance and operation of district and local road networks. As is the case for this project, this is the responsibility of the local authority. Depending on how the project workforce are transported to the construction sites, the decree law outlines the requirements for operation of urban and local regular passenger transport services, interurban regular passenger transport and occasional passenger transport.

### 2.2.6 Water Supply Law

The Decree Law 4/2004 on water supply for public consumption creates conditions for water distribution for domestic use for urban and non-urban areas. In accordance with the decree law, the Direcção Nacional Serviço de Água e Saneamento or National Directorate for Water and Sanitation (DNSAS) facilitates, at the national level, the appropriate, secure and sustainable water supply for public consumption, outside of urban areas, by community-run water supply systems. The water supply system, outside of urban areas, is managed by water management groups, which are appointed by the community. The role of the water management group is to establish a number of procedures, including who, how and how much water is distributed to members of the water management group.



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### 2.2.7 Telecommunications Law

The Decree Law 11/2003 on establishing the bases for the telecommunications sector describes the requirement for establishing, managing and operating telecommunications infrastructure and services. The law requires urbanisation schemes and the construction of buildings and urban roads to pre-install telecommunications infrastructure. The installation of telecommunications infrastructure must be in accordance with the requirements of the regulator, the Autoridade Reguladora Das Comunicações or Communications Regulatory Authority (ARCOM) and approved by the Cabinet members responsible for urbanisation, telecommunications and internal administration.

### 2.2.8 National Electricity Law

The Decree Law 13/2003 on establishing the basis for the national electricity system outlines the basis for organising the national electricity system and the principles for governing electricity production, transmission and distribution. The law requires pre-installation of electrical infrastructure for urbanisation activities and the construction of buildings and urban roads, consistent with the requirements of the regulatory authority.

In accordance with this law, electricity producers must obtain a licence from the regulator. There are two types: a binding or non-binding production licence. It is anticipated that both projects will require a non-binding commercial production licence as they apply to businesses producing electricity for its own or third party needs, or supplying electricity in an autonomous network, although this licencing requirement is yet to be confirmed by RDTL.

The Ministry of Infrastructure is responsible for the Autoridade Reguladora dos Transportes e Comunicações or Regulatory Authority for Transports and Communications and this Decree law.

## 2.3 Other Legislation and Regulations

The following legislation and regulations are also relevant to the project.

### 2.3.1 Protected Areas Regulation

During the period of the UNTAET, regulation on protected areas became law. The objective of the Regulation 19/2000 on Protected Places is to protect specific areas or sites. Wild Protected Areas are the only areas that have been declared for protection. The Betano project is surrounded by Wild Protected Areas. However, the nearest area is Sungai Clere, approximately 30 km to the east. The Sungai Clere reserve within the administrative region of Munafahi is 30,000 ha and consists of forest, savannah and wetland habitat that supports the threatened species *Turacoena modesta* slaty cuckoo-dove, *Treron psittacea* Timor green-pigeon, *Cacatua sulphurea* yellow-crested cockatoo and *Padda fuscata* Timor sparrow. For the Beaco project, Wild Protected Areas exist to the west and east. The nearest area, Irebere Estuary and Iliomar Forest, is approximately 38 km to the east. This important bird area in the Lautem administrative region is currently unprotected and supports the slaty cuckoo-dove and yellow-crested cockatoo.

The hunting, trapping, taking or disturbing of animals in Wild Protected Areas is prohibited.



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The regulation also protects the following endangered species:

- Sea turtles.
- Marine mammals, including bottlenose dolphins, whales and dugongs.
- Wallabies.
- Crocodiles.

The killing, injuring, harming, taking or disturbing endangered species and the destruction of their habitat is prohibited, unless an exemption is obtained from DNSMA.

In addition to wild protected areas and endangered species in Timor-Leste, the protected places regulation also protects wetlands and mangrove areas; historic, cultural and artistic sites; and coral reefs.

The importance of protected areas will be communicated to all project personnel and appropriate avoidance, management and mitigation measures will be implemented in the project area to avoid and protect these environmental sensitivities.

### 2.3.2 Logging Regulation

The UNTAET Regulation 2000/17 on the prohibition of logging operations and the export of wood from East Timor came into effect in 2000. This regulation prohibits the cutting, removal and logging of wood from East Timor. However, exemptions to this regulation can be sought from a UNTAET Directive. Prior to the removal of wood for the project, SERN may have to seek an exemption from the Direcção Nacional de Florestas or Forestry Department (NDF).

### 2.3.3 Quarantine Decree

The Government Decree-Law 21/2003 on Quarantine and Sanitary Control on Goods Imported and Exported establishes the processes for sanitation control of the import and export of plants and animal and their derived products. The objective of the law decree states:

- Prevent and control the introduction, establishment and propagation of exotic plagues and diseases and other harmful organisms in the national territory.
- Protect the environment, agricultural production and livestock as well as aquaculture production originating from the country.
- Control the already existing plagues and diseases in the country.
- Protect human beings and the public health from diseases transmitted by animals, plants or their derivatives, or by other organisms.

If exotic plagues, diseases and harmful organisms are identified as part of the EIA, appropriate avoidance, management and mitigation measures will be adopted in accordance with this decree.

**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT****2.4 Traditional Practices**

There are also traditional regulations and customs which in some areas have been successful in conserving natural resources such as forests and crops. This system of communal protection is known as *tara bandu*. Villagers designated as *cab-leha/tobe* are responsible for seeing that village laws are followed (Sandlund *et al.*, 2001). *Tara bandu* includes temporary prohibitions on resource extraction, such as tree cutting (including mangroves) and the designation of specific areas as sacred. *Tara bandu* prescribes fines for violations and also provides for mediation of land disputes.

Timor-Leste's constitution recognises and values customary laws, including *tara bandu*.

**2.5 Summary of Project Approvals**

Table 2-1 details the licensing required under Timor-Leste law for the full implementation of the project. SERN will be responsible for the grant and administration of the various regulatory approvals.

**Table 2-1 Government licensing approvals for the project**

Project Activities		Statutory Requirement	Relevant Legislation
<b>Betano Refinery and Petrochemical Industry Cluster</b>			
Refinery and petrochemical complex	Marine facilities – details yet to be confirmed	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
		Port licence from APORTIL	Decree law 3/2003 on the establishment of the Port Authority and on the approval of the bylaws thereof
		Downstream licence	Decree law 1/2012 on downstream sector
	Land facilities	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
		Downstream licence	Decree law 1/2012 on downstream sector
Nova Betano	New residential town for oil and gas workforce and families	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
<b>Beaco LNG Plant Cluster</b>			
LNG plant complex	Marine facilities	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
		Downstream licence	Decree law 1/2012 on downstream sector
		Port licence from APORTIL	Decree law 3/2003 on the establishment of the Port Authority and on the approval of the bylaws thereof
	Land facilities	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
		Downstream licence	Decree law 1/2012 on downstream sector

**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT****Table 2-1 Government licensing approvals for the project (cont'd)**

Project Activities		Statutory Requirement	Relevant Legislation
Nova Beaco	New residential town for locals	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
Nova Viqueque	New residential town for oil and gas workforce and families	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
Viqueque air facilities	Upgrade	Environment licence from DNSMA	Decree law 5/2011 on environment licensing law
		Authorisation from AACTL	Decree law 1/2003 on civil aviation
<b>Additional infrastructure</b>			
Internal roads			Decree law 2/2003 on basic law on the road transport system
Water			Decree law 4/2004 on water supply for public consumption
Telecommunications			Decree law 11/2003 on establishing the bases for the telecommunications sector
Electricity			Decree law 13/2003 on establishing the bases for the national electricity system

**2.6 International Conventions**

Timor-Leste has ratified a number of international treaties, conventions and protocols. Table 2-2 summarises these international agreements and identifies its relevance to the project.

**Table 2-2 Relevant international agreements to which RDTL is a signatory**

Title	Objective	Relevance to the Project
United Nations Framework to Combat Climate Change (1992) and the Kyoto Protocol	To stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Requires industrialised countries to reduce emissions by setting a mandatory emission limit. RDTL is currently exempt from the emission reduction target.	Greenhouse gas emissions.
United Nations Convention for Biodiversity (1992)	To develop national strategies for the conservation and sustainable use of biological diversity.	Terrestrial biodiversity and marine biodiversity assessment.





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**Table 2-2 Relevant international agreements to which RDTL is a signatory (cont'd)**

Title	Objective	Relevance to the Project
International Finance Corporation (IFC) (2006, 2011) Policy and Performance Standards on Social and Environmental Sustainability.	To minimise adverse impacts socially, culturally, economically or on the environment, arising from the development of a new project through a process of thorough assessment, avoidance, management and mitigation.	The standards apply to projects that are seeking project funding from the IFC and/or choose to apply 'best practice' performance standards. The application of these standards to the environment impact assessment to be undertaken for Betano and Beaco is to be determined by SERN.
United Nations Convention to Combat Desertification	To combat desertification and mitigate drought in affected countries through international cooperation and partnerships.	Geology and soils, terrestrial biodiversity, marine biodiversity, surface water and groundwater assessment.
Vienna Convention for the Protection of the Ozone Layer (1993) and the Montreal Protocol	To protect the ozone layer by controlling the production and consumption of specific chemicals and phasing out the production of numerous substances believed to be responsible for ozone depletion.	Compliance with the standards and protocols for chemical use.



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REPÚBLICA DEMOCRÁTICA DE TIMOR-LESTE  
SECRETARIA DE ESTADO DOS RECURSOS NATURAIS

# Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

## Strategic Environmental Impact Assessment

### CHAPTER 3

## ENVIRONMENTAL CONTEXT



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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## 3. ENVIRONMENTAL CONTEXT

The information presented within this section provides regional context to the project area, with more detailed information on the existing conditions at the Betano and Beaco development areas provided in each of the technical chapters (Chapters 6 and 7) of this report.

### 3.1 Betano

#### 3.1.1 Climate

Timor-Leste has two annual seasons and three climatic zones which are the result of monsoon activity. The Betano area experiences a typical tropical monsoonal climate with distinct wet and dry seasons – the Northwest Monsoon from November to May and the Southeast Monsoon from April to September (respectively), with brief transitional periods in between (Timor-Leste, 2006).

The average annual rainfall for the Timor Sea region is 1,770 mm (Heyward *et al.*, 1997). Long-term, multi-year rainfall trends are generally dictated by El Niño/La Niña effects; however, short-term annual rainfall patterns reflect the seasonality. The coastal region, including the Betano development area, generally receives less annual rainfall than the midland and highland regions further inland.

The tropical climate means that there is little variance in temperature in the region throughout the year. Daytime temperatures in the Betano area are generally in the low 30's and night-time temperatures are generally in the mid to high 20's. The daily variation in temperature can be larger than the monthly variation throughout the year.

The maximum daily relative humidity is frequently above 90% throughout the year. The minimum daily relative humidity varies considerably more than the maximum, and is on average between 45% and 73%.

The main source of extreme weather events near Timor-Leste is tropical cyclones. The majority of cyclones occur in the region between January and March, with the most severe cyclones most often occurring in the months from December to April (SKM 2001). Most of these cyclones are not fully mature, having an estimated wind speed of less than 80 km/h. Severe cyclones, with wind speeds exceeding 100 km/h occur, on average, once every 2.6 years (Heyward *et al.*, 1997).

The recorded data for the area showed that the majority of the winds blew from the northwest at reasonably low speeds (less than 3.0 m/s). Currently, there is insufficient data to be able to determine prevailing wind patterns.

#### 3.1.2 Biogeography

Timor-Leste is part of the Malay Archipelago, representing the largest and easternmost of the Lesser Sunda Islands (World Bank, 2009). The island is non-volcanic, part of the Outer Banda Arc, derived from the basement of rocks of the Australian continental margin (Audley Charles, 1993 in Rhee *et al.*, 2004) and is characteristically limestone with karst formations. The terrain in Timor-Leste is frequently steep and, as a result, has a number of large fast-flowing rivers running to the sea.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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The Betano development area is located approximately 5 km east of the Rio Caraulun which has a catchment area of approximately 554 km<sup>2</sup>.

The rates of fluvial sediment flux on the island and the broader region are naturally high as a result of the mountainous terrain, highly erodible strata and the high seasonal rainfall. The lack of estuaries, along with the narrow width of coastal shelf along Timor-Leste's south coast indicates that the river is likely to discharge sediment directly to the coastal slope and deeper offshore waters (Milliman *et al.*, 1999).

The recent field surveys confirmed that sections of coastline inspected between Suai, Betano and Beaco consist of a combination of sandy beaches and limestone rock ledges which extend from the shoreline as intertidal reef flats and slope down steeply towards the seabed. The sandy beaches consist of medium to fine sand with silt. The predominant wave direction for Timor-Leste is from the east (MetOcean Engineers, 2004) which is most likely to create net littoral movement of material from east to west.

### 3.1.3 Biological Environment

Habitats along the coastline vary due to the local influences of seasonal rainfall, geology and topography, river discharges, and regional offshore oceanographic features, as well as the impact of human occupation. This has resulted in spatial differences in marine habitats, with the northern coastline differing from the southern coast and with the eastern edge of the island having attributes that differ from those to the west.

Timor-Leste has been identified as part of the Wallacea region in Southeast Asia which has been identified as a biodiversity 'hotspot' (CI, 2007). The most ecologically important marine habitats in the Timor Sea region, in terms of biodiversity and productivity, can be grouped into:

- The various submerged banks or shoals on the northern Australian continental shelf and shelf slope.
- The coastal intertidal coral reefs and shallow (20 to 30 m) reefs.
- The mangrove and seagrass areas located along the Timor and northern Australian coast and islands (Sandlund *et al.*, 2001; SKM 2001).

Timor-Leste is located in the Central Melesia (Wallacea) region and its terrestrial flora is considered to be transitional between the main rainforest blocks of the Sunda (Peninsula Malaysia, Sumatra, Borneo, West Java) and Sahul (New Guinea) shelves (van Welszen *et al.*, 2005).

Few publications document the flora and vegetation of Timor-Leste; however, some information can be gained from studies undertaken in the bordering land of West Timor part of Nusa Tenggara provinces of Indonesia and surrounding islands. A review of literature by Monk *et al.*, (1997) concludes that Nusa Tenggara has a mixture of Indo-Malay and Australian elements.

A total of 407 endemic species and five genera of plants are known from Nusa Tenggara and Maluku, of which only eight species are shared between each location (Monk *et al.*, 1997). Nusa Tenggara and the Maluku groups of islands have differing geological origins, ranging from young, active volcanic islands, to limestone with karst formations. The plant genera endemic to Timor are *Sautiera* and



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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*Sinthraoblastes*. Timor was identified as having the highest number of endemic species recorded in Indonesia, at approximately 10.3% (Monk *et al.*, 1997).

The rate of deforestation in Timor-Leste from 1972 to 1999 has been estimated at 1.1% per year, which is four times higher than the global average of 0.3%. The direct results have been severe soil erosion, reduced forest productivity and loss of biodiversity (Alves, 2007).

Historically, the vertebrate fauna of Timor-Leste has been poorly documented, however some studies have been conducted on herpetofauna, birds and mammals. Kaiser *et al.*, (2011) conducted field surveys throughout Timor-Leste resulting in the identification of 7 species of amphibians and 30 species of reptiles. Similarly, the knowledge on the habitat requirements of Timor-Leste vertebrate fauna is lacking and most studies conducted have largely been focused on bird species.

### 3.1.4 Land and Water Resources

Timor-Leste can be broadly divided into six key land types; the mountainous areas, highland plains, moist lowland areas, arid lowland areas, coastal areas and urban areas (Metzner, 1977).

The Betano development area is located on a flat coastal plain which is underlain by the Suai Formation. The Suai Formation is generally poorly exposed and not well known. The land rises to the north-west comprising the Wai Bua Formation, and the hills to the north and north-east comprise the Wai Luli Formation. (UN, 2003).

The central core of the eastern side of the Nova Betano development area is underlain by the Baucau Limestone Formation and the central core of the western side Nova Betano is underlain by the Bobonaro Scaly Clay Formation. The Suai Formation is encountered around the lower southerly and westerly fringes of the area for Nova Betano. The Viqueque Formation occupies the northern fringe of the eastern side of the Nova Betano, and the Wai Bua Formation occupies the eastern fringe.

Most of the Nova Betano development area and surrounding area is characterised by agricultural land uses, although natural forests remain in the upper catchments and other areas that are too rugged for agriculture.

Natural groundwater springs are considered the primary source of water for domestic and agricultural uses for most villages in Timor-Leste (AusAID, 2009). Estimates of groundwater withdrawals per capita within the Clere and Belulic area were 59 m<sup>3</sup> per year, less than 1% of the total water resources per capita (8,822 m<sup>3</sup>; ADB, 2004) in an average year. During a dry year (1 in 5 low flow), groundwater withdrawals can account for up to 1.5% of total water resources due to limited water availability (3,853 m<sup>3</sup> per year; ADB, 2004).

### 3.1.5 Socio-economic Environment

The Manufahi district is located on the south coast of Timor-Leste, between the Manatuto district to the east, Ainaro district to the west, and Aileu district to the north. The Manufahi district covers an area of approximately 1,300 km<sup>2</sup> and has a population of approximately 48,600. The capital of the district is Same.





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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According to the 2010 Census, the population of Betano village was 5,151 with a relative gender distribution (52% male, 48% female). The total number of households was 869 with an average household size of 5.5 people (RDTL, 2010). The population of Betano has grown 'naturally' over the last two years, that is, the birth rate being slightly higher than the mortality rate. Immigration was not said to be a contributor to population growth. The population age distribution is relatively young, consistent for both genders.

There are four major languages spoken in the Betano village, namely Mambai which is the mother tongue for the majority of people (35%), Tetum Prasa (32%), Tetum Terik (21%) and Bunak (11%) (RDTL, 2010).

In Betano, land ownership and transition is based around the family unit. Farming is a very important livelihood for this community, as well as livestock and fishing, government jobs (e.g., teachers, nurses, police, military), and small business.

Fieldwork participants confirmed that farming is the main source of food in Betano and all families were involved in farming. Farming plots were generally located close to the village. If the fields are some distance from the village, farmers tend to have a small dwelling close to the plot.

The 2010 Census shows that the large majority (91%) of Betano households rear livestock and that most households (76%) involved in crop production. The most common crops were corn, vegetables, temporary fruits and cassava.

### 3.1.6 Cultural Heritage

Sacred sites are commonplace in Betano. They may be a stream, rock, tree, house or bush. Churches and historic grave sites are also present in the area.

Sacred houses are of particular importance to the people of Timor-Leste. Uma-Lulik (the sacred house) is a 'tall, thatched, conical shaped building' and there are estimated to be 100 sacred houses in the area. Sacred houses are associated with spirituality, tradition, ancestors, self-assurance, strength and honour for the local people. They are also the home of animist culture in Timor-Leste.

## 3.2 Beaco

### 3.2.1 Climate

Timor-Leste has two annual seasons and three climatic zones which are the result of monsoon activity. The Betano area experiences a typical tropical monsoonal climate with distinct wet and dry seasons – the Northwest Monsoon from November to May and the Southeast Monsoon from April to September (respectively), with brief transitional periods in between (Timor-Leste, 2006).

The average annual rainfall for the Timor Sea region is 1,770 mm (Heyward et al. 1997). Long-term, multi-year rainfall trends are generally dictated by El Niño/La Niña effects; however short, term annual rainfall patterns reflect the seasonality. The Beaco/Viqueque area often receives more rainfall than other lower-lying regions on the southern coast with events being torrential in nature.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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The tropical climate means that there is little variance in temperature in the region throughout the year. Daytime temperatures around Beaco tends to vary between 25°C and 36°C throughout the year, and the minimum daily temperature ranges from 23°C and 27°C. The daily variation in temperature can be larger than the monthly variation throughout the year.

The maximum daily relative humidity is frequently above 90% throughout the year. The minimum daily relative humidity varies considerably more than the maximum, and is, on average, between 45% and 73%.

The main source of extreme weather events near Timor-Leste is tropical cyclones. The majority of cyclones occur in the region between January and March, with the most severe cyclones most often occurring in the months from December to April (SKM 2001). Most of these cyclones are not fully mature, having an estimated wind speed of less than 80 km/h. Severe cyclones, with wind speeds exceeding 100 km/h occur, on average, once every 2.6 years (Heyward *et al.*, 1997).

The recorded data for the area showed that the majority of the winds blew from the northwest at reasonably low speeds (less than 3.0 m/s). Currently, there is insufficient data to be able to determine prevailing wind patterns.

### 3.2.2 Biogeography

The island of Timor-Leste is part of the Malay Archipelago, representing the largest and easternmost of the Lesser Sunda Islands (World Bank, 2009). The island is non-volcanic, part of the Outer Banda Arc, derived from the basement of rocks of the Australian continental margin (Audley Charles, 1993 in Rhee *et al.*, 2004) and is characteristically limestone with karst formations. The terrain in Timor-Leste is frequently steep and, as a result, has a number of large fast-flowing rivers running to the sea.

The site for the Beaco LNG Plant is crossed by 3 minor waterways (Ribeira Buaran, Ribeira Benaro and Ribeira Beaco), and is located approximately 2 km to the east of the Rio Cuha. The site for Nova Viqueque is located approximately 10 km inland on the banks of Rio Cuha, which has a catchment area of 268 km<sup>2</sup>.

The rates of fluvial sediment flux on the island and the broader region are naturally high as a result of the mountainous terrain, highly erodible strata and the high seasonal rainfall. The lack of estuaries, along with the narrow width of coastal shelf along Timor-Leste's south coast indicates that the river is likely to discharge sediment directly to the coastal slope and deeper offshore waters (Milliman *et al.*, 1999).

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### 3.2.3 Biological Environment

Habitats along the coastline vary due to the local influences of seasonal rainfall, geology and topography, river discharges, and regional offshore oceanographic features, as well as the impact of human occupation. This has resulted in spatial differences in marine habitats, with the northern coastline differing from the southern coast and with the eastern edge of the island having attributes that differ from those to the west.

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A total of 407 endemic species and five genera of plants are known from Nusa Tenggara and Maluku, of which only eight species are shared between each location (Monk *et al.*, 1997). Nusa Tenggara and the Maluku groups of islands have differing geological origins, ranging from young, active volcanic islands, to limestone with karst formations. The plant genera endemic to Timor are *Sautiera* and *Sinthraoblastes*. Timor was identified as having the highest number of endemic species recorded in Indonesia, at approximately 10.3% (Monk *et al.*, 1997).

The rate of deforestation in Timor-Leste from 1972 to 1999 has been estimated at 1.1% per year, which is four times higher than the global average of 0.3%. The direct results have been severe soil erosion, reduced forest productivity and loss of biodiversity (Alves, 2007).

Historically, the vertebrate fauna of Timor-Leste has been poorly documented; however, some studies have been conducted on herpetofauna, birds and mammals. Kaiser *et al.* (2011) conducted field surveys throughout Timor-Leste resulting in the identification of seven species of amphibians and 30 species of reptiles. Similarly, the knowledge on the habitat requirements of Timor-Leste vertebrate fauna is lacking and most studies conducted have largely been focused on bird species.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 3.2.4 Land and Water Resources

The Beaco development area is located on a flat coastal plain which is underlain by the Suai Formation. The Suai Formation is generally poorly exposed and not well known. North of the development, the sediments are rudite (sedimentary rocks that are composed of rounded or angular detrital) and arenite ranging to gravels (UN, 2003).

The Beaco development area is underlain by four different geological units including; the Bobonaro Scaly Clay Formation, the Viqueque Formation, the Baucau Limestone Formation and the Suai Formation.

At the proposed sites for the LNG plant and Nova Beaco, the coastal plain is underlain by the Suai Formation, with the hills emerging to the north comprising the Baucau Limestone Formation. The limestone is; however, generally overlain by clay washed down from the higher-lying Bobonaro Scaly Clay Formation to the north.

The eastern two-thirds of the site for Nova Viqueque is underlain by the Bobonaro Scaly Clay Formation, whilst the western third is underlain by the Viqueque Formation. The lower south-western corner of this site extends onto the coastal plain, which is underlain by the Suai Formation.

Natural groundwater springs are considered the primary source of water for domestic and agricultural uses for most villages in Timor-Leste (AusAID, 2009). Estimates of groundwater withdrawals per capita within the Clere and Belulic area were 59 m<sup>3</sup> per year, less than 1% of the total water resources per capita (8,822 m<sup>3</sup>; ADB, 2004) in an average year. However, during a dry (1 in 5 low flow) year, groundwater withdrawals can account for up to 1.5% of total water resources due to limited water availability (3,853 m<sup>3</sup> per year; ADB, 2004).

### 3.2.5 Socio-economic Environment

The Viqueque district is located, between the Lautem district to the east, Manatuto district to the west, and Baucau district to the north. The Viqueque district covers an area of approximately 1,780 km<sup>2</sup> and has a population of approximately 70,000. The capital of the district is also named Viqueque.

According to the 2010 Census, the population of Uma-Uain Craik was 2,787 and Maluru was 678. Both of these areas had relative gender distribution (51% male, 49% female). The total number of households was 492 and 134 respectively. The average household size was 5.7 people for Uma-Uain Craik and 5.1 for Maluru (RDTL, 2010).

The population age distribution is relatively young, consistent for both of these sub-districts, with approximately 45% of the population in both the 0 to 14 and 15 to 59 age groups.

The most common language spoken in Maluru was Makasa'e (95%). Tetum Terik accounted for 4% of the preferred language. For Uma-Uain Craik, Tetum Terik was the preferred language for 70% of the population, with around 18% described their mother tongue as being Makasa'e and 11% for Tetum Prasa (RDTL, 2010).



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Land ownership and management in Maluru and Uma-Uain Craik is consistent with other areas discussed in the baseline study. Land ownership is based around the family or household. Locals are customary landholders and do not have certificates or deeds of ownership (WorleyParsons, 2011).

Fieldwork participants confirmed that the main forms of livelihood in Maluru and Uma-Uain Craik were growing corn, fishing, livestock herding and local business.

The 2010 Census data also shows that the majority of households in Maluru (94%) and Uma-Uain Craik (62%) rear livestock. Most households in Maluru (80%) were involved in crop production, whereas this figure for Uma-Uain Craik was 27%.

### 3.2.6 Cultural Heritage

Sacred sites are commonplace in the Maluru and Uma-Uain Craik villages. These include isolated grave sites, Portuguese buildings (which may possess some archaeological value), trees, and hills. The Uma-Uain Craik respondents identified the three major sacred sites were Fatukhun (big rock), Ailemi Galiria (tree), and an area where gas is released from the ground.

As mentioned in Section 3.1.6 above for Betano, sacred houses are of particular importance to the people of Timor-Leste. Sacred houses are associated with spirituality, tradition, ancestors, self-assurance, strength and honour for the local people. They are also the home of animist culture in Timor-Leste.

Everyone in Maluru and Uma-Uain Craik is from the same cultural group. It is understood that there are 32 sacred houses in Maluru including 3 major sacred houses where the community pray.



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# Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

## Strategic Environmental Impact Assessment

### CHAPTER 4

## PROJECT DESCRIPTION



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 4. PROJECT DESCRIPTION

#### 4.1 Overview

The GoTL proposes to develop a refinery and petrochemical complex and an LNG plant, and related infrastructure, at two separate locations on the south coast of Timor-Leste to serve oil and gas industry developments in the Timor Sea. Three new towns are also proposed to support the construction and operational workforce.

The refinery and petrochemical complex and the LNG plant developments, that are the subject of this SEIA, span multiple construction phases, although the timescale of development is yet to be determined.

This chapter describes the project, based on the information available, and provides an overview of the likely construction and operational phases of the proposed refinery and petrochemical complex and LNG plant.

#### 4.2 Location

The GoTL has determined that two southern coastal locations near the town of Betano (Manufahi District) and at Beaco (Viqueque district), are the most appropriate locations to develop a refinery and petrochemical complex and a LNG plant (respectively), and the related new town developments to support them.

##### 4.2.1 Betano

The existing town of Betano is located approximately 70 km south of Dili, 75 km east of the Indonesian border, and 2 km inland from the Timor Sea. The main township of Betano is serviced by the national road network connecting to Suai (east) and Beaco (west).

Figure 1-2 (Chapter 1) shows the location of the Betano development area, which will comprise:

- Refinery and petrochemical complex.
- A new refinery and petrochemical complex between Nova Selihasan and the proposed Nova Betano.
- Nova Betano.
- A new town development, Nova Betano, will be located approximately 5 km to the north of the existing Betano village and adjacent to the Caraulun River (to the west), and will traverse the Betano to Same Main Road.

##### 4.2.2 Beaco

Beaco is located approximately 100 km south-east of Dili and is serviced by the national road network connecting to Suai and Betano (west), Viqueque (east), and Baucau to the north.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Figure 1-3 (Chapter 1) shows the location of the Beaco development area, which will comprise:

- Beaco LNG plant and jetty area.

The proposed site for the 5 million tonnes per annum (Mtpa) LNG plant (on-shore facilities and jetty only) is situated at the coastal village of Maluru, and will be traversed by three minor waterways – Ribeira Buaran, Ribeira Benaro and Ribeira Beaco.

- Nova Beaco

A new town development, Nova Beaco, will be located further along the coastline, approximately 4 km east of the proposed LNG plant site. The site for Nova Beaco is situated on the north side of the Suai to Beaco South Coast Road.

- Nova Viqueque

A new town development, Nova Viqueque, is proposed to be situated approximately 4 km southeast of the existing Viqueque town centre, near the existing Viqueque Airport. The site is located on the eastern side of the main road (national road network connection) on the banks of the Rio Cuhu, approximately 10 km inland.

- Viqueque airstrip upgrade works

Viqueque airstrip (existing) is situated approximately 9 km inland of the southern coastline and 4 km south of Viqueque town centre, between bends in the Rio Cuna on the west side of the main road.

Photos of various site features at the proposed locations of Betano and Beaco are presented in Appendix B.

### 4.3 Project related infrastructure - Betano Refinery

#### 4.3.1 Refinery and Petrochemical Complex

The GoTL proposes to build a refinery and petrochemical complex to process condensate delivered from the gas field in the Timor Sea, and to meet Timor-Leste's growing demand for transportation and domestic fuels. The GoTL has determined a coastal location at Betano, in the Manufahi district, as the most suitable location to develop a refinery and petrochemical complex and supporting infrastructure.

The establishment of the complex is expected to be a commercial arrangement between the public and private sectors; the Timor-Leste National Petroleum Company will also play a crucial role in the development. The refinery will provide domestic fuel needs (such as diesel, gasoline, jet-fuel and asphalts), and it is intended that many products will be exported to increase Timor-Leste's trade in oil and gas products (RDTL, 2011b).

The proposed development is intended to have modern infrastructure and facilities, with substantial supporting infrastructure including:

- Material Offloading Facility (MOF);
- Jetty and marine facilities for feedstock import and product export;



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

- Accommodation,
- Airstrip/ Helipad for Medivac, and a
- Quarry, with crushing plant, and haul road to site (outside scope of current assessment).

### Pre-Feasibility Study

A pre-feasibility study for a refinery and petrochemical complex has been undertaken by KBC ('Final Report' rev 2, 2011), which SERN has provided in part, to WorleyParsons for the purpose of background information for this SEIA. It is understood that the detailed engineering assessment and design phase has not yet commenced.

In the absence of design information, only the key built aspects (basic infrastructure) typically required for a condensate refinery have been listed in Table 4-1. This list is not exhaustive. Figure 4-1 shows the typical layout of a condensate refinery for illustrative purposes only. Table 4-1 and Figure 4-1 provide general information only and should not be relied upon for detailed design; nor do they consider the likely aspects required for a petrochemical facility.

A jetty would be required to facilitate a refinery and petrochemical complex at Betano for feedstock import and product export as shown in Figure 4-1.

**Table 4-1 Typical operational components for a condensate refinery**

Component	Figure 4-1 ref	Facilities
<b>Refinery plant</b>		
A condensate refinery plant would typically include:	21	Atmospheric distillation unit
	46	Atmospheric residue storage
	45	Benzene free reformat component storage
	23	Benzene saturation unit
	51	Butane component storage
	34	Caustic storage
	50	Continuous catalytic reformer feed storage
	22	Continuous catalytic reformer unit
	20	Diesel hydrotreater unit
	31	Diethanolamine storage
	35	Demineralised water storage
	10	Flare area
	19	Gas sweetening unit
	47	Isomerisate component storage
	25	Isomerisation unit
	29	Kerosene merox unit
	11	Knock out drum
	17	Liquid sulfur storage
	28	Liquified petroleum gas (LPG) merox unit
	49	Naphtha hydrotreater feed storage
	27	Naphtha hydrotreater unit
	26	Saturates gas plant
	52	Slops storage
	15	Sulfur recovery unit
	16	Tail gas



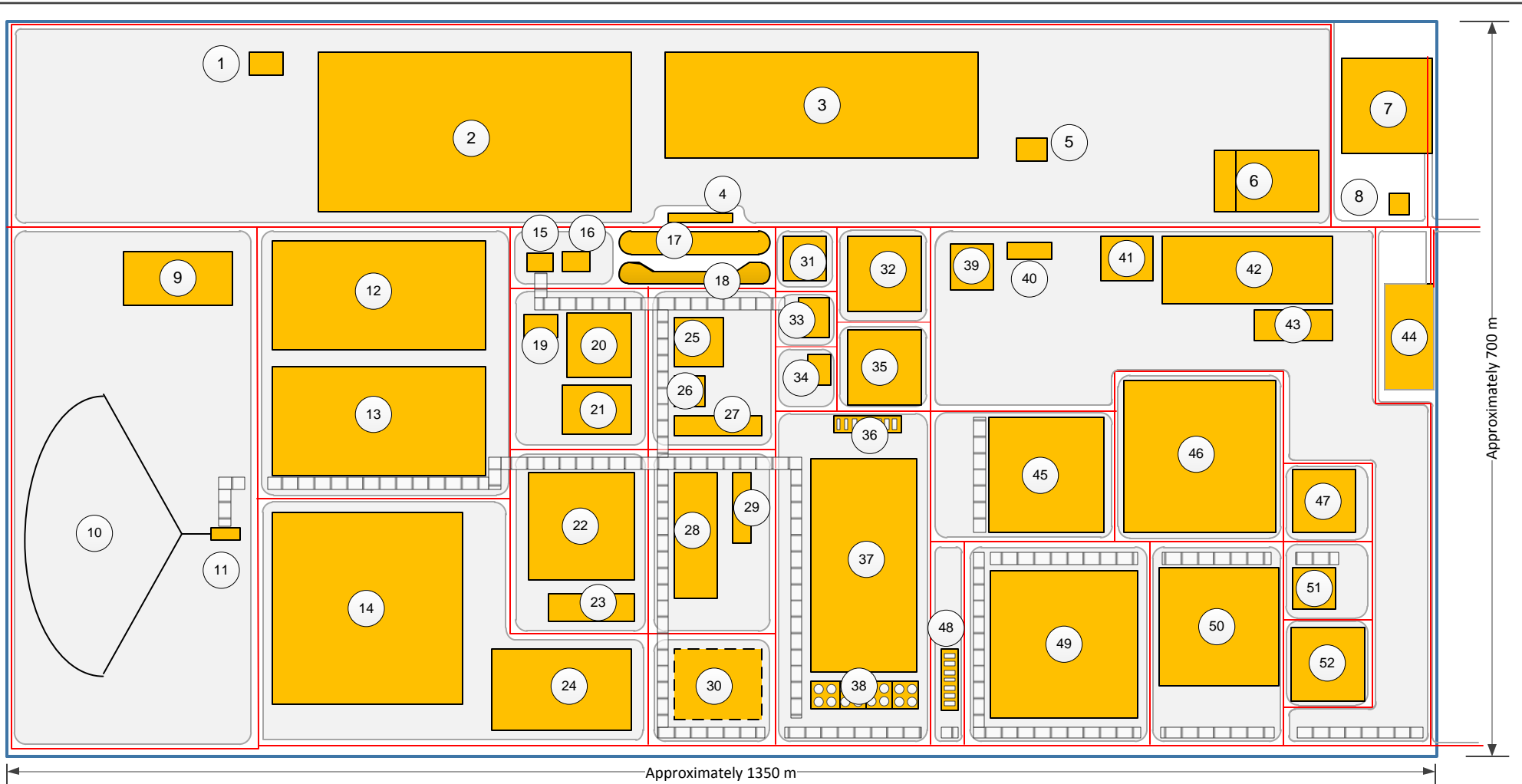
## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

**Table 4-1 Typical operational components for a condensate refinery (cont'd)**

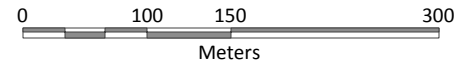
<b>Supporting infrastructure</b>		
Supporting infrastructure would typically include:	48	Blending pumps
	39	Control room
	38	Cooling towers
	3	Desalination plant
	24	Effluent holding basin
	13	Evaporation pond
	30	Future expansion area
	18	Loading bay
	33	Potable water storage
	12	Solid waste storage
1, 5	Substation	
2	Steam/power generation and flue gas desulfurisation	
36	Tankfarm pumps	
37	Utilities	
14	Waste water treatment	
4	Weigh bridge	
<b>Administration buildings</b>		
Administration buildings would typically include	6	Area administration and laboratory
	44	Car park
	8	Gatehouse
	40	Fire station
	9	Fire-fighting training area
	32	Firewater storage
	42	Maintenance shop and warehouse
	7	Staff car park
	43	Storage yard

Source: WorleyParsons (unpublished)

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LEGEND						
1 – Substation	8 – Gatehouse	17 – Liquid sulfur storage	25 – Isomerisation unit	34 – Caustic storage	42 – Maintenance shop and warehouse	49 – Naphtha hydrotreater feed storage
2 – Steam/power generation and flue gas desulphurisation	9 – Fire fighting training ground	18 – Loading bay	26 – Saturates gas plant	35 – Demineralised water storage	43 – Storage yard	50 – Continuous catalytic reformer feed storage
3 – Desalination plant	10 – Flare area	19 – Gas sweetening unit	27 – Naptha hydrotreater unit	36 – Tank farm pumps	44 – Car park	51 – Butane component storage
4 – Weigh bridge	11 – Knock out drum	20 – Diesel hydrotreater unit	28 – LPG merox unit	37 – Utilities	45 – Benzene free reformate component storage	52 – Slops storage
5 – Substation	12 – Solid waste storage	21 – Atmospheric distillation unit	29 – Kerosene merox unit	38 – Cooling towers	46 – Atmospheric residue storage	
6 – Area administration and laboratory	13 – Evaporation pond	22 – Continuous catalytic reformer unit	30 – Future expansion area	39 – Control room	47 – Isomerate component storage	
7 – Staff car park	14 – Waste water treatment	23 – Benzene saturation unit	31 – Diethanolamine storage	40 – Fire station	48 – Blending pumps	
	15 – Sulfur recovery unit	24 – Effluent holding basin	32 – Firewater storage	41 – Catalyst storage		
	16 – Tail gas		33 – Potable water storage			



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**Figure 4-1**  
Typical condensate refinery layout

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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### ***Indicative Scale and Phasing***

The initial phase would establish a refinery with a capacity of 30,000 barrels per day (BPD). Construction of the first phase of the refinery is to commence between 2013 and 2016 (30,000 BPD) and is predicted to be completed between 2017 and 2023. The GoTL intend for the site layout and configuration to be designed to accommodate a progressive increase in capacity to 100,000 BPD as petrochemical industries expand (RD TL, 2011b). This will result in some overlap of the construction and operational project phases.

The scale and location of some built aspects are likely to change during the feasibility and detailed design stages of the development.

Information relating to the operational phases of the refinery development (inputs, processes, storage requirements, etc) was not known at the time of preparation of this SEIA.

### ***Hours of Operation***

The refinery and petrochemical complex are expected to operate continuously 24 hours/day, 365 days per year subject to scheduled maintenance shutdowns. The hours of operation for staff facilities have not yet been determined.

### ***Capital and Labour***

SERN has advised that the capital cost during the construction phase is expected to be in the range of US\$350 million to US\$820 million, depending on local market conditions at the time of procurement.

Engineering, procurement and construction contracts will be awarded to local contractors, and supplies and materials sourced locally wherever possible (GoTL, 2012).

### ***Associated Infrastructure Requirements***

Timor-Leste is deficient in the core infrastructure, support industries and human resources to fully operate and manage the country's developing petroleum sector (RD TL, 2011b) and, as a result, a range of infrastructure and services will be upgraded to facilitate the local petroleum industry.

These works do not form part of the scope of this SEIA but are considered logical and necessary developments to facilitate the project.

The Suai to Beaco South Coast Road will be developed to support the growth of the petroleum industry and to open up this area of coastline to allow economic development and the delivery of social services (RD TL, 2011b). The upgrade of the road will be a staged development, responding to the growth of the petroleum industry as it evolves. The Timor-Leste Strategic Development Plan 2011 – 2030 (SDP) also sets out that by 2020, all national and regional roads will have been fully upgraded to international standards.

Power supply for the refinery will be provided by the proposed Southern Power Plant, which forms part of the GoTL's National Electricity Grid infrastructure program to support social and economic development across Timor-Leste. The power station is proposed to be located adjacent (west) to the Betano refinery site. *'The station will include a substation that raises the voltage to 150 kV for the*



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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*purposes of connection with the transmission system. The engines will initially run on light or heavy fuel oil and will be capable of being converted to natural gas.*' (RDTL, 2011b). As mentioned above, this does not form part of the scope for this SEIA.

### **Construction Activities**

The SDP schedules the construction of the initial phase (~30,000 BPD) to be completed between 2013 and 2016, and for the expansion to be completed between 2024 and 2030 (RDTL, 2011b). Details of the actual proposed construction periods and logistics are not yet known.

The proposed construction phasing for the project is not currently available. In considering the typical sequence of activities for developments of a similar scale and nature, the construction of the refinery and petrochemical complex, Nova Viqueque and Nova Betano are likely to include the following activities:

- Site surveying:  
Surveying the site to mark the boundaries, access ways, and locations of structures and features in accordance with the co-ordinates on the detailed design drawings.
- Access and administration:  
Establishment of temporary access ways (to and within the sites) and the construction management office on site.
- Perimeter fencing:  
Installation of perimeter fencing around each site to restrict unauthorised entry, for the safety and security of staff, the community, equipment and property.
- Vegetation clearance:  
Clearing of vegetation necessary to facilitate the built and sealed aspects, and temporary construction laydown areas.
- Site levelling:  
Carry out earthworks activities using heavy machinery to move and compact soil for leveling.
- Construction laydown area and temporary buildings:  
Establishment of construction laydown areas and temporary buildings and structures, including administration buildings, staff facilities, and waste management areas.
- Power supply:  
Secure power supply (e.g., power station connection or temporary generators) to provide power during the construction sites.
- Key equipment:  
The type of heavy machinery (including specifications) and vehicles to be used during construction (including their frequency of use and duration on site) will be determined by the awarded construction contractor upon appointment.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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- Facilities construction:

The construction method for the project is not currently available but, a combination of imported, modularized components bought in by barge and on-site construction is likely. It is assumed that the awarded contractor will prepare a construction EMP upon appointment which will include details of construction activities, method and phasing.

### **Commissioning**

It is expected that all plant and equipment at the refinery and petrochemical complex will go through a period of testing and commissioning (approximately four months) prior to handing over to the operators.

### **Rehabilitation and Decommissioning**

Given the likely lifespan of the refinery and petrochemical complex, the decommissioning phase has not been assessed at this stage.

Typically, a decommissioning and closure plan would be developed approximately 10 years prior to commencement of decommissioning, and the associated environmental impacts are assessed as part of the development of the plan.

### **4.3.2 Nova Betano**

Nova Betano, to be known as the 'Petroleum Administration City' (RDTL, 2011b), is intended to support the refinery and petrochemical complex.

The new town will provide for up to 14,500 residents, primarily intended for staff and their families involved in the oil and gas industry development including primary contractors, support companies and visitors but, will also provide a resettlement area for relocated communities as a result of the proposed refinery development.

The GoTL publication Book 7 Master Plan and Urban Design Package of Nova Betano sets out the preliminary physical framework for a new settlement at Betano and forms part of the government's Spatial Design Planning for Southern Coast of Timor-Leste (2011), which have been prepared to align with the SDP (RDTL, 2011b).

Book 7 has been prepared as an initial concept document, setting out an approach to master plan and urban design guidelines for Nova Betano. It forms the basis for a detailed master plan and urban design package and detailed engineering to be prepared at subsequent stages, and provides an early indication of infrastructure requirements.

Figure 4-2 shows the indicative layout for the new town and the total general land use areas which will comprise:

#### *Eastern area:*

- Single family residential houses: approximately 240.1 ha.
  - Four areas of single house units and amenities.
  - 240 sqm houses on 450 sqm lots.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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- Multi-family residential apartments: approximately 51.2 ha.
  - Apartments and amenities with 96 sqm living space per apartment.
- Employee dormitory: approximately 19.7 ha.
- Schools: approximately 20.0 ha.
  - International school and associated facilities.
  - National school and associated facilities.
- Business hotel: approximately 8.6 ha.
- Hospital: approximately 28.7 ha.
- Commercial area: approximately 16.4 ha.
  - Town center.
  - Supermarket.
- Community center: approximately 10.7 ha.
  - Assembly hall.
  - Sporting facilities.
  - Restaurant.
  - Library.
- Park and recreation areas: approximately 99.6 ha.
- Golf course and driving range: approximately 43.7 ha.
- Golf residences: approximately 14.0 ha.
- Gate landmark entrance: approximately 0.4 ha.
- Public services: approximately 9.6 ha.
  - Security office.
  - Fire department.
  - Internal road infrastructure: approximately 73.1 ha.
- Support facilities:
  - Stormwater pond.
  - Water supply and facilities.
  - Sanitation (sewerage and waste water treatment).
  - Power plant.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### *Western area:*

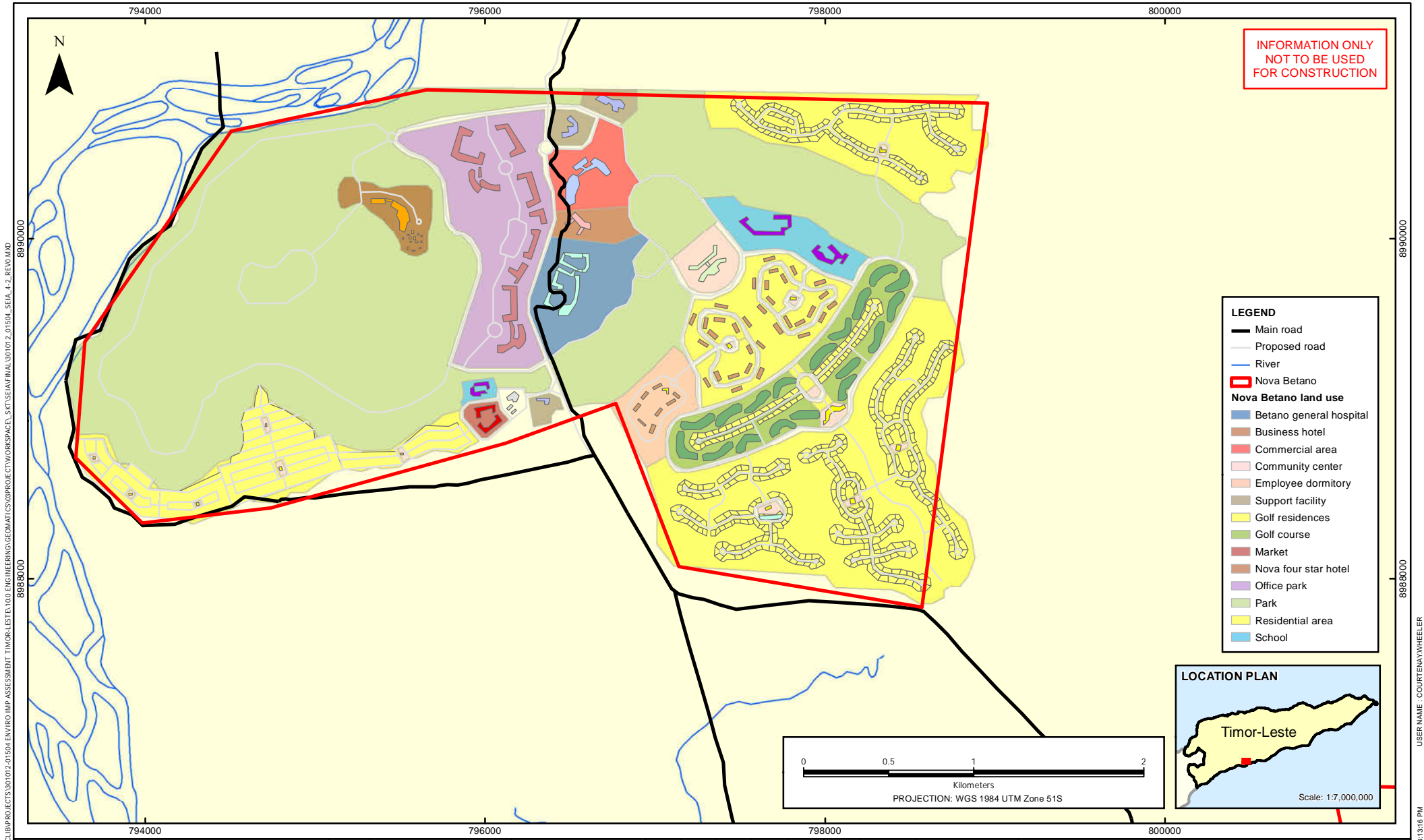
- Resettlement area: approximately 114.6
  - Residential area with 68 sqm houses on 300 sqm lots.
  - Primary and secondary schools.
  - Church.
  - Market.
- Hotel: approximately 13.8.
- Offices: approximately 77.3 ha.
- Recreation park and open space: approximately 310.2 ha.
- Internal road infrastructure: approximately 55.2 ha.
- Support facilities.
  - Stormwater pond.
  - Water supply and facilities.
  - Sanitation (sewerage and waste water treatment).
  - Power plant.

Nova Betano will be the largest of the four new towns being developed under the wider Tasi Mane Project. Nova Suai will be developed as part of the Suai supply base development and is considered under a separate study. Nova Viqueque and Nova Beaco are considered under Sections 4.4.2 and 4.4.3 (respectively) below as part of the Beaco development.

The current plan for developing Nova Betano is to build multi-family and single family residential areas, commercial areas, and a community center and support facilities. The SDP schedules the construction of the first stage of Nova Betano to be completed between 2013 and 2016, and for the expansion to be completed between 2024 and 2030. Details of the actual proposed construction periods and logistics are not yet known (RDTL, 2011b).

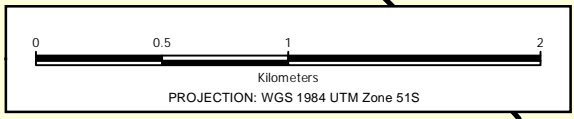
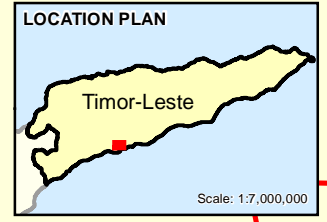
It is understood that access to the new settlement would be facilitated by the upgraded Suai to Beaco South Coast Road. As outlined in Section 4.3.1 above, the road upgrade does not form part of the scope for this EIA.

Existing land use at the site of Nova Betano is shown by the aerial imagery in Figure 4-3 and is discussed further in Section 6.2.



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- LEGEND**
- Main road
  - - - Proposed road
  - River
  - ▭ Nova Betano
- Nova Betano land use**
- ▭ Betano general hospital
  - ▭ Business hotel
  - ▭ Commercial area
  - ▭ Community center
  - ▭ Employee dormitory
  - ▭ Support facility
  - ▭ Golf residences
  - ▭ Golf course
  - ▭ Market
  - ▭ Nova four star hotel
  - ▭ Office park
  - ▭ Park
  - ▭ Residential area
  - ▭ School



NOTES:  
This map consists of:  
1. Rivers: Geographic Information Group TimorLeste (2010)  
2. Roads: DivaGIS (2010)  
3. Land Use Layout: RDTL Ministry of Finance (2011)

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TASI MANE PROJECT - BETANO AND BEACO  
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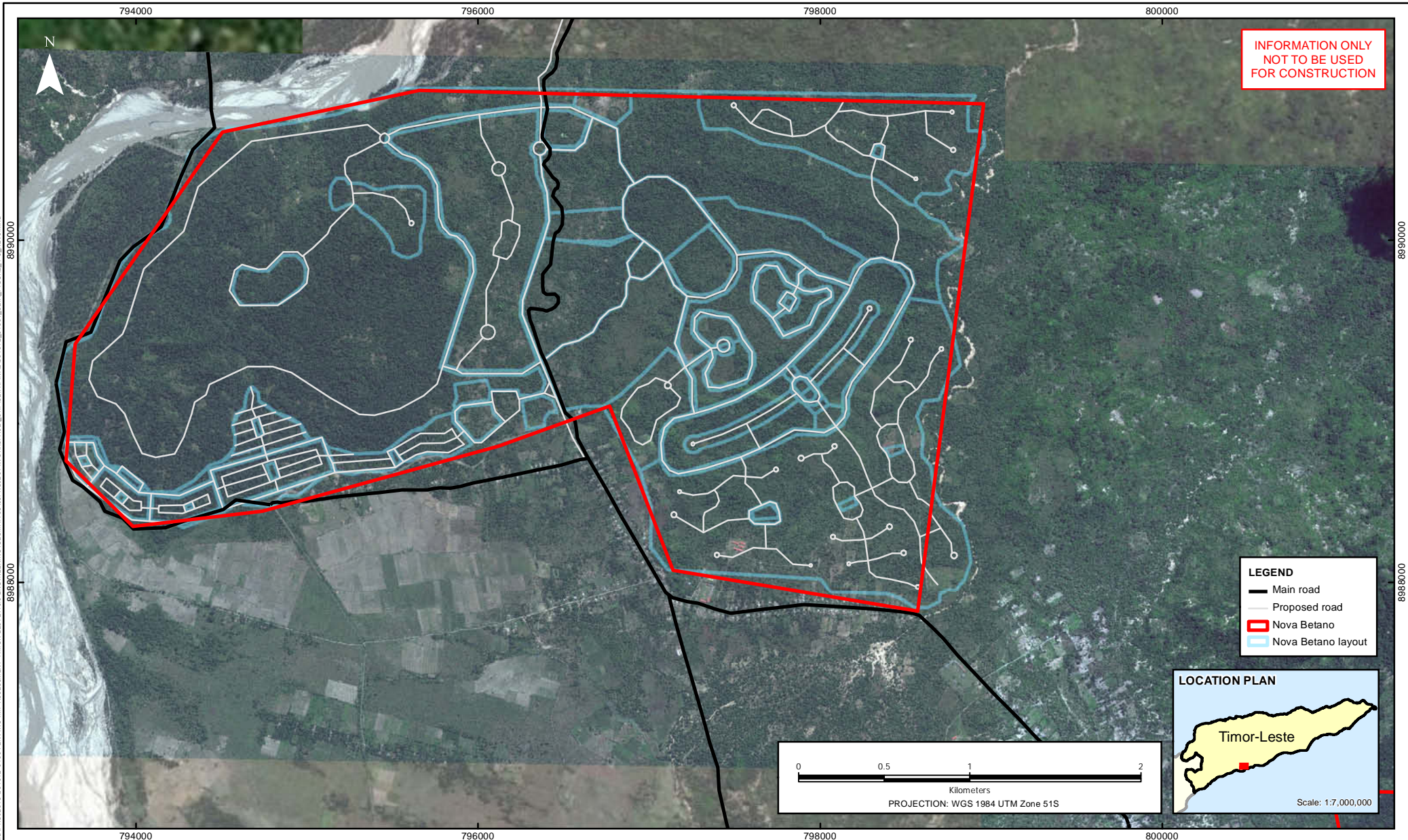


**Figure 4-2**  
Indicative layout of Nova Betano

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**LEGEND**

- Main road
- Proposed road
- Nova Betano
- Nova Betano layout

**LOCATION PLAN**

Timor-Leste

Scale: 1:7,000,000

0 0.5 1 2  
Kilometers  
PROJECTION: WGS 1984 UTM Zone 51S

- NOTES:  
This map consists of:  
1. Imagery: DigitalGlobe (2008-2011)  
2. Imagery: Google Earth (2011)  
3. Roads: DivaGIS (2010)  
4. Land Use Layout: RDTL Ministry of Finance (2011)

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REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504		



**Figure 4-3**  
Aerial imagery showing the existing landuse at Nova Betano

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USER NAME: COURTENAYWHEELER  
PLOT DATE & TIME: 30 MAY 2012, 1:26:44 PM



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 4.4 Project Related Infrastructure – Beaco

#### 4.4.1 LNG plant

The GoTL proposes to build an LNG plant to develop the existing petroleum exploration in the Timor Sea and provide hydrocarbons processing facilities ('downstream' activities) in Timor-Leste. The GoTL has determined a coastal location at Beaco, in the Viqueque district, as the most suitable location to develop an LNG plant and supporting infrastructure.

The LNG plant would receive gas from off-shore fields via a pipeline for process into LNG, propane and butane for export. The LNG plant is intended to have modern infrastructures and facilities to provide a fully capable natural gas processing complex to export standards. A preferred LNG production process has not yet been selected.

It is proposed to initially construct a 5 Mtpa capacity LNG plant (one train), with expansion to up to 20 Mtpa subject to gas reserves. The proposed phasing for the project is not currently available. WorleyParsons has been requested to assess the potential impacts associated with a 5 Mtpa plant. The ultimate gas requirements and train configuration will be determined during the front-end engineering and design (FEED) phase of the project.

The criteria for the ideal location of an on-shore LNG plant typically includes: close proximity to the shoreline/where the off-shore pipeline reaches land, level terrain (ideally < 5%), close proximity to a good road network, and within approximately 50 km of an airport.

#### **Conceptualisation**

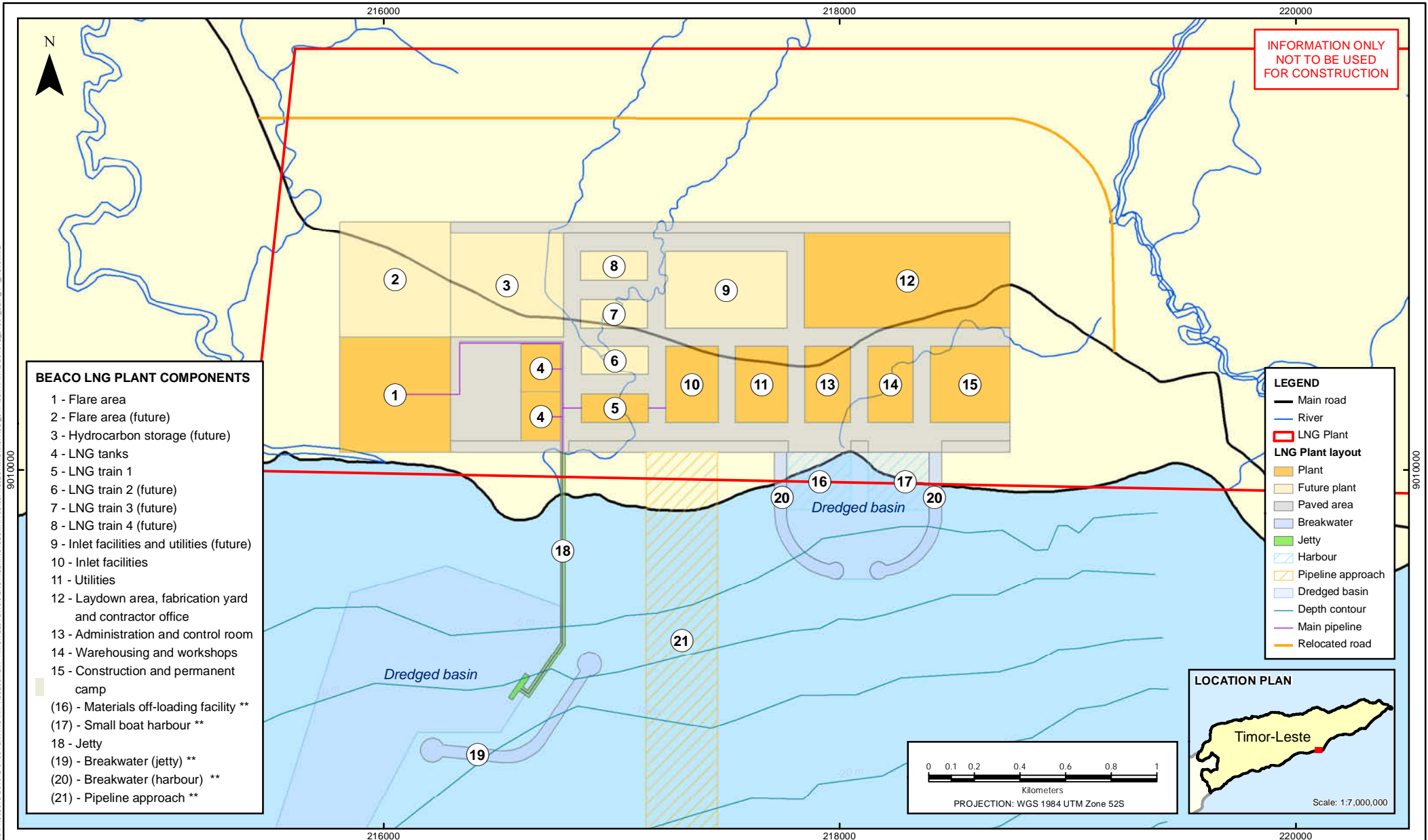
A conceptualisation study (pre-feasibility) has been undertaken by KBC, with GS Engineering and Construction, (Timor LNG - Conceptualisation and Cost Estimation KBC Project no. 105125, undated) which identifies the key built aspects that are likely to be required for the on-shore components of an LNG plant and associated jetty area at Beaco. An indicative layout of the proposed LNG plant is shown in Figure 4-4. It is understood that engineering assessment and detailed design is in progress.

A conceptualisation study undertaken by KBC *et. al.* records the design information and key built aspects that are likely to be required for an LNG plant at Beaco (KBC, undated). These are summarised in Table 4-2.

The scope of the conceptualisation study, and this SEIA, is the on-shore component of a 5 Mtpa LNG plant, and dedicated jetty for product loading for export. It is understood that studies relating to off-shore components (i.e., pipeline, any off-shore production facilities) are yet to be commissioned. These, and a breakwater that would be required to shelter the jetty area, do not form part of the scope for this SEIA.

Existing land use at the site of LNG Plant at Beaco is shown by the aerial imagery in Figure 4-5 and is discussed further in Section 7.2.





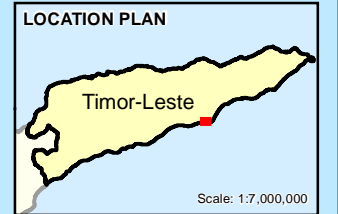
**BEACO LNG PLANT COMPONENTS**

- 1 - Flare area
- 2 - Flare area (future)
- 3 - Hydrocarbon storage (future)
- 4 - LNG tanks
- 5 - LNG train 1
- 6 - LNG train 2 (future)
- 7 - LNG train 3 (future)
- 8 - LNG train 4 (future)
- 9 - Inlet facilities and utilities (future)
- 10 - Inlet facilities
- 11 - Utilities
- 12 - Laydown area, fabrication yard and contractor office
- 13 - Administration and control room
- 14 - Warehousing and workshops
- 15 - Construction and permanent camp
- (16) - Materials off-loading facility \*\*
- (17) - Small boat harbour \*\*
- 18 - Jetty
- (19) - Breakwater (jetty) \*\*
- (20) - Breakwater (harbour) \*\*
- (21) - Pipeline approach \*\*

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**LEGEND**

- Main road
- River
- LNG Plant
- LNG Plant layout**
- Plant
- Future plant
- Paved area
- Breakwater
- Jetty
- Harbour
- Pipeline approach
- Dredged basin
- Depth contour
- Main pipeline
- Relocated road



**NOTES:**  
This map consists of:  
1. Rivers: Geographic Information Group Timor-Leste (2010)  
2. Roads: DivaGIS (2010)  
3. Plant layout: KBC (n.d)

**\*\* Items 16, 17, 19, 20 and 21 were not part of WorleyParsons' study scope**

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								Copyright © WorleyParsons Services Pty Ltd		

**TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT**

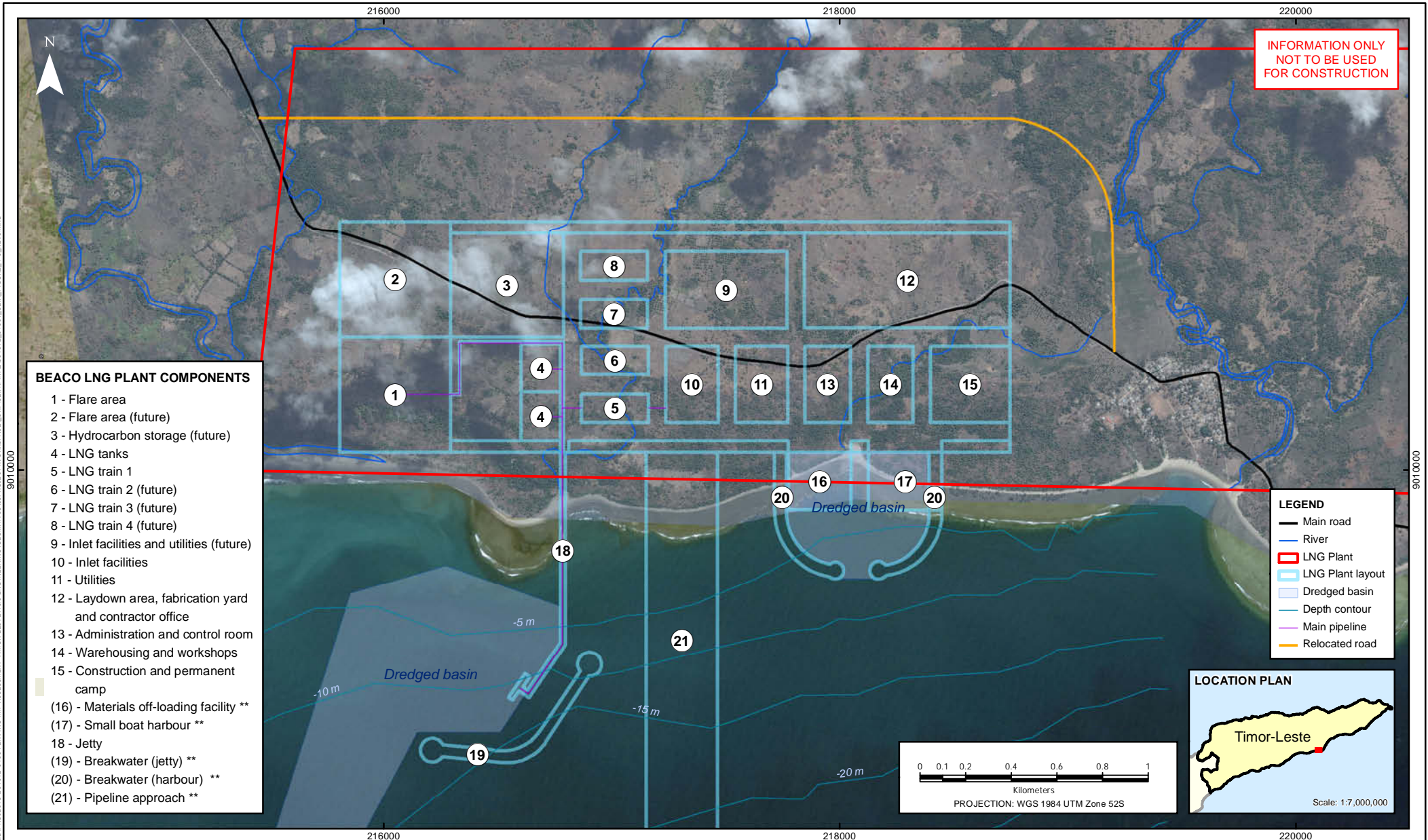
**Figure 4-4**  
Indicative layout of the proposed LNG Plant at Beaco

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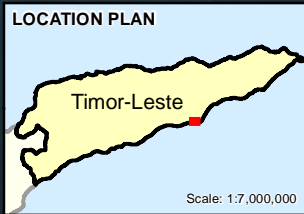
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- BEACO LNG PLANT COMPONENTS**
- 1 - Flare area
  - 2 - Flare area (future)
  - 3 - Hydrocarbon storage (future)
  - 4 - LNG tanks
  - 5 - LNG train 1
  - 6 - LNG train 2 (future)
  - 7 - LNG train 3 (future)
  - 8 - LNG train 4 (future)
  - 9 - Inlet facilities and utilities (future)
  - 10 - Inlet facilities
  - 11 - Utilities
  - 12 - Laydown area, fabrication yard and contractor office
  - 13 - Administration and control room
  - 14 - Warehousing and workshops
  - 15 - Construction and permanent camp
  - (16) - Materials off-loading facility \*\*
  - (17) - Small boat harbour \*\*
  - 18 - Jetty
  - (19) - Breakwater (jetty) \*\*
  - (20) - Breakwater (harbour) \*\*
  - (21) - Pipeline approach \*\*

INFORMATION ONLY  
NOT TO BE USED  
FOR CONSTRUCTION

- LEGEND**
- Main road
  - River
  - LNG Plant
  - LNG Plant layout
  - Dredged basin
  - Depth contour
  - Main pipeline
  - Relocated road



**NOTES:**  
This map consists of:  
1. Imagery: DigitalGlobe (2008-2011)  
2. Imagery: Google Earth (2011)  
3. Rivers: Geographic Information Group Timor-Leste (2010)  
4. Roads: DivaGIS (2010)  
5. Plant layout: KBC (n.d.)

**\*\* Items 16, 17, 19, 20 and 21 were not part of WorleyParsons' study scope**

0	6/06/2012	FINAL FOR ISSUE	CW	MW	CS	-	GH	-	A4 SHEET	SCALE 1:22,500
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										Copyright © WorleyParsons Services Pty Ltd

**TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT**

**Figure 4-5**  
Aerial imagery showing the existing landuse at the Beaco LNG Plant

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**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

**Table 4-2 Likely operational components and construction phasing for the Beaco LNG plant**

Component	Phase	Figure 4-4 ref	Facilities	Capacity/Area
<b>Land-based facilities</b>				
Process and utilities area (1,000 m x 1,000 m)	1 1, 2	5 - 8	<b>Gas reception:</b> Pig receiver, slug catcher, and feed gas heater <b>LNG train:</b> Acid gas remover unit (including bulk liquid storage) Gas dehydration and mercaptan removal Mercury removal unit LPG recovery unit Liquefaction unit Refrigeration unit Fractionation unit Waste heat recovery	<b>Phase 1:</b> 300 m (L) x 125 m (W) single train with a liquefaction rate of 5.0 Mtpa of LNG.  <b>Future expansion:</b> Additional three trains for a total liquefaction rate of 20.0 Mtpa of LNG.  Power: nominal load 150MW. Water supply: estimated use 1,000 m <sup>3</sup> /day.
	1	10, 11	<b>Utilities:</b> Power generation and distribution Water systems (sea water, service water, demineralised water, cooling water, drinking water) Air systems Inert gas Heating medium Fuel (fuel gas and diesel) Fire protection (firewater and foam) Pressure relief and liquid disposal (vapour and liquid disposal) Drainage and effluent treatment (process water, waste water, oil contamination, uncontaminated surface water run-off system)	





**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

**Table 4-2 Likely operational components and construction phasing for the Beaco LNG plant (cont'd)**

Component	Phase	Figure 4-4 ref	Facilities	Capacity/Area
<b>Land-based facilities</b>				
Flare and hydrocarbon storage (1,000 m x 1,000 m)	1	1, 4	<b>Phase 1:</b> Refrigeration (Ethane and Propane) – insulated tanks LNG tanks (2) – full containment design (inner and outer tanks) Propane tank – full containment design (inner and outer tanks) Butane tanks – full containment design (inner and outer tanks) Chemical (see 'warehouse' below) Flare area	(unknown) 2 x 175,000 m <sup>3</sup> tanks 1 x 45,000 m <sup>3</sup> tank 1 x 45,000 m <sup>3</sup> tank (unknown) (unknown)
		1, 3	<b>Future expansion:</b> Expansion to flare area Expansion to hydrocarbon store	
Buildings (1,000 m x 1,000 m)	1	13	Administration	~200 perm, ~3000 temp
		13	Control rooms	
		15	Accommodation, mess facilities, medical facilities	
		13	Security	
		14	Workshops and warehousing	
	12	Temporary construction laydown and contractor office		
<b>Marine facilities</b>				
Jetty area	1	18	Dedicated jetty-head for product loading (LNG, propane and butane export).	4 x loading arms with a rate of approximately 4,000 to 6,000 m <sup>3</sup> /hr

Source: tabled information from the report by KBC, undated.





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### ***Key components***

The key components likely to be required for an LNG plant at Beaco can be divided into four areas:

- Process and utilities area (gas reception, LNG train, utilities).
- Flare and hydrocarbon storage.
- Buildings.
- Marine facilities (jetty area).

The processing facilities are expected to have a design life of 20 years, and the infrastructure facilities are expected to have a design life of 40 years.

The establishment of the LNG facility will require the construction of wharf and jetty structures to enable the loading of the LNG vessels. A materials offloading facility (MOF) is also required to enable the transfer of materials and heavy equipment to the project site for construction and operation.

A dedicated jetty-head is likely to be located approximately 1,500 m off-shore in 13.5 m of water, and will be connected to the shore by a trestle. It is understood that LNG, propane and butane will be exported by ship from the jetty (KBC, undated). Requirements for dredging (capital and maintenance) to create shipping access and wave protection structures (i.e. breakwaters) are yet to be determined.

### ***Indicative Scale and Phasing***

The initial phase would establish a single train with a production capacity of 5 Mtpa, which this SEIA is based on. The GoTL intend for the site layout and plant configuration to be designed to accommodate a further three trains of similar size to process up to 20 Mtpa of LNG at a later stage.

Approximately 300 ha of land would be required for the LNG plant facilities for adequate separation distances between certain facilities within the site, temporary construction laydown areas, and allowing for future expansion. The indicative layout shown in Figure 4-4 is based on a 1,000 m by 3,000 m plot, which assumes there will be significant modularisation of the process design (KBC, undated).

The scale and location of some built aspects are likely to change during the feasibility and detailed design stages of the development.

### ***Operations (Inputs, Processes, and Storage)***

There will be three main input streams to the LNG facility:

- Plant feed gas.
- Seawater that is desalinated and treated to provide the quality requirements for plant processes and utilities.
- Miscellaneous supplies and chemicals required for the general operation and maintenance of the facility.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Liquefaction allows gas to be shipped and stored safely and economically. It is understood from SERN that the preferred liquefaction technology (refrigeration) and processing configurations are yet to be selected.

Two refrigerants are required to operate the liquefaction process, propane and a mixed refrigerant (a mixture of nitrogen, methane, ethane and propane). The propane and ethane will be stored in insulated tanks and will be pumped into the refrigerant process as required (KBC, undated).

Two 175,000m<sup>3</sup> LNG storage tanks will be provided (KBC, undated). Each LNG storage tank will be equipped with loading pumps, level gauges, level transmitters, relief valves, vents, temperature elements, and other basic instrumentation. Safety systems i.e., emergency shutdown, gas detectors and fire detection systems will be developed during detailed design.

### ***Hours of Operation***

The LNG plant would be designed for an on-stream availability of 340 days per year (KBC, undated). The hours of operation for staff facilities have not yet been determined.

### ***Capital and Labour***

Estimates associated with capital and operational expenditure are yet to be released by SERN. Engineering, procurement and construction contracts will be awarded to local contractors for works and services, as well as for purchase of local supplies and materials, wherever possible (GoTL, 2012).

It is expected that operational services at the LNG plant will also be provided by a combination of government and private organisations that will be resolved through normal tendering processes as the project progresses.

### ***Associated Infrastructure Requirements***

The power generation source will be designed to meet the requirements of the processing facility, administration buildings, workshops, warehouses and operations camp. Emergency power will be provided by diesel driven power generator units (KBC, 2011).

The LNG Plant will also require substantial quantities of water. A desalination plant is proposed as part of the development. Following construction (peak water demand period), this may be reduced to a smaller, desalination plant for long-term water supply (KBC, 2011)

In the order of 1.5 million tonnes of quarry materials; rock and sand, is likely to be required for construction as concrete aggregate, general fill, or for road construction.

### ***Construction Activities***

The SDP schedules the construction of the initial phase (5 Mtpa) of the plant to be completed between 2017 and 2023, and for the expansion to be completed between 2024 and 2030 (RDTL, 2011b). Details of the actual proposed construction periods and logistics are not yet known.

The proposed construction phasing for the project is not currently available. In considering the typical sequence of activities for developments of a similar scale and nature, the construction of the LNG plant and Nova Beaco are likely to include the following activities:



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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- Site surveying:  
Surveying the site to mark the boundaries, access ways, and locations of structures and features in accordance with the co-ordinates on the detailed design drawings.
- Access and administration:  
Establishment of temporary access ways (to and within the sites) and the construction management office on site.
- Perimeter fencing:  
Installation of perimeter fencing around each site to restrict unauthorised entry, for the safety and security of staff, the community, equipment and property.
- Vegetation clearance:  
Clearing of vegetation necessary to facilitate the built and sealed aspects, and temporary construction laydown areas.
- Site levelling:  
Carry out earthworks activities using heavy machinery to move and compact soil for leveling
- Construction laydown area and temporary buildings:  
Establishment of construction laydown areas and temporary buildings and structures, including administration buildings, staff facilities, and waste management areas.
- Power supply:  
Secure power supply (e.g., power station connection or temporary generators) to provide power to the construction sites.
- Key equipment:  
The type of heavy machinery (including specifications), hand tool equipment and vehicles to be used during construction (including their frequency of use and duration on site) will be determined by the awarded construction contractor upon appointment.
- Facilities construction:  
The construction methodology for the project is not currently available. It is assumed that the awarded contractor will prepare a construction EMP upon appointment which will include details of construction activities, methodology and phasing.

### **Commissioning**

It is expected that all plant and equipment at the LNG plant will go through a period of testing and commissioning prior to handing over to the operators.

### **Rehabilitation and Decommissioning**

Given the likely lifespan of the refinery and petrochemical complex, the decommissioning phase has not been assessed at this stage.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Typically, a decommissioning and closure plan would be developed approximately 10 years prior to commencement of decommissioning, and the associated environmental impacts are assessed as part of the development of the plan.

### 4.4.2 Nova Viqueque

Nova Viqueque is proposed to accommodate the workforce for the LNG Plant.

The new town will provide for up to 6,400 residents, primarily intended for staff and their families involved in the oil and gas industry development, as well as guests associated with the company.

The GoTL publication 'Book 8 Master Plan and Urban Design Package of Nova Suai' sets out the preliminary physical framework for a new settlement at Viqueque and forms part of the government's 'Spatial Design Planning for Southern Coast of Timor-Leste' (2011), which have been prepared to align with the SDP (RDTL, 2011b).

Book 8 has been prepared as an initial concept document, setting out an approach to master plan and urban design guidelines for Nova Viqueque. It forms the basis for a detailed master plan and urban design package and detailed engineering to be prepared at subsequent stages, and provides an early indication of infrastructure requirements.

Figure 4-6 shows the indicative layout for the new town and the total general land use areas which will comprise:

- Multi-family residential houses (two areas): approximately 38.7 ha.
  - Apartment buildings, 208 sqm living space per apartment.
  - Employee dormitory buildings.
  - Recreational facilities .
- Single family residential houses ('Hillside Residential'): approximately 66.8 ha.
  - 235 sqm single houses on 450 sqm lots.
  - Common areas.
- Single family residential houses ('The Top') and common areas: approximately 11.9 ha.
- International school: approximately 8.2 ha.
  - Elementary school and associated facilities.
  - Junior high school and associated facilities.
- Commercial area: approximately 3.4 ha.
  - Supermarket and grocery store.
  - Shopping mall.
  - Petrol station.
  - Hotel.
- Community center: approximately 5.3 ha.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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- Assembly hall.
- Recreation facilities.
- Library.
- Park and recreation: approximately 44.6 ha.
- Gate landmark entrance and security building: approximately 0.8 ha.
- Main office and rental office: 17.6 ha.
- Public facilities: approximately 6.1 ha.
  - Security office.
  - Estate management office.
  - Fire department.
  - Maintenance and workshop.
- Internal road infrastructure and utility network: approximately 14.3 ha.
- Support facilities: approximately 31.5 ha.
  - Stormwater pond.
  - Water supply and facilities.
  - Sanitation (sewerage and waste water treatment).
  - Power plant.

Nova Viqueque will be one of the four new towns being developed as part of the wider Tasi Mane Project.

The current plan for developing Nova Viqueque is to build part of the multi-family residential and single family residential areas, the community center, offices, commercial area and public facilities developed first. Stage 2 would include the development of the school, the multi-family residential area will be completed, and the office and single family residential area will be expanded. Stage 3 will include the development of the remaining areas of the single family residential area.

The SDP schedules the construction of Nova Viqueque to be completed between 2017 and 2023. Details of the actual proposed construction periods and logistics are not yet known. (RDTL, 2011b).

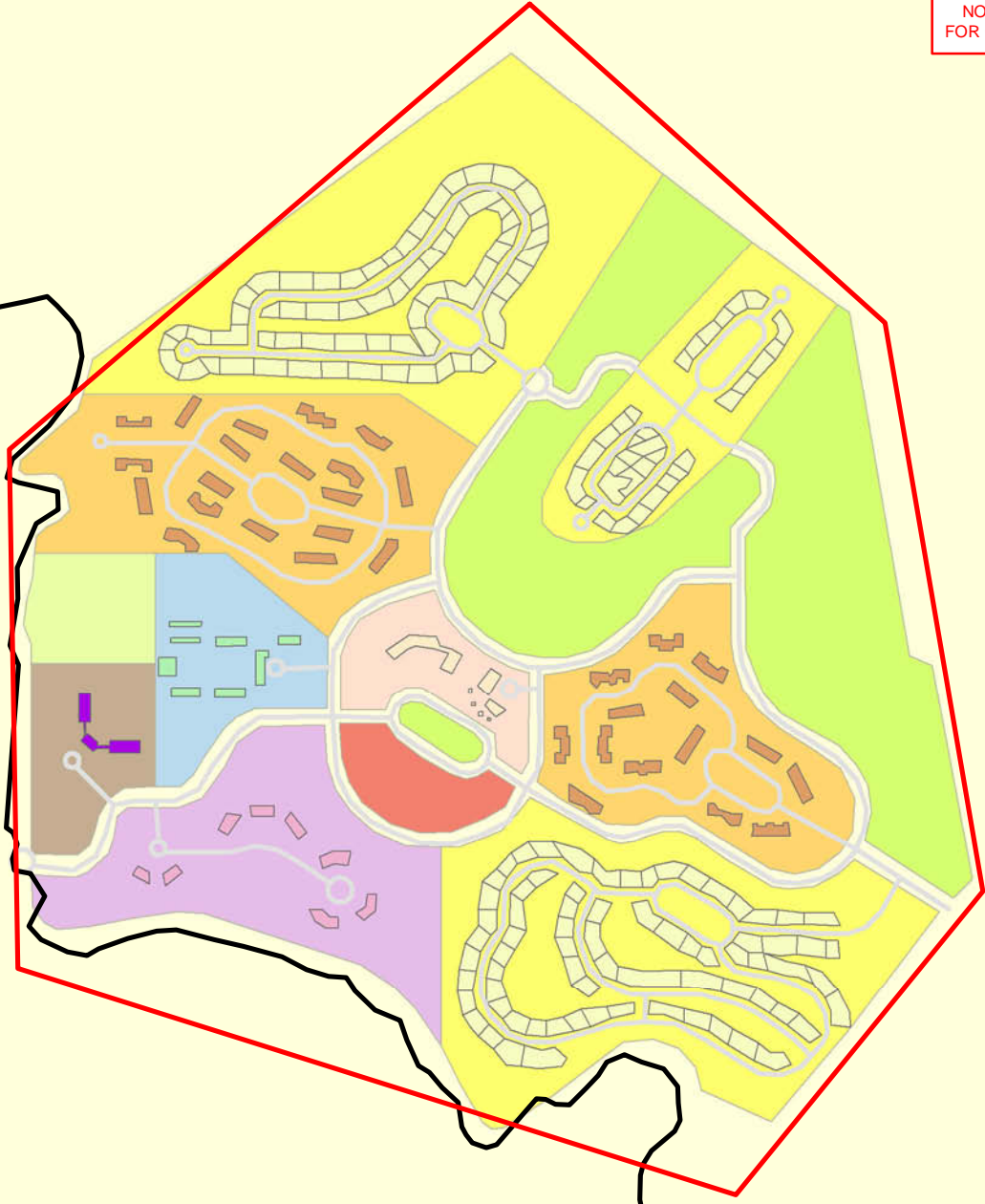
Existing land use at the site of Nova Viqueque is shown by the aerial imagery in Figure 4-7 and is discussed further in Section 7.2.

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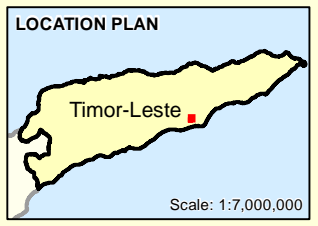
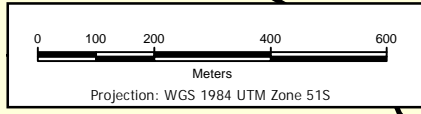


**LEGEND**

- Main Road
- Proposed road
- River
- Nova Viqueque

**Nova Viqueque land use**

- Commercial area
- Community center and assembly hall
- Empty space
- Single family residential
- Multi-family residential and employee dormitory
- International school
- Park
- Support facilities
- Office area



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NOTES:  
This map consists of:  
1. Roads: DivaGIS (2010)  
2. Rivers: Geographic Information Group Timor-Leste (2010)  
3. Land Use Layout: RDTL Ministry of Finance (2011)

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								Figure 4-6 Indicative layout of Nova Viqueque		

TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

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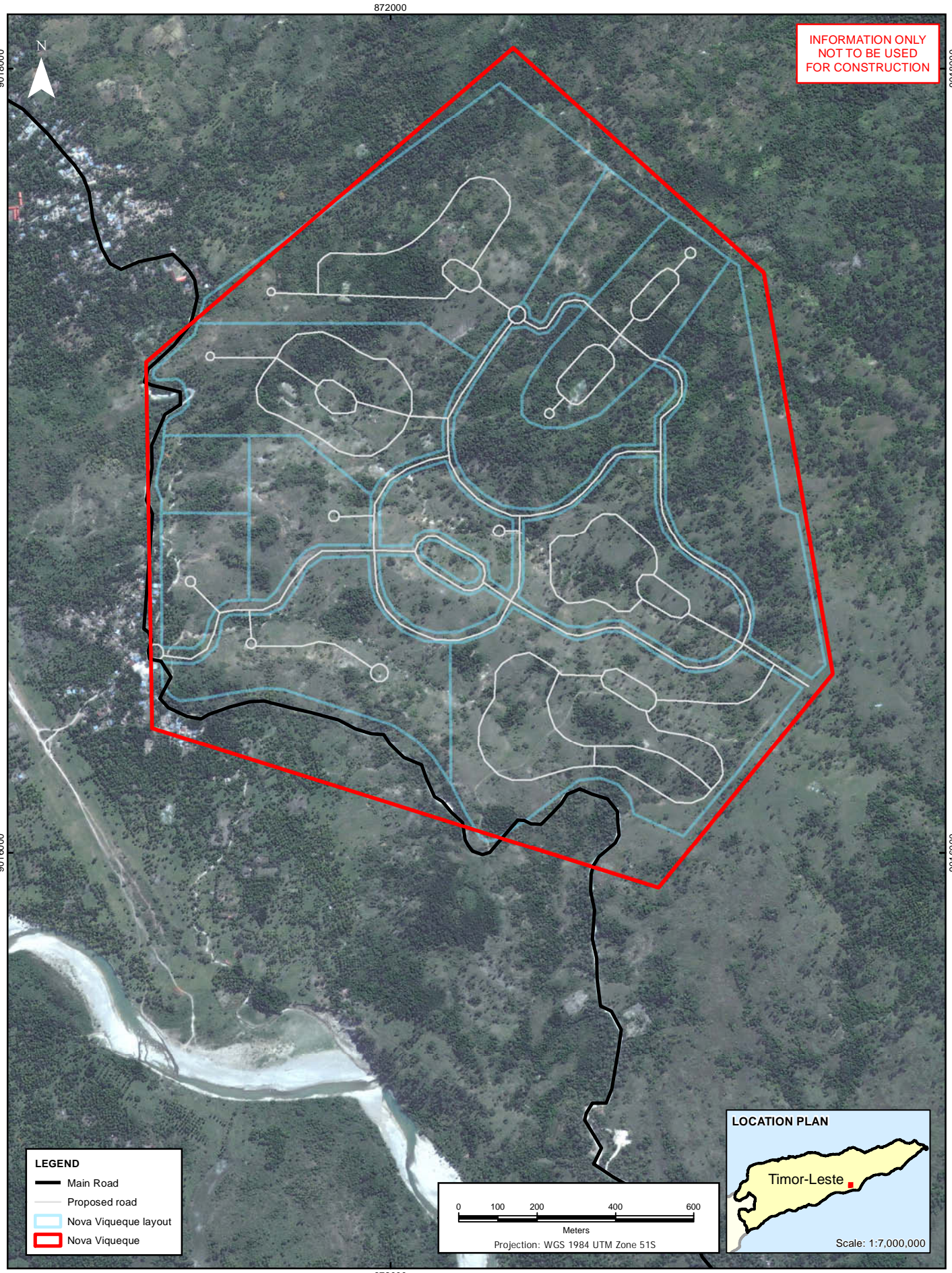
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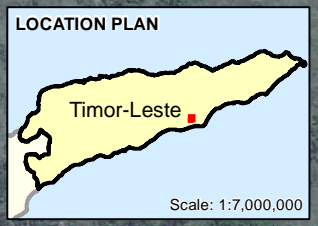
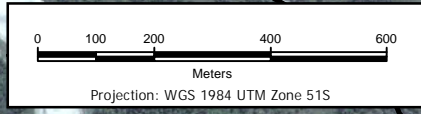
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LEGEND	
	Main Road
	Proposed road
	Nova Viqueque layout
	Nova Viqueque



NOTES:  
This map consists of:  
1. Imagery: DigitalGlobe (2008-2011)  
2. Roads: DivaGIS (2010)  
3. Land Use Layout: RDTL Ministry of Finance (2011)

0	30/05/2012	FINAL FOR ISSUE	CS	MW	-	-	GH	-	A4 SHEET	SCALE 1:13,000	TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504		



**Figure 4-7**  
Aerial imagery showing the existing landuse at Nova Viqueque

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PLOT DATE & TIME: 30 MAY 2012, 8:49:52 AM





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 4.4.3 Nova Beaco

Nova Beaco is primarily intended to accommodate existing residents of nearby villages who will require relocation as a result of the development of the LNG plant.

The preliminary design allocates approximately 200 ha for the new town, and is intended to accommodate up to 1,900 people.

The GoTL publication *Book 9 Master Plan and Urban Design Package of Nova Beaco* sets out the preliminary physical framework for a new settlement at Beaco and forms part of the government's *Spatial Design Planning for Southern Coast of Timor-Leste* (2011), which have been prepared to align with the SDP (RDTL, 2011b).

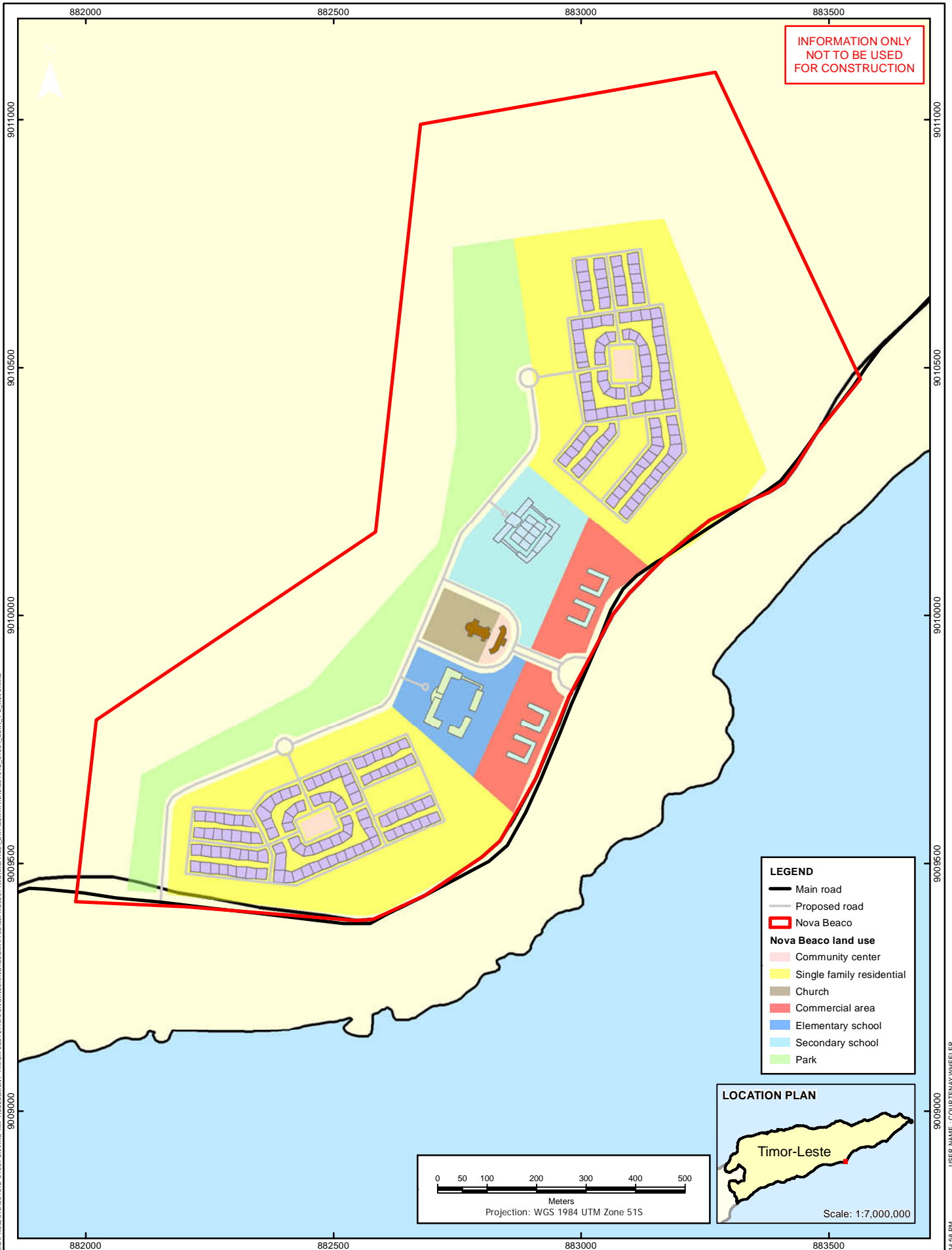
Book 9 has been prepared as an initial concept document, setting out an approach to master plan and urban design guidelines for Nova Beaco. It forms the basis for a detailed master plan and urban design package and detailed engineering to be prepared at subsequent stages, and provides an early indication of infrastructure requirements. A master plan will guide the development for the next 20 years; the duration of this preliminary version is five years (2012-2017).

The design principles for the proposed accommodation are for the use of modern materials and sanitations, and will follow traditional architectural form. Figure 4-8 shows the indicative layout for the new town and the total general land use areas which will comprise:

- Single family residential houses (two areas): approximately 46.4 ha.
  - Common areas.
  - 300 sqm single storey houses on 500 sqm lots.
- Schools: approximately 10.3 ha:
- Elementary school and associated facilities.
- Junior high school and associated facilities.
- Commercial areas for markets (two areas): approximately 6.3 ha.
- Community center and church: approximately 2.0 ha.
- Open space: approximately 24.5 ha.
- Gate landmark entrance and security building: approximately 0.4 ha.
- Internal road infrastructure and utility network: approximately 11.0 ha.
- Support facilities:
  - Stormwater pond.
  - Water supply and facilities.

Nova Beaco will be the last of the four new towns being developed as part of the wider Tasi Mane Project.

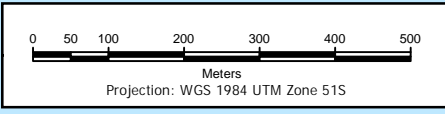
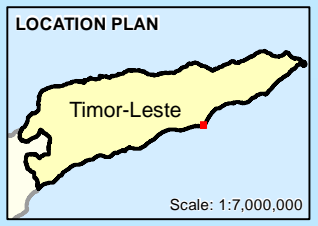
Existing land use at the site of Nova Beaco is shown by the aerial imagery in Figure 4-9 and is discussed further in Section 7.2.



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**LEGEND**

- Main road
- Proposed road
- Nova Beaco
- Nova Beaco land use**
- Community center
- Single family residential
- Church
- Commercial area
- Elementary school
- Secondary school
- Park



NOTES:  
This map consists of:  
1. Roads: DivaGIS (2010)  
2. Rivers: Geographic Information Group TimorLeste (2010)  
3. Land Use Layout: RDTL Ministry of Finance (2011)

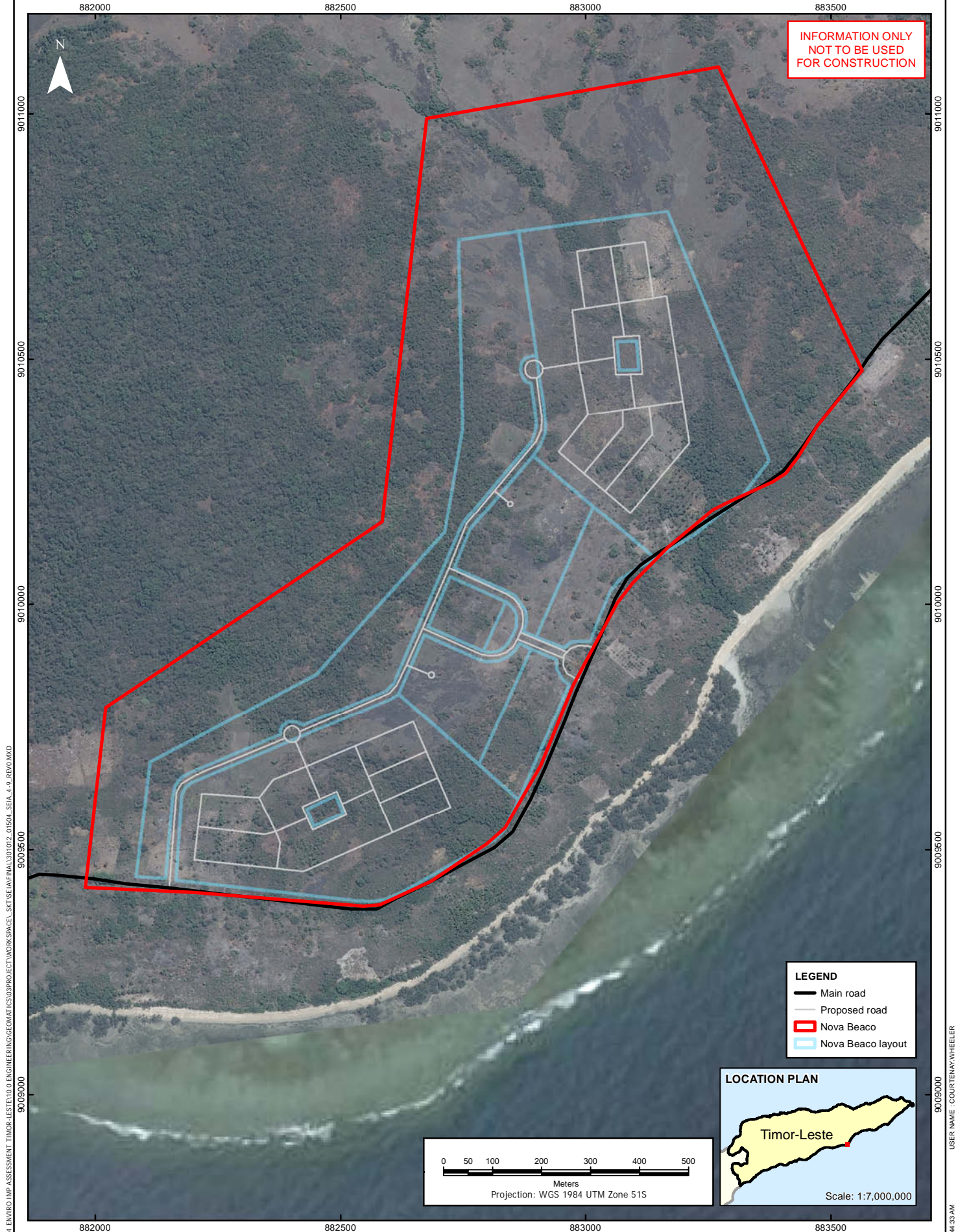
0	29/05/2012	FINAL FOR ISSUE	CS	MW	CW	-	GH	-	A4 SHEET	SCALE 1:10,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
								Copyright © WorleyParsons Services Pty Ltd		

**Figure 4-8**  
Indicative layout of Nova Beaco

LOCATION: \\PWERDOR\FULL\INSTRUC\BIBR\PROJ\ETS\301012-01504\ENVIRO\IMP\ASSESSMENT\TIMOR-LESTE\10.0\ENGINEERING\GEMAT\GIS\PROJECT\WORKSPACE\_S\KTS\SET\FINAL\301012-01504\_SEIA\_4.8\_REV0.MXD

USER NAME: COURTENAY\WHEELER  
PLOT DATE & TIME: 29 MAY 2012, 3:14:58 PM





INFORMATION ONLY  
NOT TO BE USED  
FOR CONSTRUCTION

**LEGEND**

- Main road
- Proposed road
- Nova Beaco
- Nova Beaco layout

**LOCATION PLAN**

Timor-Leste

Scale: 1:7,000,000

0 50 100 200 300 400 500

Meters

Projection: WGS 1984 UTM Zone 51S

**NOTES:**  
This map consists of:  
1. Imagery: DigitalGlobe (2008-2011)  
2. Roads: DivaGIS (2010)  
3. Land Use Layout: RDTL Ministry of Finance (2011)

0	30/05/2012	FINAL FOR ISSUE	CS	MW	CW	-	GH	-	A4 SHEET	SCALE 1:10,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
								Copyright © WorleyParsons Services Pty Ltd		

**Figure 4-9**  
Aerial imagery showing the existing landuse at Nova Beaco

LOCATION: I:\PROJECTS\301012-01504-ENVIRO\IMP ASSESSMENT\TIMOR-LESTE\10.0-ENGINEERING\GEMAT\CS\03\PROJECT\WORKSPACE\SKT SE (A4)\FINAL\301012\_01504\_SFA\_4.r REV01.MXD

USER NAME: COURTNEY WHEELER  
PLOT DATE & TIME: 30 MAY 2012, 8:44:33 AM



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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The currently plan for developing Nova Beaco is to build the main gate, southern single family residential area, southern market area, the elementary school, the church and community center developed first. Stage 2 would include the development of the remaining single family residential area, northern market area, and the junior high school.

The SDP schedules the construction of Nova Beaco to be completed between 2017 and 2023. Details of the actual proposed construction periods and logistics are not yet known. (RDTL, 2011b).

It is understood that access to the new settlement would be facilitated by the upgraded Suai to Beaco South Coast Road. As outlined in Section 4.3.1 above, the road upgrade does not form part of the scope for this EIA.

Existing land use at the site of Nova Beaco is shown by the aerial imagery in Figure 4-9.

### 4.4.4 Viqueque Airstrip upgrade

The GoTL proposed to upgrade the existing airport at Viqueque to be a fully operational regional airport, to operate as a fly-in-fly-out (FIFO) airport for the operators of the proposed LNG plant.

Improved civil aviation facilities at Viqueque airstrip also forms part of the sustainable growth strategy set out in the National Planning Document (2002) and the SDP.

Viqueque airstrip currently has an unsealed airstrip approximately 100 m in length and 100 m in width, which is displayed in Figure 4-10.

The upgrade works will include a new sealed runway, and new facilities for customs and immigration, arrival and departure, fire-fighting, and site fencing.

The SDP schedules the upgrade works to be completed between 2017 and 2023. Details of the actual proposed construction periods and logistics are not yet known (RDTL, 2011b).



LOCATION: \P\PROJECTS\TIMOR-LESTE\01504\_ENVIRO\_IMP\_ASSESSMENT\TIMOR-LESTE\01504\_ENVIRO\_IMP\_ASSESSMENT\GOMAT\GIS\PROJECT\WORKSPACE\SKT\SET\FINAL\2012-01504\_SEIA\_FIGURE\_4-10\_REV0.MXD

9016000

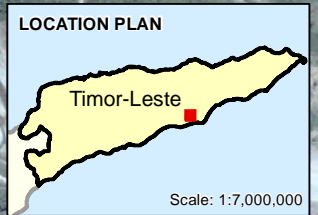
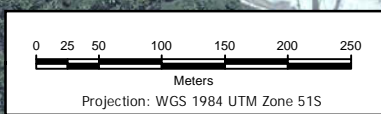
9016000

USER NAME: COURTENAY/WHEELER  
PLOT DATE & TIME: 30 MAY 2012, 4:29:46 PM



**LEGEND**

- Main road
- Nova Viqueque



**NOTES:**  
This map consists of:  
1. Imagery: DigitalGlobe (2008-2011)  
2. Roads: DivaGIS (2010)

0	5/06/2012	FINAL FOR ISSUE	CS	MW	-	-	GH	-	A4 SHEET	SCALE 1:6,000	
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504		

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**Figure 4-10**  
Aerial imagery showing the existing landuse at the Viqueque Airport





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# Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

## Strategic Environmental Impact Assessment

### CHAPTER 5

## STAKEHOLDER CONSULTATION



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 5. STAKEHOLDER CONSULTATION

This section addresses requirements of Timor-Leste Decree Law No. 5/2011 (Article 11 of Chapter IV) which outlines specific requirements for public consultation in the environmental impact of those projects designated as Category A by the law. The law states that public consultation should have the following objectives:

- Providing access to the EIA findings.
- Inform and enlighten the public about the project, including potential environmental impacts and their way of mitigation.
- Promote discussion about the EIA and EMP.

Any member of the public may provide recommendations or proposals based on the EIA and EMP to the Evaluation Committee, during the public exhibition of the EIA. Public consultation is required to define the project scope and to discuss the project terms of reference (ToR) and the opinions of interested parties must be reflected in the ToR.

The NDSMA, the GoTL department responsible for assessment and approval of the EIA, has developed various guidelines that have been considered in this SEIA; the most important of those from the social perspective being NDSMA Guideline No. 5 on Public Consultation.

#### 5.1 Objectives

Stakeholder consultation aims to create an environment of informed and constructive participation of all parties interested in, or affected by, a proposed development. On its own, consultation cannot prevent conflict; rather it facilitates a process in which people feel heard and included in decision-making and project design, and where potentially satisfactory outcomes are identified.

On-going consultation with stakeholders regarding the Tasi-Mane project will continue following the submission of the EIA for the Suai Supply Base. It is also recognised by SERN that further consultation is required regarding the Betano Refinery and Petrochemical Complex, and the Beaco LNG Plant. The objectives of further consultation are twofold in nature. It will:

- Ensure full disclosure of project information at local, district and national level.
- Provide feedback on the key findings of the SEIA and the continuing environment assessment process at these proposed development sites.

#### 5.2 Stakeholders

The stakeholder consultation process includes the identification of stakeholders that are directly or indirectly affected by the project, also referred to as interested and affected parties (IAPs).

As part of its investigation for the socio-economic study, an initial stakeholder identification process was undertaken using data received from secondary sources including:

- GIS data, to identify villages in the project area.



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

- Reference books and internet sites.

A diverse range of stakeholders were identified and divided into two groups – primary stakeholders and secondary stakeholders, as shown in Table 5-1. Primary stakeholders are defined as those who are directly affected or can influence the development, while secondary stakeholders are those who are not directly affected; however, have a strong interest in the development.

**Table 5-1 Identified stakeholders**

Primary Stakeholders	Secondary Stakeholders
<p>Directly affected residents (landowners and land users) within 500 m of the proposed development areas. More specifically, the following villages should be consulted during forthcoming stakeholder consultation:</p> <ul style="list-style-type: none"> <li>• Betano: Betano.</li> <li>• Beaco: Maluru (Beaco), Uma-Uain Craik, Uma-Uain-Leten and Watu Dere.</li> </ul>	<p>Nearby settlements (between 500 m and 1 km from proposed developments).</p> <p>The following villages should be included in forthcoming consultations:</p> <ul style="list-style-type: none"> <li>• Betano: Foho-Ai-Lico.</li> <li>• Beaco: Caraubalo and Uma Quic.</li> </ul>
<p>Regulatory authorities, councillors and tribal authorities covering national, district and sub-district levels with authority in the directly affected project area including:</p> <ul style="list-style-type: none"> <li>• NDSMA – main regulatory body for assessment and approval of ESIA.</li> <li>• Ministry of Agriculture, Forestry and Fisheries (MAFF).</li> <li>• Ministry of Public Works (MPW).</li> <li>• Minister of Justice (in case a business license is required).</li> </ul>	<p>NGOs and community-based organisations (CBOs) active at a national and local level, as well as those having international representation in the country.</p> <p>The following NGOs were reported to be active in the project-affected villages:</p> <ul style="list-style-type: none"> <li>• Betano: Kadalak Sulimutuk Institute (KSI), La'o Hamutuk.</li> <li>• Beaco: GTZ, Cailalo, Colegas da Paz, La'o Hamutuk (No NGOs were reported in Maluru village).</li> </ul>
<p>Government ministers with directly relevant portfolios:</p> <ul style="list-style-type: none"> <li>• Ministry of Environment.</li> <li>• MAFF.</li> <li>• Ministry of Transport and Communication.</li> <li>• Ministry of Development.</li> <li>• Ministry of Education and Culture (Secretary for Culture).</li> <li>• Secretariat of State for Employment and Professional Training (SEFOPE).</li> <li>• Ministry of Planning and Finance.</li> </ul>	<p>Other government ministers:</p> <ul style="list-style-type: none"> <li>• Ministry of Health.</li> <li>• Ministry of Justice.</li> <li>• Ministry of Internal Administration.</li> </ul>



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 5.3 Consultation Activities

There has been limited stakeholder consultation to date for the proposed developments around Betano and Beaco. SERN has undertaken some consultation in both project areas and further consultation during the fieldwork that informed the preparation of the socio-economic study of this report (Sections 6.10 and 7.10). SERN held one public village meeting in Maluru village in April 2011 (Beaco development) and another meeting in August 2011 at Betano village (Betano development). The meetings were attended by local people from the areas where the project is proposed to be built, community leaders, and various Government stakeholders.

Stakeholder consultation undertaken specifically to gather information to inform the SEIA was aimed at identifying the socio-economic baseline characteristics for the study areas<sup>1</sup> and to describe community perceptions about the project, as previously disclosed by SERN. Section 5.2 details the key informant interviews and focus group meetings that were held to gather socio-economic baseline information.

Based on the feedback of residents, it is clear that people in the Betano and Beaco study areas would like to receive more information about a range of aspects for each project and more importantly for the future approval of these projects. These villages have not been able to develop an informed opinion about either project. It appears that the greatest interest is in:

- The location of the proposed developments.
- Project schedules.
- Accommodation facilities for the construction workforce.
- Preferential recruitment policies for local residents.
- Composition and number of the workforce.
- Details of the new settlement at Nova Betano, Nova Beaco and Nova Viqueque
- The implications of mandatory resettlement (in particular Maluru village).
- Impacts on farming and fishing activities
- Compensation procedures for assets and fields.

As far as information disclosure at a district and national level is concerned, a non-government organisation (NGO) - La'ó Hamutuk, was interviewed. La'ó Hamutuk reported that it was unaware of project information being widely disclosed at either district or national level.

#### 5.3.1 Socio-economic Consultation Activities

In the fieldwork that informed preparation of this SEIA, baseline socio-economic information was gathered through participatory methods such as key informant interviews, focus group meetings, cultural mapping and, GIS analysis of aerial imagery. A site visit was undertaken by two social

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<sup>1</sup> Betano study area includes the village interviewed by WorleyParsons namely Betano village and Beaco study area includes Maluru village and Uma-Uain-Craik village.



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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specialists, working independently, to obtain more information on the surrounding socio-economic elements that could be affected by the project.

The key informant interview for the Betano development was held on 10 December 2011 with Chief Saturnino Tilman. The focus group meeting was held with thirteen village representatives on 11 December 2011.

The key informant interview for the Beaco development was held on 11 December 2011 with Chief Jeronimo Pinto. The focus group meetings were held in Maluru and Uma-Uain Craik villages on 13 December 2011. Nine village representatives attended the focus group meeting in Maluru and six representatives attended the meeting in Uma-Uain Craik.

## 5.4 Further Consultation

As stated previously, on-going consultation should take place with identified stakeholders following the submission of the SEIA and any future EIA fieldwork. Consultation for the SEIA for Betano and Beaco will also be undertaken prior to, and during, project construction. The consultation will be conducted through a socialization process, similar to the process undertaken for the Suai Supply Base, and will present the key messages and aspects of the SEIA for both Betano and Beaco. On-going consultations can be divided into:

- 'Full' SEIA fieldwork notifications.
- SEIA feedback.
- Ongoing consultation during construction and operations.

Village leaders should be notified before any specialists commence with EIA fieldwork. These notifications should detail the dates, number of specialists and objectives of fieldwork to set the local population at ease about their presence in the area. Notifications will also enable the local villagers to make time available for interviews to gather further social baseline information.

It is suggested for EIA feedback to be presented during two stages, namely project information sharing and EIA feedback. For the project information sharing meetings, public meetings should be held at Dili, Beaco and Betano respectively. Project information to be presented at these meetings may include the project aspects listed under Section 5.3. The project information needs to be presented in a way that is easy to understand. In order to provide feedback on the key EIA findings, a draft EIA report should be presented to stakeholders at a national and local level as well as other stakeholders such as NGOs and lobby groups. These EIA feedback meetings should be held at Dili, Betano and Beaco respectively. To ensure the findings of the EIA report are clearly understood, a non-technical summary of the findings of the EIA should be developed for distribution to stakeholders and the general public. The minutes from the EIA feedback meetings should be distributed to ensure that an accurate account of the meetings was kept and to allow IAPs the opportunity to ratify the minutes from each meeting. All concerns, issues and suggestions raised should be documented in the minutes. Copies of the minutes should be made available at Dili and relevant village halls within the Betano and Beaco study areas.

On-going consultation and engagement should be undertaken during the construction and operation phases as well. This consultation should be done by means of the grievance mechanism (as





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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described in Section 5), establishing project information offices at Betano and Beaco respectively (as suggested under mitigation measures in Chapters 6 and 7 and additional public meetings, to announce key construction and operation phase milestones.

Potential communication mechanisms to be further investigated and refined closer to the commencement of the EIA are discussed under Section 5.4.1.

### 5.4.1 Communication Mechanisms

There are a number of culturally appropriate communication mechanisms which should be considered to support the disclosure of additional project information:

**Background Information Documents:** Detailed project information will inform stakeholders about the proposed project, the area involved, additional project activities, the timeline for the proposed project, initial issues (both positive and negative) identified by the project team and the further consultations. These should be distributed in Tetun, Tetum Teric (Betano development) and Makasai (Beaco development) where possible. Background Information Documents should be targeted at stakeholders with a higher level of education and technical understanding of LNG developments.

**Educational posters:** These should be distributed in Portuguese and Tetum Teric (Betano development) and Makasai (Beaco development) to assist people who have little or no knowledge about the LNG process thereby creating a basic understanding of the activities of the proposed project. These posters should be placed at the directly affected villages to convey information by means of illustrations to cater for illiterate people in the villages.

**Letters of Invitation:** Letters detailing dates, times and venues inviting relevant authorities and interested and affected parties to meetings should be distributed.

**Notification posters:** These should be distributed in Portuguese and Tetum Teric (Betano development) and Makasai (Beaco development) to advise the general public and specific villages about the proposed project and about public and community meetings. These notices should be placed at the respective villages at each site.

**Radio announcements** should be prepared in Tetum Teric (Betano development) and Makasai (Beaco development) and broadcast via radio to remind the general public and communities about the public village meetings taking place in their areas. These announcements should be broadcast on a regular basis two weeks before meetings commence.

**Megaphones (loud hailers)** should also be used on the day of meetings to remind villagers who do not have radios of the meeting.

**Response sheets:** These sheets mainly target IAPs at a national and district level and not so much directly affected villagers. The sheets should be sent to authorities, interested parties and the general public in Portuguese and Tetum Teric (Betano development) and Makasai (Beaco development) to give IAPs an opportunity to register for the project and raise their concerns, issues or suggestions. Response sheets should also be the method by which IAPs who are unable to attend meetings can become a part of the stakeholder consultation process.



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### 5.4.2 Grievance Mechanism

A grievance procedure should be developed to ensure that concerns and potential conflicts arising during the continuing project feasibility and development stages can be satisfactorily addressed. WorleyParsons has developed this grievance mechanism framework for discussion with stakeholders (including government) to refine the procedure to meet stakeholder needs through consultation.

Once refined, project staff (comprising a representative who will receive grievances at a site grievance office, and a Dili office representative) should be provided with training. These staff will accept and log incoming grievances and, if the grievance is directly related to the project's actions, follow a prioritisation process to identify the required remedial action.

Figure 5-1 illustrates a suggested procedure for managing and resolving complaints during the feasibility stage. The procedure is equally relevant during the development stage of the project with responsibility for resolution defined between the project proponent and the construction contractor. It is important to ensure the following values are upheld throughout the grievance process:

- Awareness.
- Accessibility.
- Transparency.
- Expediency.

Stakeholder awareness of the existence of the mechanism will mean that when an issue arises, community members will know where to go to address and resolve the issue. This will encourage the issue to be dealt with through the appropriate mechanism and will improve expediency of resolution and good will with the community. Therefore when engaging with the villages and other stakeholders they should be made aware of the grievance mechanism and where or whom they should contact to access the mechanism.

Accessibility to the grievance mechanism will also enable stakeholders to air their complaints directly thereby avoiding other forums such as the media. Typically, the earlier the proponent becomes aware of potential issues, the more efficiently these can be mitigated and contained. Furthermore early detection of potential issues can prevent problems arising later in the project lifecycle. It will be essential to break down barriers to accessibility which, based on baseline investigations, include, geographic location, literacy levels, language and cultural appropriateness, and distrust in government or corporate structures. Recommended strategies to overcome these barriers include:

- Establishing a grievance office at Dili and at the Betano and Beaco study areas.
- Upon request, remote locations and vulnerable individuals (e.g., elderly and disabled) should be visited by a representative of the project who will disseminate information regarding the project and receive complaints from stakeholders at their village or residence. This will promote accessibility of the grievance procedure and help build a relationship with communities and encourage dialogue.
- Complaints should be able to be registered via a toll-free telephone line to allow direct access to each individual to the grievance mechanism. Another option is to provide a pre-paid mobile



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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phone to each village chief to be exclusively used for lodging grievances. The mobile phone would allow the chief to send a message to the nearest grievance office requesting the grievance officer to visit the village and record the grievance. The pre-paid mobile option needs to be further investigated in consultation with village chiefs.

- Representatives should be instructed to note down complaints where the individual is unable or unwilling to write the complaint themselves.
- Local people fluent in the relevant languages should be engaged as representatives.
- Locals should be consulted regarding the cultural appropriateness of the complaints process.
- Complainants should be given the option of maintaining anonymity throughout the complaints process.

Transparency of process cultivates trust and ensures expectations among the stakeholders are set at an appropriate level. Elements of the grievance procedure which will encourage transparency include explaining the process and timescales associated with processing a complaint, providing the complainant with a copy of the complaint when it has been submitted and ensuring the complainant is kept informed of developments in processing their complaint. Written complaints should be held at the respective grievance offices where the complainant (or a designated advocate) should be allowed access.

Expediency will enable efficient processing of complaints. In order to encourage expediency the project should set deadlines for processing complaints and a case management approach should be established among the relevant staff, with oversight from a senior individual who should be assigned responsibility for management of the grievance mechanism.

As well as committing to the values mentioned here, it is suggested for the project to work to International Finance Corporation (IFC) guidelines (IFC, 2011) regarding grievance mechanisms.





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# Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

## Strategic Environmental Impact Assessment

### CHAPTER 6

## ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT – BETANO REFINERY AND PETROCHEMICAL CLUSTER



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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## 6. ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT – BETANO REFINERY AND PETROCHEMICAL CLUSTER

### 6.1 Climate and Meteorology

This study was designed to provide a baseline description of the general climate and meteorological profile of the region in which the Betano development is proposed to be located.

The study method adopted for the climate and meteorological assessment of the Betano study area is summarised as follows:

A literature review to identify:

- Relevant documentation describing climatic trends.
- Relevant sources of regional meteorological data.
- Establish of a temporary meteorological station in close proximity to the Betano Refinery area in general accordance with Australian Standard AS 3580.14-2011 *Methods for sampling and analysis of ambient air Part 14: Meteorological monitoring for ambient air quality monitoring applications* (AS 3580.14-2011).
- Determination of general climate and meteorological trends.
- Development of recommendations for any future or ongoing meteorological monitoring for the Betano study area.

#### 6.1.1 Study Scope

Meteorological trends are more adequately described on a scale of tens of kilometres or greater. Therefore, the study scope includes the Betano Refinery and Nova Betano areas plus the wider coastal lowland region extending approximately 10 km along the coast in either direction, and approximately 9 km inland to the foothills.

#### 6.1.2 Literature Review

Several sources of information are available describing the general climate for Timor-Leste on a country-wide scale. However, few sources describe the particular meteorological trends for the southern coastal region of the country around Betano. The following documents were reviewed as part of this assessment:

- Report on restoration of meteorological network – Timor Loro’Sae (Keefer, 2000);
- Vulnerability to climate variability and change in East Timor (Barnett et.al, 2007);
- Climate change in Timor-Leste – a brief overview on future climate projections (CSIRO, 2010);  
and
- Climate Risk and Agriculture in Timor Loro’Sae (Dolcemascolo, 2003).



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

Meteorological information was provided from an automated weather station (AWS) owned by the Ministry of Agriculture (MoA, 2012a) within the Betano study area. The reported information is provided in Appendix C. Location coordinates of the AWS are provided in Table 6-1. The information spans the 2004 to 2011 calendar years and reports daily averaged information for the following parameters:

- Maximum, minimum and mean temperature (degrees Celsius).
- Maximum, minimum and mean relative humidity (%).
- Rainfall (mm).
- Mean wind speed (m/s).
- Solar radiation (MJ/m<sup>2</sup>).
- Evapotranspiration (mm).

The supplied data are daily averages and do not report wind directions. Typically meteorological AWS' make observations on an hourly basis. In addition, there are significant data gaps over the reported period. As such, this information does not provide sufficient time-dependant resolution to adequately determine prevailing climate trends.

#### 6.1.3 Baseline Measurement Method

A temporary, semi-automated meteorological station was established in Betano from 10 December 2011 to 13 February 2012, approximately 750 m west of the area designated for development of the Southern Power Plant. Location coordinates of the meteorological station are provided in Table 6-1. The meteorological station was sited in general accordance with AS 3580-14-2011 – *A guide to sampling and analysis of air emissions and air quality*). The meteorological station comprised of two parts: the weather vane and instrumentation; and the hand-held data storage device. The data storage device also incorporated an internal electronic thermometer for indoor temperature measurements and an internal electronic hygrometer for indoor humidity measurements. Meteorological parameters were recorded automatically and downloaded periodically over the monitoring period to a computer for statistical analysis.

**Table 6-1 AWS and temporary meteorological station coordinates**

Label	Location Coordinates		Elevation Above Ground Level	Total Elevation Above Sea Level
	Latitude	Longitude		
AWS (Ministry of Agriculture)	9° 08' 50.5" S	125° 41' 41.0" E	2 m	32 m
Betano Weather Station (WorleyParsons)	9° 09' 51.3" S	125° 43' 42.6" E	3 m	10 m

Parameters measured by the meteorological station are listed below:

- Date and time;
- Measurement interval (minutes);
- Indoor and outdoor humidity (relative %);



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- Indoor and outdoor temperature (degrees Celsius);
- Absolute and relative pressure (hPa);
- Wind speed and gust speed (m/s);
- Wind direction (16 directions);
- Dewpoint temperature and Wind-chill (degrees Celsius);
- Hourly, 24 hourly, weekly, monthly and total rainfall (mm); and
- Wind and gust speed (Beaufort wind force scale 0 to 12). Whilst this data was recorded, data relating to wind speeds has been presented in m/s for this assessment.

Measurements were made automatically at 30 minute intervals from the time the device was reset. Measurements that are analysed on an hourly average (wind speed/direction and rainfall) were averaged or totalled over each hour period.

### 6.1.4 Data Assumptions and Limitations

There have been several limitations to this study as outlined below:

- The monitoring period for the baseline measurements spanned 66 days and is not representative of seasonal or long-term trends.
- An equipment failure resulted in only the 'indoor' temperature and humidity values, and minimal wind speed and direction data being recorded.
- The meteorological station installed on site was oriented as close as reasonably practicable to true north; however, it cannot be guaranteed that the orientation angle was exact.
- Site personnel were not present for the entire duration of the monitoring period, therefore it is possible that the meteorological station may have been interfered with, altering the results.
- It was indicated in the proposal that more than 50 years of data should be available for up to 15 to 20 locations across the country. This data was not made available for analysis.

### 6.1.5 Existing Environment

#### *General Description*

The Betano study area displays a typical tropical monsoonal climate with distinct wet and dry seasons. Seasonal variation in temperature is minimal, with the diurnal temperature variation often greater than the seasonal variation. Daytime temperatures are typically in the low 30's and night-time temperatures are in the mid to high 20's. Humidity is consistently high, typically above 75% and ranging up to 85%. Long-term multi-year rainfall trends are generally dictated by El Niño/La Niña effects; however, shorter-term annual rainfall patterns are monsoonal in nature experiencing a 7 to 9 month wet season with two peak months, December and May (CSIRO, 2010). The coastal region in which the Betano study area resides generally receives less annual rainfall than the midland and highland regions further inland. Rainfall events are often torrential in nature and short in duration.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Little wind speed and wind direction information was able to be obtained, therefore generalised trends are not able to be determined at this time. Two cyclone events have been reported to be within 100 km, with an additional nine cyclone events within 200 km of the Betano study area since 1920.

### ***Major Influencing Climate Processes***

The primary climate process that influences the rainfall across Timor-Leste is the El Niño Southern Oscillation (ENSO). The ENSO is an air-sea interaction in the Pacific Ocean that affects climate variability in the Indo-Pacific region with a cycle of three to seven years. An El Niño/La Niña event occurs when the eastern tropical Pacific is much warmer/cooler than normal (CSIRO, 2010).

CSIRO (2010) reports that a strong association exists between the Southern Oscillation Index (SOI) and both the dry season total rainfall, and the onset date of the wet season. Some reported effects of El Niño events in (Barnett et.al, 2007) are:

- Annual rainfall in Dili during the 1997/1998 and 1982/1983 El Niño events are the lowest and second lowest in 48 years of records (1950 to 1999).
- Districts such as Ainaro and Lautém have experienced annual rainfall as low as 50% of average while districts such as Baucau and Oecussi experienced greater than average rainfall.

El Niño events are commonly associated with prolonged drought and it is reported that Timor-Leste experiences agricultural and hydrological drought approximately once every four years (Dolcemascolo, 2003).

During the monitoring period, the SOI ranged from 23.0 in December 2011 to 2.5 in February 2012. Prolonged periods with the SOI greater than 8.0 are indicative of La Niña conditions. This indicates that Timor-Leste experienced weak La Niña conditions during the monitoring period.

Solar radiation is a driving force for climatic processes. In the case of the Betano study area, cloud cover is often minimal during daylight hours. Large cloud banks covering the sky later in the afternoon were observed on occasion; however, these cloud banks were directly related to significant rainfall events. In addition, these cloud banks are an indirect result of the evaporation of the ocean due to solar radiation.

The mountainous region spanning the length of the Timor island acts as a barrier to trade winds emanating from the northwest. Moisture-laden air from the surrounding oceans encounter the mountains and are pushed higher into the atmosphere. The moisture then precipitates out of the atmosphere due to the cooler conditions and results in torrential downpours throughout the highlands. These downpours affect the lowlands on the southern coast of the island by the frequent flushing of the river systems in the area, as well as deposition of sediment eroded from the highlands.

### ***Temperature***

Timor-Leste has a tropical climate in which the temperature varies little throughout the year (CSIRO, 2010). However, the diurnal (daily) variation can be larger than the monthly variation throughout the year. It is also estimated that the annual mean temperature decreases with increasing altitude at a rate of 5.5°C per 1,000 metres above sea level (CSIRO, 2010). As the Betano study area is in the coastal low-lying region with an approximate elevation of less than 25 m above sea level, and the monitoring





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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period was during the southern hemisphere summer, it is expected that the measured temperatures are representative of the hottest period of the calendar year.

The time series for indoor temperatures and a daily temperature profile for the monitoring period are presented in Figure 6-1 and Figure 6-2. The indoor temperatures show less diurnal variation than the outdoor measurements taken at other sites across the southern coast. This is due to the air inside the building in which the handheld device was kept was insulated from the ambient temperature fluctuations. The time series data appears consistent with (CSIRO, 2010) during the monitoring period as there was very little temperature variation day to day. The maximum daily indoor temperature varied between 28.3°C and 39.8°C and the minimum daily temperature varied between 25°C and 28.3°C. The average daily temperature difference between maximum and minimum over the monitoring period is 5.4°C.

The daily profile plot shows the average minimum temperature occurs at approximately 6:00 a.m. with an increase in temperature occurring between 6:00 a.m. and 11:00 a.m. The maximum temperature is reasonably consistent between 11:00 a.m. and 4:00 p.m. and there is a consistent gradual decline in temperature between 4:00 p.m. and 6:00 a.m. the next day.

Table 6-2 presents the maximum and minimum daily indoor temperatures recorded for Betano throughout the monitoring period.

### ***Relative Humidity***

Relative humidity is one of several measures used to describe the amount of moisture in the atmosphere, and is the ratio of the actual amount of moisture in the atmosphere to the maximum amount that could be held, at a given temperature. Both (CSIRO, 2010) and (Keefer, 2000) report that the south coast of Timor-Leste is marginally more humid than the north coast and that with increasing altitude, humidity decreases. Betano was observed to have a marginally less humid climate than coastal regions to the southwest (Suai).

Very little seasonal variation is evident from analysis of the Ministry of Agriculture data (2012). The maximum daily relative humidity is frequently above 90% throughout the year. The minimum daily relative humidity varies considerably more than the maximum and is on average in the range of 45% to 73%.

The time series for indoor relative humidity and a daily humidity profile for the monitoring period are presented in Figure 6-3 and Figure 6-4. The time series data and the daily profile show that the measured indoor relative humidity varies less than the Ministry of Agriculture data (2012). The indoor humidity does not fall below 45% over the entire monitoring period and ranges up to approximately 85%. On average, the humidity would fall to a minimum slightly below 70% at 2:00 p.m. to 3:00 p.m. and then steadily climb to approximately 80% by 6:00 a.m. the following day.

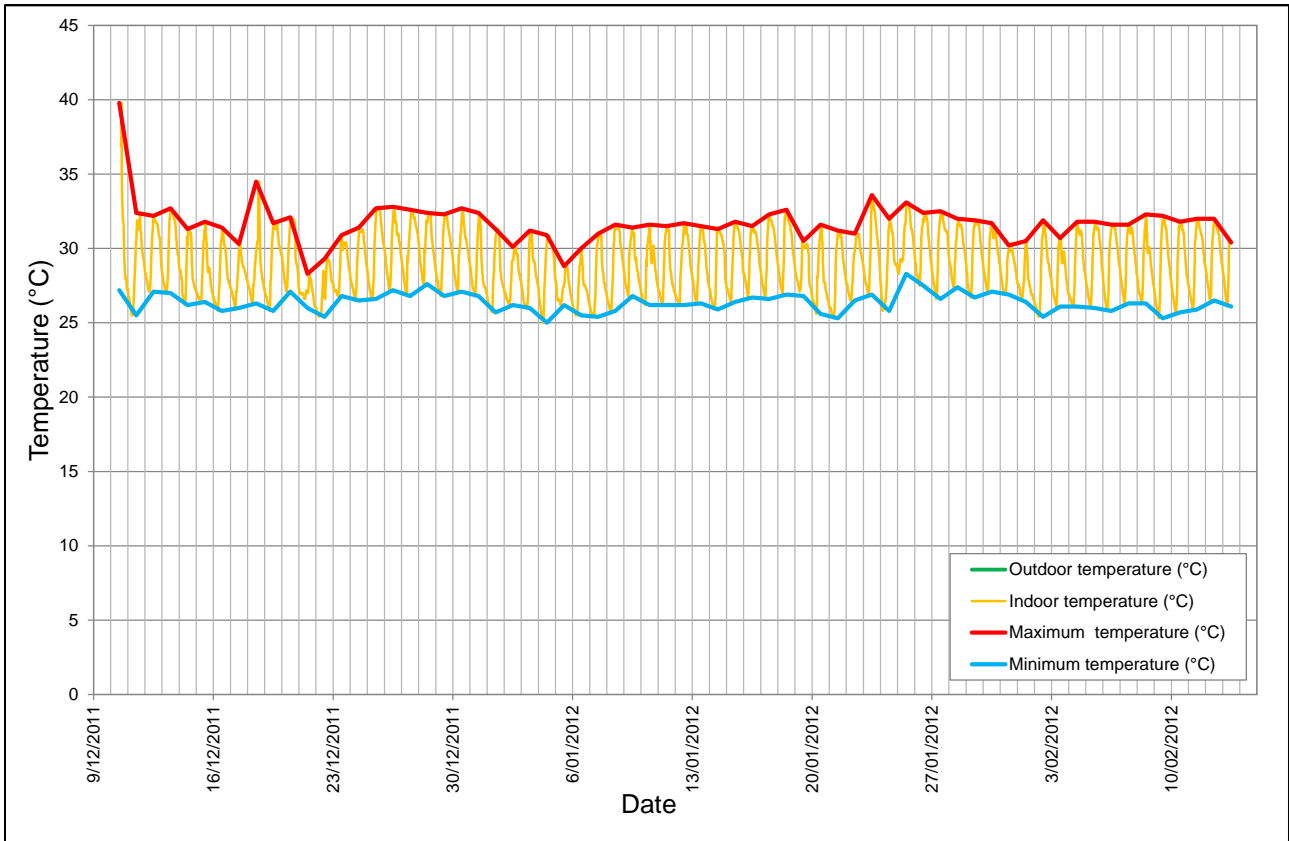


Figure 6-1 Betano Temperature Plot 1: Time series of recorded data

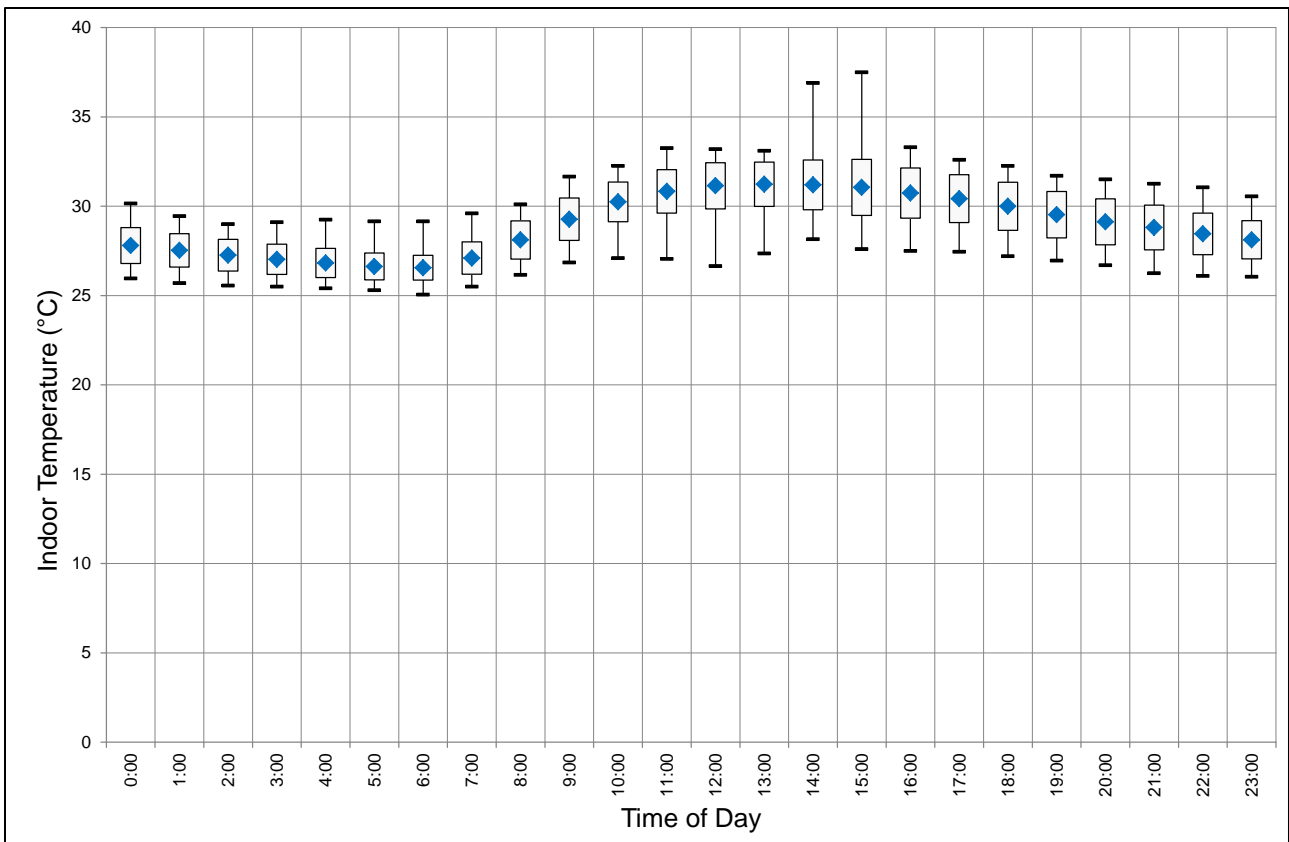


Figure 6-2 Betano Temperature Plot 2: Daily temperature profile

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Creator: Courtney Wheeler  
PLOT DATE AND TIME: 29 May 2012, 4:10 PM

0	29/05/2012	FINAL FOR ISSUE	CS	GHi	CW	-	GH		A4 SHEET	TASI MANE PROJECT – BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT: 301012-001504	
									Figure 6-1 Figure 6-2	
				<small>REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS</small>			<small>Copyright © WorleyParsons Services Pty Ltd</small>			



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Table 6-2 Maximum and minimum recorded daily indoor temperatures

Date	Temperature (°C)		Date	Temperature (°C)		Date	Temperature (°C)	
	Maximum	Minimum		Maximum	Minimum		Maximum	Minimum
10/12/2011	39.8	27.2	01/01/2012	31.3	25.7	23/01/2012	33.6	26.9
11/12/2011	32.4	25.5	02/01/2012	30.1	26.2	24/01/2012	32	25.8
12/12/2011	32.2	27.1	03/01/2012	31.2	26	25/01/2012	33.1	28.3
13/12/2011	32.7	27	04/01/2012	30.9	25	26/01/2012	32.4	27.5
14/12/2011	31.3	26.2	05/01/2012	28.8	26.2	27/01/2012	32.5	26.6
15/12/2011	31.8	26.4	06/01/2012	30	25.5	28/01/2012	32	27.4
16/12/2011	31.4	25.8	07/01/2012	31	25.4	29/01/2012	31.9	26.7
17/12/2011	30.3	26	08/01/2012	31.6	25.8	30/01/2012	31.7	27.1
18/12/2011	34.5	26.3	09/01/2012	31.4	26.8	31/01/2012	30.2	26.9
19/12/2011	31.7	25.8	10/01/2012	31.6	26.2	01/02/2012	30.5	26.4
20/12/2011	32.1	27.1	11/01/2012	31.5	26.2	02/02/2012	31.9	25.4
21/12/2011	28.3	26	12/01/2012	31.7	26.2	03/02/2012	30.7	26.1
22/12/2011	29.3	25.4	13/01/2012	31.5	26.3	04/02/2012	31.8	26.1
23/12/2011	30.9	26.8	14/01/2012	31.3	25.9	05/02/2012	31.8	26
24/12/2011	31.4	26.5	15/01/2012	31.8	26.4	06/02/2012	31.6	25.8
25/12/2011	32.7	26.6	16/01/2012	31.5	26.7	07/02/2012	31.6	26.3
26/12/2011	32.8	27.2	17/01/2012	32.3	26.6	08/02/2012	32.3	26.3
27/12/2011	32.6	26.8	18/01/2012	32.6	26.9	09/02/2012	32.2	25.3
28/12/2011	32.4	27.6	19/01/2012	30.5	26.8	10/02/2012	31.8	25.7
29/12/2011	32.3	26.8	20/01/2012	31.6	25.6	11/02/2012	32	25.9
30/12/2011	32.7	27.1	21/01/2012	31.2	25.3	12/02/2012	32	26.5
31/12/2011	32.4	26.8	22/01/2012	31	26.5	13/02/2012	30.4	26.1



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

#### **Rainfall and Evaporation**

The rainfall patterns for Timor-Leste are primarily influenced by Asian monsoon patterns. The southern part of the country experiences the Southern Bimodal Rainfall Pattern which provides 7 to 9 wet months with two peaks, one from December/January and the other from May (CSIRO, 2010). The variability of rainfall is considerable with typically the lower-lying areas experiencing lower total rainfall when compared to the higher altitude areas. There are several exceptions to this general trend across the country but the Betano study area is not one of them.

It was observed during the field work that, although rain did not fall frequently during the monitoring period, each recorded rainfall event was high in volume. The recorded rainfall events all coincide with the downloading of data from the hand held device and their high volume may represent false data measurements due to automatic recalibration.

The daily total rainfall over the monitoring period spanning 10 December 2011 to 13 February 2012 is presented in Figure 6-6. Three rainfall events were recorded during the monitoring period. By far the heaviest rainfall (121.5 mm) occurred on 5 January 2012. Table 6-3 presents the rainfall measured over the monitoring period.

**Table 6-3 Daily rainfall measurements**

Date	Rainfall (mm)	Date	Rainfall (mm)	Date	Rainfall (mm)
10/12/2011	7.5	01/01/2012	0	23/01/2012	0
11/12/2011	0	02/01/2012	0	24/01/2012	0
12/12/2011	0	03/01/2012	0	25/01/2012	0
13/12/2011	0	04/01/2012	0	26/01/2012	0
14/12/2011	0	05/01/2012	122	27/01/2012	0
15/12/2011	0	06/01/2012	0	28/01/2012	0
16/12/2011	0	07/01/2012	0	29/01/2012	0
17/12/2011	0	08/01/2012	0	30/01/2012	0
18/12/2011	79.5	09/01/2012	0	31/01/2012	0
19/12/2011	0	10/01/2012	0	01/02/2012	0
20/12/2011	0	11/01/2012	0	02/02/2012	0
21/12/2011	0	12/01/2012	0	03/02/2012	0
22/12/2011	0	13/01/2012	0	04/02/2012	0
23/12/2011	0	14/01/2012	0	05/02/2012	0
24/12/2011	0	15/01/2012	0	06/02/2012	0
25/12/2011	0	16/01/2012	0	07/02/2012	0
26/12/2011	0	17/01/2012	0	08/02/2012	0
27/12/2011	0	18/01/2012	0	09/02/2012	0
28/12/2011	0	19/01/2012	0	10/02/2012	0
29/12/2011	0	20/01/2012	0	11/02/2012	0
30/12/2011	0	21/01/2012	0	12/02/2012	0
31/12/2011	0	22/01/2012	0	13/02/2012	0









### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

Evaporation rates were not measured over the monitoring period as this was beyond the capability of the installed meteorological stations. However, the following results are reported in CSIRO (2010):

- *In the lowlands, the monthly evaporation ranges from 60 to 230 mm while in the highlands it is 100 to 190 mm per month.*
- *The average daily potential evaporation was in the range of 5.2 to 6.5 mm in the lowlands and 2.6 to 4.9 mm in the midlands.*

#### **Relative Atmospheric Pressure**

Relative atmospheric pressure is the measure of the force exerted by the weight of the air above an area on the surface of the Earth adjusted to sea-level altitude. Relative pressure is fundamental in describing climatic patterns for a region. The measured relative pressure in Figure 6-5 shows two separate trends: the synoptic behaviour related to the migration of high- and low-pressure cells across the wider Australasian region; and the diurnal (daily) variation about the mean.

The synoptic-level trends are presented by examining the daily average relative pressures presented in Table 6-4. An oscillating decline in pressure occurred between the 10 December and 23 December 2011. After this period, a rapid increase in pressure occurred until the 31 December 2011. The pressure generally declined again until the minimum point on 25 January 2012. The pressure sharply increased again in an oscillating pattern until the end of the monitoring period on 13 February 2012.

**Table 6-4 Daily average relative pressure measurements**

Date	Average Relative Pressure (hPa)	Date	Average Relative Pressure (hPa)	Date	Average Relative Pressure (hPa)
10/12/2011	1014.0	01/01/2012	1017.1	23/01/2012	1012.8
11/12/2011	1014.5	02/01/2012	1017.4	24/01/2012	1011.9
12/12/2011	1014.1	03/01/2012	1017.0	25/01/2012	1011.0
13/12/2011	1013.0	04/01/2012	1016.9	26/01/2012	1013.4
14/12/2011	1013.5	05/01/2012	1016.6	27/01/2012	1014.1
15/12/2011	1012.4	06/01/2012	1016.4	28/01/2012	1014.0
16/12/2011	1012.3	07/01/2012	1016.5	29/01/2012	1013.7
17/12/2011	1012.5	08/01/2012	1015.9	30/01/2012	1015.6
18/12/2011	1013.4	09/01/2012	1015.4	31/01/2012	1016.6
19/12/2011	1014.2	10/01/2012	1015.4	01/02/2012	1016.0
20/12/2011	1013.8	11/01/2012	1016.4	02/02/2012	1014.2
21/12/2011	1013.8	12/01/2012	1016.3	03/02/2012	1015.1
22/12/2011	1011.8	13/01/2012	1016.3	04/02/2012	1016.4
23/12/2011	1011.3	14/01/2012	1015.4	05/02/2012	1016.4
24/12/2011	1012.2	15/01/2012	1015.0	06/02/2012	1015.1
25/12/2011	1012.9	16/01/2012	1014.8	07/02/2012	1014.9
26/12/2011	1013.8	17/01/2012	1015.5	08/02/2012	1015.8
27/12/2011	1014.3	18/01/2012	1015.1	09/02/2012	1016.2
28/12/2011	1015.1	19/01/2012	1014.6	10/02/2012	1016.6
29/12/2011	1015.8	20/01/2012	1013.1	11/02/2012	1017.1
30/12/2011	1016.7	21/01/2012	1012.4	12/02/2012	1018.1
31/12/2011	1017.4	22/01/2012	1013.5	13/02/2012	1018.8



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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The diurnal pressure oscillates in a sinusoidal pattern between local maxima and minima on a 12 hour cycle. Daily minima occur at approximately 4:00 a.m. and 4:00 p.m. and daily maxima occur at approximately 10:00 a.m. and 10:00 p.m. The daily variation in pressure is on average 3.8 hPa, this oscillation is representative of 'atmospheric thermal tidal patterns' based on the 24 hour solar heating/cooling cycle. In general, the measured relative pressure over the Betano study area is representative of the tropical Australasian region.

### ***Wind Speed and Direction***

A major factor that influences local wind speed and direction trends is the topography and land use of the region. The Betano development area and the surrounding coastal region is low-lying and has reasonably flat terrain with elevations at approximately 20 m and local peaks located around Nova Betano up to 250 m above sea level. Inland, approximately 10 km, the foothills begin with elevations approximately 400 to 500 m above sea level. Approximately 20 km inland, the terrain becomes mountainous with elevations rapidly increasing to greater than 1,000 m above sea-level. Predominantly, the low-lying land in the region is pasture. Regions of jungle vegetation to the north and northeast of the refinery development remain intact. The height of the jungle canopy can result in increased turbulence and therefore decreased wind speed near ground-level; however, the meteorological station was located away from elevated vegetation and is unlikely to be affected by the decreased wind speeds.

Historic wind speed data for the Betano study area was available however the data was daily averaged and wind direction data was not available. Therefore the wind rose presented in Figure 6-7 represents data collected from the monitoring period only (December 2011 to February 2012). Due to the failure of the meteorological station, only 6% of the monitoring period produced valid wind speed and wind direction data. The wind rose shows that for the recorded data, a majority of the winds blew from the northwest at reasonably low speeds (less than 3.0 m/s). Currently, there is insufficient data to be able to determine prevailing wind patterns.

Figure 6-8 presents wind roses for the Dili airport, Baucau and the three study areas: Suai, Betano and Beaco. For Dili, available data spans the period from July 2008 to October 2011. For Baucau, available data spans the period from January to October 2011. For the three study areas the data spans each monitoring period:

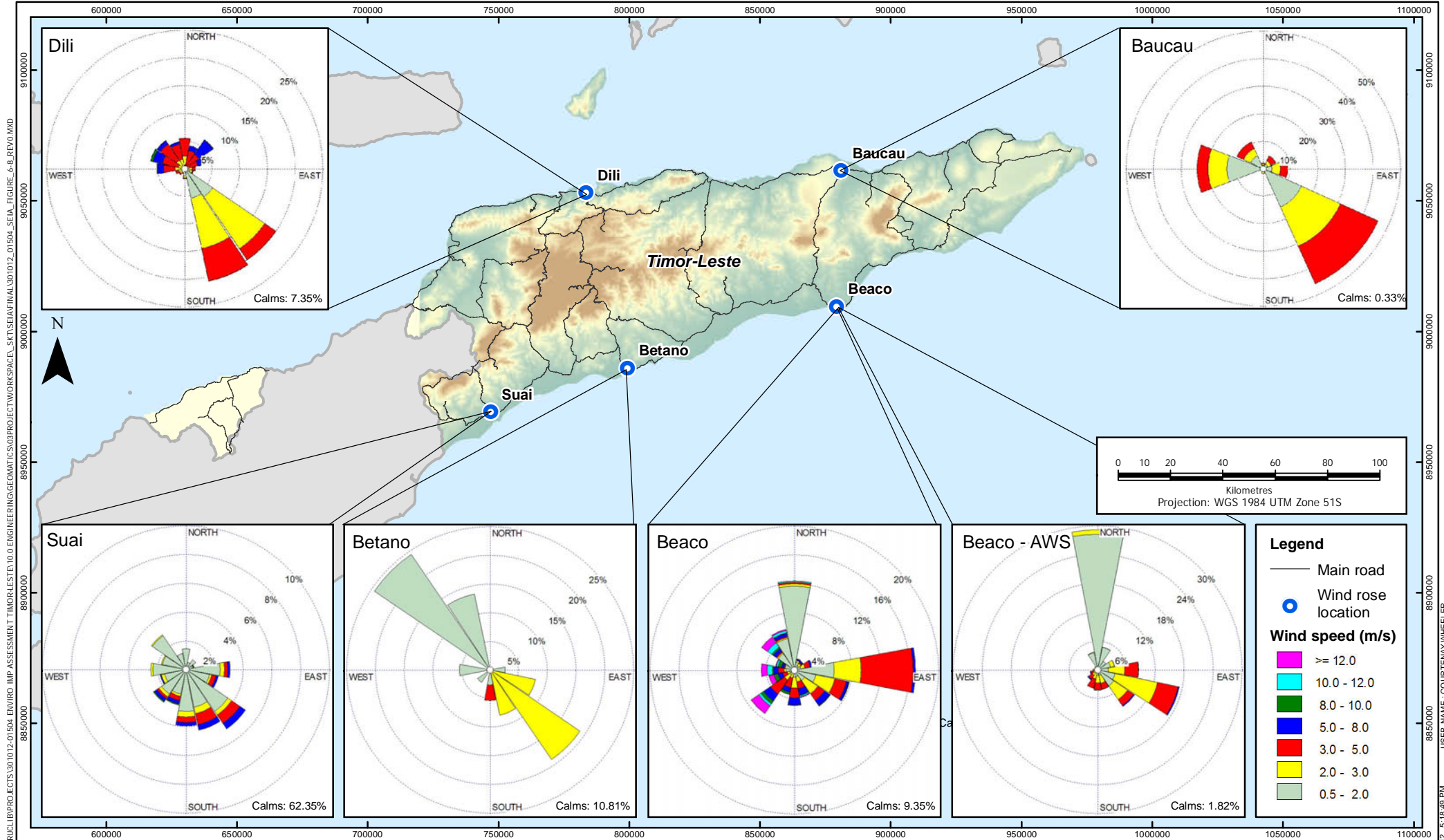
- Suai study area: 15 December 2011 to 7 February 2012.
- Betano study area: 10 December 2011 to 13 February 2012.
- Beaco study area: 12 December 2011 to 14 February 2012.

For the Dili region, the annual wind rose shows that for all winds measured, approximately 20% are blowing from the southeast and another 20% are blowing from the south-southeast. The predominant south-easterly winds have typically lower speeds ranging up to 5 m/s whereas; winds from the northern arc have been recorded to range up to 10 m/s.

Recorded winds for the Baucau region were only measured on an 8 point compass scale and averaged over an entire day. As such, the data is only indicative of generalised wind proportions recorded during 2011. Similar to the Dili region, a high proportion of winds ranging up to 5 m/s were recorded to blow from the southeast.

For both the Suai and Beaco semi-automated meteorological stations, a high proportion of winds were measured to blow from the northern arc. This reflects the trend shown across the sites of winds predominantly blowing from the landmass to offshore.





NOTES:  
 This map consists of:  
 1. Digital Elevation Model: SRTM (2011)  
 2. Roads: DivaGIS (2010)  
 3. Beaco wind rose: Ministry of Agriculture (2011)  
 4. Other wind roses: WorleyParsons (2012)

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REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504
resources & energy		TIMOR GAS & PETROLED		REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS			Copyright © WorleyParsons Services Pty Ltd		

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**Figure 6-8**  
 Timor-Leste wind roses

LOCATION: \\PERVOR\B\PROJECTS\301012-01504\_ENVIRO\_IMP\_ASSESSMENT\_TIMOR-LESTE\10. ENGINEERING\GEMATIC\301012-01504\_SEIA\_FIGURE\_6-8\_REV0.MXD  
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 USER NAME : COURTENAY\WHEELER



**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

**Extreme Weather Events**

The primary source of extreme weather events in the general vicinity of Timor-Leste is tropical cyclones. Tropical cyclone events typically result in strong winds and heavy rainfall and can potentially cause widespread flooding and damage to property if they encounter inhabited areas. The major climatological cycle that regulates the formation of tropical cyclones in the Timor Sea is the ENSO. Tropical cyclones form from thunderstorms over the ocean when favourable conditions are present. Some of the required conditions are listed below:

- Warm ocean temperature (greater than 26.5°C).
- High relative humidities in the lower and middle troposphere (lower atmospheric layer);
  - High humidities reduce the evaporation in the clouds and maximize the latent heat released from the moisture due to the increased precipitation.
- Poor vertical wind shear (change in wind direction with altitude).

A search of the Australian Bureau of Meteorology Australian Tropical Cyclone database ([http://www.bom.gov.au/clim\\_data/IDCKMSTM0S.csv](http://www.bom.gov.au/clim_data/IDCKMSTM0S.csv)) which has data on all recorded cyclones in the southern hemisphere since 1906 revealed that 11 tropical cyclones travelled within a 200 km radius of Betano, with two of these tropical cyclones travelling within a 100 km radius of the Betano study area between 1906 and 2012. These cyclones are listed in Table 6-5 below. The paths for the cyclones within a 100 km radius of the Betano study area are presented in Figure 6-9. CSIRO (2010) also reports that in April of both 1918 and 1919, cyclones passed in close proximity to the southern coast of Timor-Leste; however, their exact locations could not be determined. Cyclonic weather patterns were not observed in the Betano study area during the monitoring period. However, tropical cyclonic activity (Tropical Cyclone Grant) occurred off the coast of the Australian Northern Territory between 21 and 31 December 2011.

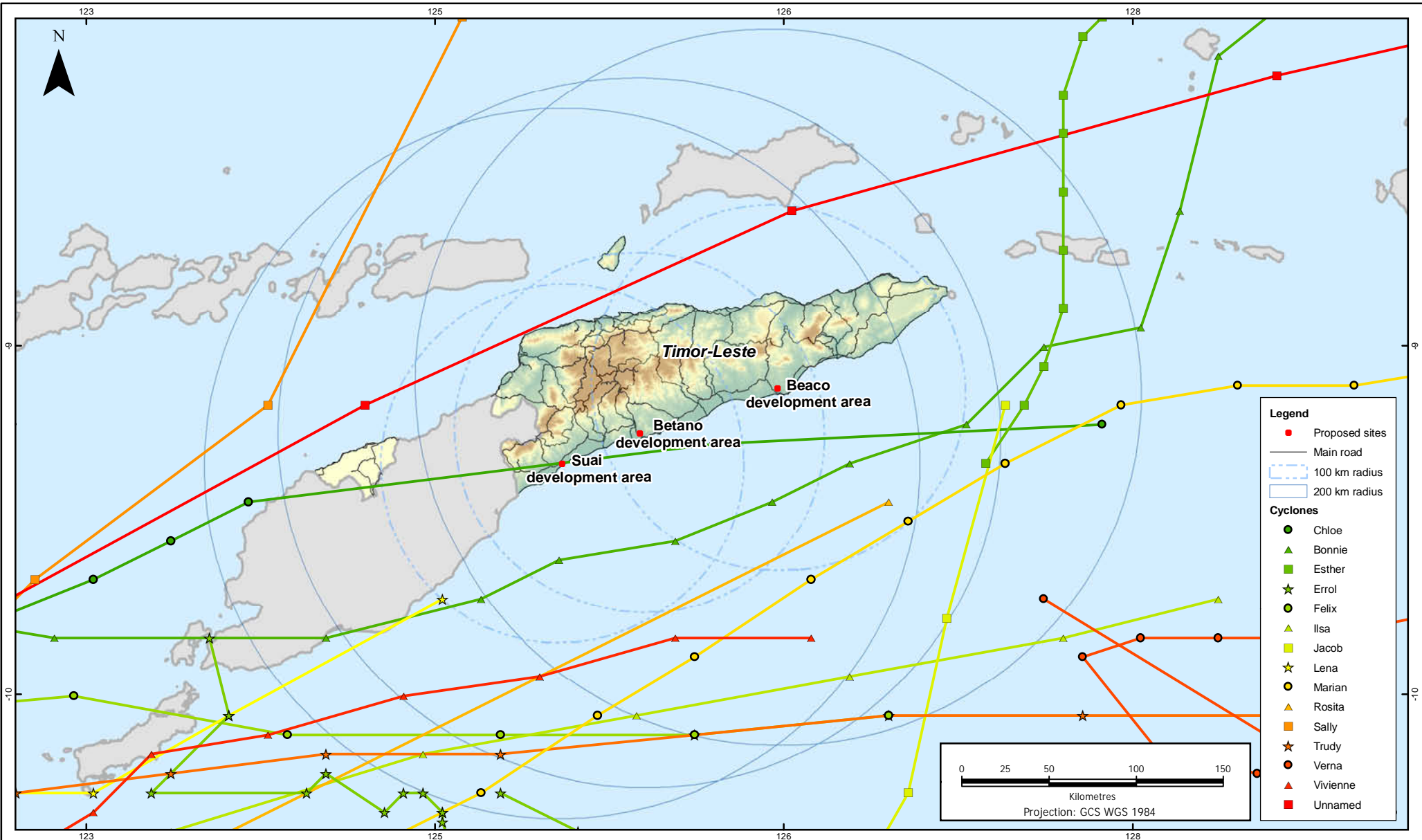
**Table 6-5 Historic tropical cyclones near Betano study area**

200 km Radius of Betano		100 km Radius of Betano	
Date Range	Cyclone Name	Date Range	Cyclone Name
6 – 13 April 1920	Unnamed #4	3 – 8 April 1995	Chloe
10 – 16 January 1978	Trudy	7 – 15 April 2002	Bonnie
22 – 31 December 1980	Felix		
2 – 9 April 1983	Lena		
18 – 20 December 1983	Esther		
9 – 19 April 1991	Marian		
6 – 12 April 1994	Vivienne		
3 – 8 April 1995	Chloe		
14 – 20 April 2000	Rosita		
7 – 15 April 2002	Bonnie		
15 – 24 March 2009	Ilsa		

Cyclonic activity in the vicinity of Timor-Leste primarily occurs during the monsoonal wet season focussing around the two maximum rainfall peak periods, December and late April/May.



LOCATION: \\PERWORLD\TIMES\TRUCK\PROJECTS\301012-01504-ENVIRO-IMP-ASSESSMENT\TIMOR-LESTE\0-ENGINEERING\GEO\GEO\PROJECT\WORKSPACE\SKTS\SEINF\FINAL\301012-01504\_SEIA\_FIGURE\_6-9\_REV0.MXD



NOTES:  
 This map consists of:  
 1. Digital Elevation Model: SRTM (2011)  
 2. Cyclone tracking data: BoM (2012)  
 3. Roads: DivaGIS (2010)

0	5/06/2012	FINAL FOR ISSUE	MW	GHI	CW	-	GH	-	A4 SHEET	SCALE 1:3,000,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
						 REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS			 to zero harm Copyright © WorleyParsons Services Pty Ltd	

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 STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
**Figure 6-9**  
 Timor-Leste cyclones tracks

PLOT DATE & TIME : 05 JUN 2012 5:08:28 PM USER NAME : COURTNEY.WHEELER





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Although thunderstorm activity was observed frequently in Timor-Leste during the site investigation, thunderstorm activity was not observed specifically in the Betano study area.

Due to the torrential nature of the rainfall in the monsoonal wet season, there is a risk of flooding of river beds in the development area. Due to its proximity to the Caraulun River, the Betano study area is defined to be in a high flood risk region due to the low-lying nature of the topography. No information was available regarding specific flooding events in the Betano study area.

### **6.1.6 Impacts of Weather Patterns and Extremes of Climate on the Project**

When designing and constructing the Betano Refinery and Petrochemical complex, particular regard should be given to the historical weather patterns and climate extremes. Several meteorological effects will need to be addressed including climate change and cyclone/severe storm events.

The meteorological parameters related to climate change are: sea level, cyclone intensity, rainfall and extreme wind speed. Within the timescale of the development (20-30 years), climate change projections CSIRO (2010) indicate that:

- Sea levels are to rise.
- Cyclone frequency is to reduce but, intensity is projected to increase.
- Extreme rainfall events are to become fewer but, more intense with similar trends projected for extreme wind speeds.

These projections are inherently uncertain and by nature are subject to change; however, as the development is located in a coastal region, the engineering design will need to take into account the projected rise in sea level over the lifespan of the development.

Cyclone and severe storm events are likely to be the most important factors to be considered throughout the project lifespan. As cyclones are known to potentially cause widespread damage to property and endanger human life, it is recommended that a cyclone management plan is developed covering both the construction and operational phases of the Betano development.

Lightning can also pose a safety risk for site personnel. During the construction phase of the development, tall machinery can attract lightning strikes. Similarly, during the operational phase of the development, tall project structures like exhaust stacks and flares can also attract lightning. It is recommended that a policy is developed in the cyclone management plan regarding actions in response to lightning storms.

As the Betano development includes facilities adjacent to the ocean, the effects of high energy waves need to be considered. These waves may interfere with construction and/or operation activities and potentially pose a safety risk to site personnel. It is also recommended that the cyclone management plan incorporates a construction and operational policy for high energy waves.

Soil erosion from flooding or high rainfall events also have the potential to effect project infrastructure by subsidence of foundations. This has the potential to affect project schedule for both construction and/or operational phases as well as posing a potential safety risk for site personnel.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 6.1.7 Avoidance, Management and Mitigation Measures

The recommended cyclone management plan typically would include, but not be limited to, the following:

- Potential cyclone identification methods and warning systems.
- 'Warning', 'Alert' and 'All Clear' communication methods for workers and the local populace.
- Cyclone-proofing for temporary structures/objects that are at risk of damage.
- Construction and operational policies for lightning strikes and high energy waves.
- Lockdown procedures, describing methods to secure all structures, vehicles and maritime vessels.
- Emergency action plans and evacuation procedures.
- Distress notification methods if additional aid is required.
- Allowance for increased precipitation intensity in the design of water affected infrastructure.

Recommendations for the avoidance, management or mitigation of soil erosion effects, sedimentation, stormwater flow and waste containment are provided in the Topography, Geology and Soils (Section 6.3), Hydrology, Drainage and River Water Quality (Section 6.6), and Waste Management (Section 6.12) sections of the SEIA.

### 6.1.8 Further Work

Adequate long-term meteorological monitoring of the study area would be of benefit to the future project proponent, the GoTL and the local community. It would aid in restoring the meteorological network established across Timor-Leste in the early 20<sup>th</sup> century, and provide input information for various environmental studies as well as providing a valuable information source to agricultural workers for planning and optimising crop yields.

It is recommended that the automated weather station (AWS) in the Betano study area be upgraded to provide a more complete dataset than what is currently recorded and that the location and elevation coordinates be remeasured. The upgrade should be conducted in accordance with (AS 3580.14-2011) *Methods for sampling and analysis of ambient air Part 14: Meteorological monitoring for ambient air quality monitoring applications*, or an equivalent guideline. It is also recommended that the following parameters be continuously monitored and averaged on an hourly basis by the AWS:

- Station identification number.
- Date and time of record/observation.
- Air, wet bulb and dew point temperatures.
- Precipitation and evaporation.
- Relative humidity.
- Wind speed and direction.
- Solar radiation.



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- Barometric pressure (relative and absolute).
- Visibility.
- Cloud cover.
- Cloud ceiling height (if practicable).

Some requirements of the above parameters listed in (AS 3580.14-2011) are provided in Table 6-6 below.

**Table 6-6 Minimum requirements for meteorological monitoring instrumentation**

Parameter	Units	Minimum Requirements		
		Range	Resolution	Accuracy
Wind Speed	m/s	0.5 to 30 m/s	≤0.25 m/s	1% or 0.2 m/s*
Wind Direction	Degrees to True North	0 to 360°	1°	±3°
Temperature	°C	-10 to 50°C	0.1°C	±0.3°C
Relative Humidity	% Ratio	5 to 100%	1%	±2% (10 to 90%) ±4% (90 to 100%)
Solar Radiation	W/m <sup>2</sup>	-	-	±30 to 50 W/m <sup>2</sup>
Atmospheric Pressure	hPa	750 to 1050 hPa	1 hPa	±3 hPa
Precipitation	mm (or mm/hour)	0 to 400 mm/hour	0.5 mm	±5% (0 to 120 mm/hour)

Note: \* Whichever is the greater value.



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### 6.2 Land Use and Visual Amenity

Land use compatibility and changes to visual amenity associated with the Betano development have been identified as issues with the potential to adversely impact the surrounding communities.

Currently there are no specific assessment standards or legislation relating to landscape and visual impact in Timor-Leste. In the absence of specific legislation, this strategic assessment has been carried out using a study method generally in accordance with *'The Guidelines for Landscape and Visual Impact Assessment' (2002) Second Edition*, published by the Landscape Institute (LI) and the Institute of Environmental Management and Assessment (IEMA) (United Kingdom), with some minor modifications to reflect the site's Timor-Leste context.

#### 6.2.1 Study Method

This study was designed to undertake a preliminary land use and visual amenity impact assessment of the project, at a strategic level. The scope of this study is to:

- Consider how the changes in land use may affect the broader geographical area of Betano, with a more detailed approach to the proposed refinery and petrochemical complex at Betano. This includes a discussion of the local landscape, a description of the land use compatibility of the area with the proposed infrastructure and consideration of future impacts on land uses; and
- Conduct a high-level visual amenity assessment of the Betano development area, based on the information available, to consider changes in views that may be experienced by people observing the landscape.

This study method proposed for this assessment is summarised as follows:

- Desktop study: Undertake a literature review to identify GoTL or other relevant assessment standards and prevailing land uses in the Betano development area;
- Site reconnaissance: The Betano development area was visited between 9 and 12 December and 17 and 18 December 2011 with the aim of gathering site-specific data for land use and visual amenity assessment purposes, including the topographical context to inform the assessment. Topographical considerations are more formally assessed in Section 6.3 (Topography, Geology and Soils).

#### **Literature Review**

As mentioned, the IEMA guidelines have been adopted in order to define the study method. The IEMA guidelines are internationally recognised guidelines which provide advice on assessing the landscape and the visual impacts of development projects.

The following guidance documents have also been referenced within this study:

- *Guidance on the New Approach to Appraisal*. Department of the Environment, Transport and the Regions, 1998. A New Deal for Trunk Roads in England; and
- *Guideline for Involving Visual & Aesthetic Specialists in EIA processes*. Oberholzer, 2005. Cape Town: CSIR, Provincial Government of the Western Cape, Department of Environmental Affairs and Development.



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### **Site Visit**

The site visit was undertaken between 9 and 12 December and 17 and 18 December 2011 to gather site-specific data for the project from a land use and visual amenity perspective. The objectives of the site visit were to:

- Identify the location and sensitivity of visual impact receptor sites for the project; and
- Gather baseline photographs from the visual receptor locations.

The site visit also included an account of aesthetic values (such as viewsheds, coastal vistas) and cultural values; these included:

- Religious and ceremonial significances (e.g., churches, graveyards);
- Traditional and indigenous significance sites (e.g., shrines); and
- Architectural significance (e.g., traditional and Portuguese forts, offices and houses).

### **Land Use**

The land use aspect of this strategic assessment has been informed by a desktop review of relevant literature and aerial photography, GIS data obtained from the Timor-Leste GIS portal, websites and recent land use maps to provide an overview of the current land use. The existing land uses within and around the Betano development area were noted (access permitting) during the site visits undertaken between 9 and 12 December and 17 and 18 December 2011.

In the absence of a national planning scheme that would define preferred land uses in discrete zones, current and future land use compatibility could not be compared at this stage.

### **Visual Amenity**

The visual amenity aspect of this strategic assessment considers a high level review of the likely visual sensitivity, significance of impact, and visual exposure of the Betano development. Initial information was obtained from existing GIS data during the desktop review of topography and landmarks, and supplemented by field study findings, photographs and subsequent analysis.

Visual amenity impacts relate to how changes in the views resulting from a development are experienced by people who observe that landscape. The magnitude and sensitivity of a receptor would depend on the location and duration of the view of the development. Visual impacts relate to the appearance of the changes that arise in the composition of the view which results from a change to the landscape, to the viewer's response to the changes, and to the overall effects with respect to visual amenity (LI and IEMA, 2002).

### **Visual Sensitivity**

Visual sensitivity is typically defined by the duration and the nature of a view. For example, the longer the duration of the view and the more potential viewers who value the view, the higher the level of perceived visual sensitivity. It also relates to the degree of discord of the new view compared to the existing. The degree of discord of the refinery and petrochemical complex with the tropical agrarian setting would be very high, compared to an existing industrialised setting.



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The degree of sensitivity is subjective and also reflects the attitude of the viewer to a view. Residential land users and medical institutions are often regarded as having a higher visual sensitivity, compared to agricultural and commercial areas whose day-to-day operations are less focussed on the fulfilment of visual amenity. High sensitivity to a view can also result from a short duration of exposure to the view but for a large numbers of potential viewers, for example from a public road or recreational space. The extent of the potential impact Betano development has been assessed objectively according to the sensitivity of the receptor, taking into account potential mitigation measures to consider any residual impact. The identified viewpoints were assessed in the following order of sensitivity (adapted from LI and IEMA, 2002).

- High Sensitivity;
- Medium to High Sensitivity;
- Medium to Low Sensitivity; and
- Low Sensitivity.

### *Visual Impact Significance*

In the absence of Timor-Leste standard or any other more comparative guideline, the significance of the visual impact of the refinery and petrochemical complex is likely to be 'substantially adverse', according to the following scale (adapted from DETR, 1988):

- Substantial adverse or beneficial impact;
- Moderate adverse or beneficial;
- Slight adverse or beneficial; and
- Neutral.

Although there are no recognised Timor-Leste standards and guidelines for determining the significance of visual impact, there is a need to assign significance to this assessment, where possible, for a more consistent method of evaluating visual impact. This is particularly so given that a detailed viewshed analysis could not be undertaken at this stage due to the lack of detailed contour baseline data available and three-dimensional design model of the proposed plant.

### *Visual Exposure*

Visual exposure refers to the relative visibility of a project or feature in the landscape. Exposure and visual impact tend to diminish exponentially with distance. The exposure is classified as follows (adapted from Oberholzer 2005):

- **High exposure** – dominant or clearly noticeable;
- **Moderate exposure** – recognisable to the viewer; and
- **Low exposure** – not particularly noticeable to the viewer.





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### 6.2.2 Existing Environment

The coastal location of the Betano development area and surroundings are largely undeveloped.

The proposed refinery and petrochemical complex will be located adjacent the coast approximately 4 km east of the River Kara-Ulan. The existing town of Betano appears to be the only village within a 500 m radius of the development areas and likely to be the most directly affected by the construction and operation of the Betano development. Nova Betano will be located further inland and located to the north-west of the development area and north of the existing Betano Village.

#### ***Landscape Setting***

The topography of Timor-Leste is dominated by the Ramelau mountain range located along the central axis of the island with heights up to 3,000 m above sea level. The mountain range is dissected by deep valleys prone to flash floods. Towards the northern side, the mountains almost extend to the sea without extensive coastal plains. However, on the south coast, the mountains gently slope towards the sea, leaving a wide littoral plain that is more suitable for agriculture. The plain is generally between 20 and 30 km wide running almost the length of Timor-Leste, widening in the east.

The proposed site for the refinery and petrochemical complex will extend from the high water mark above the beach, inland (northwards) along the narrow coastal plain, before intersecting a few low hills which occupy the northern part of the site. These low hills coincide with a change in the geology.

In contrast, Nova Betano, which will be located approximately 5 km north-west of the refinery site, will be established on a hilly location, bisected by the road to Viqueque and separated by a prominent valley. The two parts to Nova Betano are herein referred to as Nova Betano East and Nova Betano West. Gradients in this area are generally moderate to fairly steep.

Prominent valleys run through the hilly area north of the coastal plain before flowing out over the coastal plain as a network of shallow rivers and streams, with a few swampy or marshy depressions.

The central south coast of Timor-Leste around the existing town of Betano is currently relatively sparsely populated with little infrastructure. The Betano development area is primarily forested with a long, sandy coastal strip on its seaward side.

#### ***Land Use***

Agriculture is the single largest land use in Timor-Leste, accounting for approximately 24% of the total land area. Subsistence farming (Plate 6-2) and rotational cropping supports the majority of rural communities in Timor-Leste (Bouma and Kobryn 2002).

Farmers depend on rainfed agriculture and grow corn, cassava and other tuberous crops. Corn was probably introduced into Timor by Europeans in the seventeenth century and, being well suited to the ecology of the island, it constitutes a staple of the Timorese diet. Rice is grown in irrigated fields and, where possible, has been introduced to the river valleys (Ormeling 1957).

During the site visit it was noted that the majority of the Betano development area comprised agricultural land used for subsistence farming, natural landscape and scattered dwellings along the coastline. The land around the area allocated for Nova Betano had mostly natural vegetation and plantations along the existing roads cutting through the site with few scattered dwellings on the southern boundary.

Source: Andrew Larsen, 2011



**Plate 6-1** Steeply sloping lands in the mountainous terrain north of the Betano development area

Source: Andrew Larsen, 2011



**Plate 6-2** The coastal plain is characterised by small scale subsistence agriculture



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Human activity in the development area included grazing land and some terraced fields. The primary crops being grown were corn, cassava, peanuts, long beans, papaya, watermelon and bananas. Some of the commercial trees in Betano included mango, coconut, teak, kapok, sago and banana.

The identified land uses in and around the Betano development area are shown in Figure 6-10.

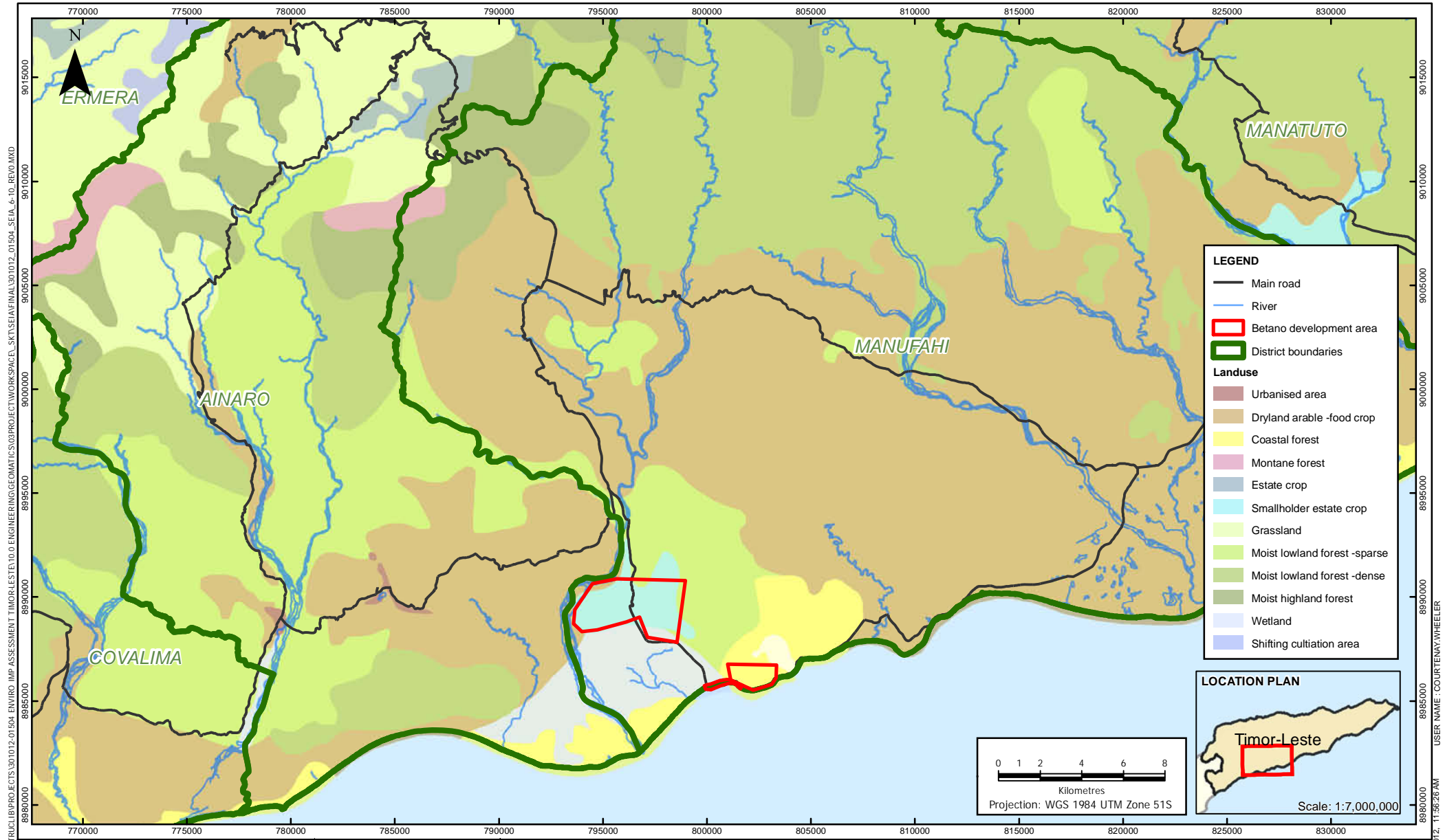
### ***Visual Amenity***

Timor-Leste can be broadly divided into six ecological regions; namely, the mountainous areas, highland plains, moist lowland areas, arid lowland areas, coastal areas and urban areas (Metzner 1977).

The coastal landscape of the south coast of Timor-Leste is highly diverse with high aesthetic values. This is primarily due to the mountainous nature of the area inland, the steep coastal gradients, long isolated beaches and interspersed rocky headlands. The coastline is characterised with intact coastal vistas and mountain-sea landscapes.

A series of photographs were taken from many vantage points along existing roads and vehicle tracks during the December 2011 site visit. These photographs (Plate 6-3 to Plate 6-21) provide a record of the existing environment from a visual amenity perspective and their locations are shown in Figure 6-11.





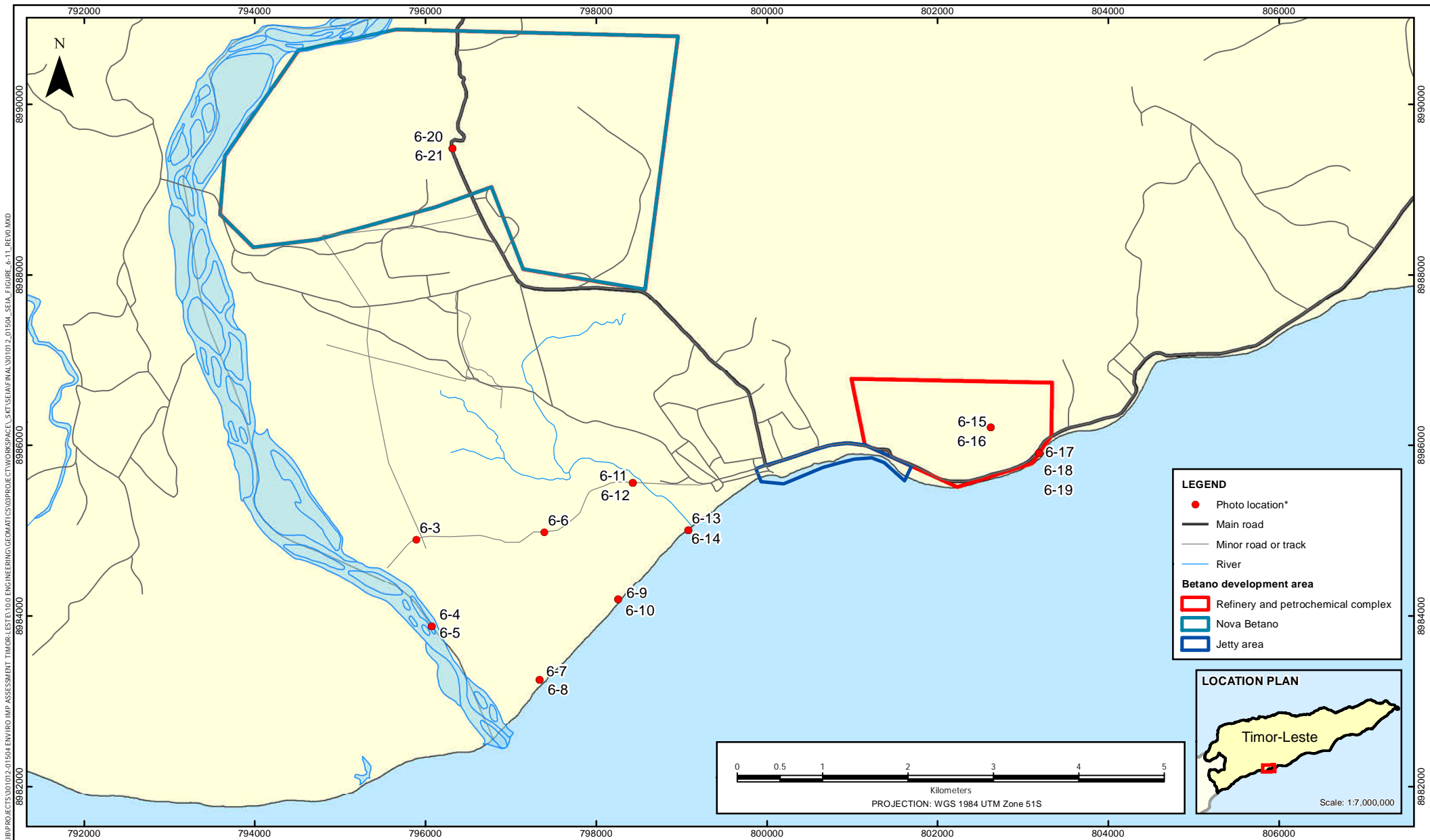
NOTES:  
 This map contains:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. Roads: DivaGIS (2010)  
 3. District boundaries: Geographic Information Group TimorLeste (2010)  
 4. Landuse: Pacific Disaster Center, (<http://www.pdc.org/ghin/>) (2010)

0	29/05/2012	FINAL FOR ISSUE	MW	CS	-	-	GH		A4 SHEET	SCALE 1:250,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
resources & energy		TIMOR GAS & PETRÓLEO		REPUBLICA DEMOCRÁTICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				Copyright © WorleyParsons Services Pty Ltd		

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**Figure 6-10**  
 Land uses in the Betano development area

LOCATION: \\PERVORBEL\TIMES\DRUCLIP\PROJECTS\301012-01504\_ENVIRO\_IMP\_ASSESSMENT\TIMOR-LESTE\10\_0\_ENGINEERING\GEMATIC\03PROJECT\WORKSPACE\_S\KTS\SEI\FINAL\301012-01504\_SEI\_A\_5-10\_REV00.MXD  
 PLOT DATE & TIME : 29/MAY/2012, 11:56:26AM  
 USER NAME : COURTENAY/WHEELER



**NOTES:**

- This map consists of:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. Roads: DivaGIS (2010)

\*Photographs taken at each of the photo locations are shown in plates 6-3 to 6-21

0	5/06/2012	FINAL FOR ISSUE	CS	GHI	CW	-	GH	-	A4 SHEET	SCALE 1:60,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
									Copyright © WorleyParsons Services Pty Ltd	

TASI MANE PROJECT - BETANO AND BEACO  
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**Figure 6-11**  
 Betano development area photo locations

LOCATION: \\PWERMORHEL1\INFSTRUC\UBPROJECTS\301012-01504 ENV\RO IMP ASSESSMENT\TIMORLESTE\00 ENGINEERING\GEM\TASI\SET\EN\FINAL\301012\_01504\_SEA\_FIGURE\_6-11\_REV01.MXD

PLOT DATE & TIME: 05 JUN 2012 5:06:23 PM USER NAME: COURTNEY WHEELER





Plate 6-3 on Figure 6-11 (looking south-east)



Plate 6-4 on Figure 6-11 (looking north-east)



Plate 6-5 on Figure 6-11 (looking south-east)



Plate 6-6 on Figure 6-11 (looking east)



Plate 6-7 on Figure 6-11 (looking west)



Plate 6-8 on Figure 6-11 (looking north-west)



Plate 6-9 on Figure 6-11 (looking north-west)



Plate 6-10 on Figure 6-11 (looking west)









Plate 6-19 on Figure 6-11 (looking west)



Plate 6-20 on Figure 6-11 (looking south)



Plate 6-21 on Figure 6-11 (looking east)



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### 6.2.3 Environmental Impacts

#### *Change in Land Use*

The Betano development is expected to introduce a new style of industrial development to the largely rural landscape setting that is currently characterised by low-intensity agricultural land use and fishing activities. This is expected to cause a permanent change from the current uses.

The refinery and petrochemical complex will introduce a new and unprecedented land use to the region. This change in land use, combined with an increase in industrial and commercial activities in the area, will significantly change the interaction with existing land uses in the area.

The development of Nova Betano will also result in a change in land use with visible impacts on the landscape and the lifestyle of the local residents.

The planned increase in population associated with the Betano development may result in pressure on existing land uses and potentially increase the rate of land degradation (forest clearance, erosion, and water harvesting). This will require appropriate consideration as part of an environmental assessment during the detailed design stage of the project.

#### *Visual Impact*

The Betano development would introduce a new development to the largely rural landscape setting which is characterised by agricultural and coastal landscapes. There are no other examples of a similar development within the region, either in scale or character.

The introduction of the industrial activities that comprise the refinery and petrochemical complex would change the landscape significantly from the present coastal agriculture setting to one that is industrial.

Nova Betano would be situated in a hilly location and within vegetated surroundings, and includes extensive landscaping as part of the initial design proposal. For this reason, the potential visual impact of this aspect is considered in less detail for this strategic assessment than for the development of the refinery and petrochemical complex.

The clearing of vegetation and earthworks activities to facilitate construction of the refinery and petrochemical complex is likely to generate the most visible impact on the landscape. The refinery and petrochemical complex site is currently well vegetated, and vegetation clearance and the establishment of buildings and structures will significantly alter the appearance of the area. The project has a lifespan of 50 years therefore is deemed a permanent change to the physical landscape.

Night lighting will also be a necessary component for most aspects of the project, including security, safety, and night operations and maintenance work. Given the limited distribution of electric lighting in the area, light spillage during the operation of the refinery and petrochemical complex is likely to be significant. Some light-related impacts are also possible during construction; however, this will be of a smaller scale than the operational phase, and for a temporary duration.



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### *Visual Impact Assessment*

#### *Visual Exposure*

Due to the relatively flat topography and exposed coastal location, the refinery and petrochemical complex is likely to be highly visible from both higher vantage points and at some areas of lower terrain (e.g., local roads and settlements) in the immediate vicinity. In certain areas, the existing vegetation and the topography may offer some screening (Plate 6-25).

Based on the information available to date, Nova Betano is expected to be located within a rural based setting with relative remoteness which is likely to, along with the topography, provide a reasonable amount of screening. Nova Betano is therefore likely to have relatively moderate to low visibility.

#### *Sensitivity*

Using the order of sensitivity outlined in Section 6.1.1 above, the refinery and petrochemical complex is expected to have a 'high' visual sensitivity for settlements along the primary road, which are generally located to the west and south. The same level of significance would likely apply to users of the southern coastline (Plate 6-22 to Plate 6-24) due to the scale and coastal location of the proposed structures.

The refinery and petrochemical complex would also likely to have a 'high' visual sensitivity for the existing residents of Betano (and the proposed Nova Betano), as well as nearby villages and settlements to the north and east. This would be due to scale and location of the complex, particularly due to the visibility from higher elevations and the contrast that the appearance of the development would have with the surrounding agricultural and coastal environments which are natural and visually softer landscapes.

Based on the information available to date, Nova Betano would likely have a 'medium to high' visual sensitivity when viewed from the surrounding area.

#### *Significance of the Impact*

The intensity of the impact on the landscape from the operation of the refinery and petrochemical complex is likely to be 'high' due to the scale of the development and the prominent coastal location on relatively flat topography.

In addition, the significance of the visual impact is likely to be 'substantially adverse' for most nearby settlements, including viewers those located within 500 m to the north and west. This is based on a qualitative evaluation for the visibility of the development which is likely to have a 'high exposure' and 'high' sensitivity. Whilst the visibility is likely to remain in the landscape of most viewsheds, the significance of the impact to receptors will lessen with distance from the site.

Based on information available to date, the significance of the impact of Nova Betano is likely to be 'moderate adverse' for local residents and nearby land users for the reasons outline above.

Due to the early stages of the project, the likely visual impact of the Betano development during construction has not been evaluated in this strategic assessment.

Source: Andrew Larsen, 2011



**Plate 6-22** The Betano development area is characterised by flat coastal plain topography

Source: Andrew Larsen, 2011



**Plate 6-23** A view of the Timor Sea from the Betano development area



Source: Andrew Larsen, 2011



**Plate 6-24** A view of the Betano coastline from the Timor Sea

Source: Andrew Larsen, 2011



**Plate 6-25** Dense vegetation around the Betano development area



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**Visibility Analysis**

Maximum distance of a development is a very important factor that has to be taken into consideration in a viewshed analysis, because the greater the distance, the lower the visual impact that an object can bring to the landscape, depending on the scale, form, texture, architectural lines and colour (Matos, 2001). As mentioned in Section 6.1.1, a detailed viewshed analysis could not be undertaken at this stage due to the lack of detailed contour baseline data available, however a calculation of the visible distance of the proposed refinery and petrochemical complex from an offshore (or a completely flat topography) location can be estimated.

The visible distance can be calculated in nautical miles (nm) using the following equation (BHP, 2006):

$$\text{Visible Distance (in nm)} = 1.17 \times \text{the square root of the height (in feet)}$$

If the height of the tallest structure is, for example, 20 m (65 feet), including mountains in the background, it could be viewed from 9.4 nm offshore. Plate 6-22 to Plate 6-24 shows the current view of the coastline of Betano region from the Timor Sea. An accurate calculation is recommended at the next stage once the scale (and location) of built aspects for the complex are known.

**6.2.4 Avoidance, Management and Mitigation Measures**

In order to minimise the potential impacts on the visual amenity, the strategies in Table 6-7 should be considered as part of an avoidance, management and mitigation strategy to be developed at the detailed design stage of the project. This list is not exhaustive, and has been prepared to provide a guide at this early stage.

**Table 6-7 Avoidance, Management and Mitigation Measures**

Potential Issue	Measure	Description
Loss of screening vegetation	Retention of existing vegetation (where possible)	The retention, where practical, of existing landscape and vegetation will assist in partially screening the proposed development areas during construction and operation. Particular attention should be paid to the retention of the well-established vegetation around the Betano development area. It is recommended that the visual impact from vegetation loss be given due consideration during the detailed design stage, including the retention of existing vegetation within the development area where possible.
Vegetation restoration	Restore existing vegetation (where possible)	Where it is necessary to remove existing vegetation, such as grasses and trees, the affected area should be restored to its previous or an improved state using the same or similar vegetation species. Screening the development area using indigenous vegetation will not conceal the built aspects, but it will soften the appearance and reduce the visibility.



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**Table 6-7 Avoidance, Management and Mitigation Measures (cont'd)**

Potential Issue	Measure	Description
Appearance and visual impact	Planting of vegetative screens	Further tree plantings should be implemented along the boundaries of the proposed development areas to provide a soft screen and reduce the visibility of infrastructure. In particular, screening should be planted between the proposed development areas and the adjacent local roads, and where practical, should not interfere with existing local activities and infrastructure.
Light spill	Implement a lighting strategy	Where lighting is deemed necessary, low-level lighting should be used to reduce light spill onto sensitive land uses. It is recommended that the visual impact of lighting be given due consideration during the detailed design stage, including the use of down-lighting to angle the light source, shielding, and lighting with lower lux ratings. All lighting should be kept to a minimum within the requirements of safety and efficiency.
Glare	Use of paint finishes	The use of non-reflective paints and coatings for external surfaces should be considered to reduce reflection and glare. Uncoated galvanised metallic surfaces should be avoided where possible, and the use of colours on exterior walls that will blend in with the surrounding landscape should be encouraged.

Visual amenity considerations in site design and layout combined with the application of accepted industry practice (including adoption of environmental management controls for field development activities) will minimise such impacts.

**6.2.5 Residual Impacts**

The Betano development would result in significant changes to the appearance of the landscape and existing land uses. However, if the specified avoidance and management measures are implemented, this should reduce any significantly adverse impacts.

**6.2.6 Further Work**

A landscape and visual impact assessment is recommended once the project design has been confirmed, in an iterative approach to minimise any adverse impacts on visual amenity. This is particularly relevant to the refinery and petrochemical complex in terms of structure scale, site configuration (for screening), site appearance, and finishing (where possible) to reduce the impact of its appearance.

A vegetation management plan should be developed at the next stage to minimise vegetation loss and maintain as much of the boundary vegetation as possible for soft screening of the infrastructure for the closest visual receptors. A re-vegetation strategy should also be developed at the next stage.

It is also recommended that the visual impact of lighting be given consideration at the detailed design stage of the project, including consideration of downlighting, shielding of lights and purchase of lighting with lower lux ratings.



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### 6.2.7 Summary

The significance of the impact of the refinery and petrochemical complex on nearby land users is likely to be 'substantially adverse' due to the scale and nature of the proposal, and the likely visibility and estimated sensitivity by sensitive receptors.

The significance of the impact of Nova Betano is likely to have be 'moderate adverse' on nearby land users.

This strategic assessment provides a preliminary consideration of the potential impacts of the Betano development in terms of the changes in land use and visual amenity impacts for identified sensitive receptors. This strategic assessment has been undertaken in accordance with published guidelines with some minor modifications to reflect the Timor-Leste context.

The implementation of appropriate mitigation measures may reduce visual impacts from the operation of the project; however, further assessment would need to be undertaken to determine the extent to which potential impacts could be avoided, managed and/or mitigated.





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### 6.3 Topography, Geology and Soils

#### 6.3.1 Study Method

A preliminary geological and engineering geological assessment has been undertaken for the Betano development area. The scope of the assessment is to:

- Subject the Betano development area to a geological and engineering geology overview, including a description of the prevailing topography, geomorphology, underlying hard rock geology and overlying superficial/soft sediments (soils), as well as soil/geology and vegetation associations. This has been achieved through a combination of desktop study and a site inspection.
- Briefly assess the soil profile within the Betano development area through excavation of a number of test pits. The soil profile in each test pit has been logged with the aim of describing the physical attributes of the soil and associated broad engineering geological characteristics (including soil erosion potential). Representative soil sampling was also to be undertaken for environmental chemical testing.
- Assess the prevailing geo-hazards within the Betano development area, which could potentially impact on development and the environment. Potential geohazards include expansive clay, collapsible soil, dispersive/erodible soil, compressible soils, saline/sodic soils, acid sulfate soils (ASS), karst conditions, asbestiform materials, slope instability, shallow bedrock, seismic conditions, and flooding and inundation.

Recommendations to achieve a stable and functioning post-construction landform also needed to be made.

This scope has been implemented through the following:

- Desktop study: The topography, geomorphology, geology and engineering geology has been assessed by consulting available literature and previous studies covering the Betano development area.
- Site reconnaissance: The Betano development area was visited on 15 December 2011 with the aim of assessing the study sites and planning the fieldwork (test pitting) stage of the investigation.
- Fieldwork: Fieldwork was undertaken between 20 and 21 December 2011. A total of five test pits were excavated in the Betano development area, three at the refinery site and one each at Nova Betano East and Nova Betano West. The test pit locations were pre-selected during the site reconnaissance phase and placed in accessible areas which were deemed representative of the local geology. The test pits were excavated by hand to a depth of 1.5 m below surface. They were logged according to an adapted version of the WorleyParsons' geotechnical logging system, thus facilitating description of the physical attributes of the soil and broad engineering geological characteristics (including soil erosion potential). Eighteen representative soil samples were taken from the test pits for laboratory.





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- Laboratory testing: The 18 soil samples taken during the geological test pitting program were sent to ALS Environmental in Brisbane, Australia for environmental chemical testing. ALS is an Australian National Association of Testing Authorities (NATA) accredited laboratory.
- Reporting: An internal field report collating and presenting all relevant site data was produced in the WorleyParsons' Dili office. This field report was subsequently reviewed and evaluated in Perth, informing the preparation of this section of the SEIA.

### **Soil Chemistry Sampling**

Soil sampling was conducted primarily to establish baseline soil chemical conditions across the study area. The incremental change to the soil chemical properties once the operations have been established is of primary interest and therefore the results have not been compared to assessment criteria. A comparison with future soil chemistry testing against the baseline data reported herein will provide a measure of any impact the project operations may have on the chemical profile of the soil.

Soil chemistry samples were collected from the test pit walls at depth intervals of 0.5 m from ground level, to the base of each test pit, except at Nova Betano where soil samples were collected to a maximum depth of 1.0 metres below ground level (m BGL). Topsoil samples were also collected from each test pit location.

To avoid cross-contamination of samples, a new pair of clinical rubber gloves were worn by the field staff for each sampling event. Samples were placed into individual containers labelled with the following information:

- Unique sample identifier.
- Date and time of sample collection.
- Depth below ground level (m BGL).
- Site staff name.

The list of samples collected from the Betano development area is provided in Table 6-8.

Soil samples were placed directly into a cooler box for temporary storage until they were transferred to a freezer for longer-term storage. This storage method preserves the samples by slowing the degradation due to chemical reactions associated with exposure to the atmosphere. The samples were submitted to ALS Environmental for analysis under full chain-of-custody protocols at the end of the fieldwork program.

The samples were subject to laboratory analysis of the following criteria:

- Physical parameters: pH; electrical conductivity; and moisture content.
- Nitrogen content: total nitrogen; total Kjeldahl nitrogen (TKN); ammonia; and nitrate/nitrite compounds.
- Extractable cations: phosphorus; potassium; and sulfur.
- Total organic carbon.



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**Table 6-8 Collected soil chemical samples – Betano**

Test Pit Number	Sampling Date (dd/mm/yyyy)	Sampling Time	Sample Depth (m BGL)
Test Pit Refinery Betano I (TPRB I)	20/12/2011 (Topsoil)	7:30 am	Topsoil
			0.5m
	21/12/2011 (0.5, 1.0 and 1.5 m)		1.0m
			1.5m
TPRB II	20/12/2011	8:05 am	Topsoil
			0.5m
			1.0m
TPRB III	20/12/2011	9:15 am	Topsoil
			0.5m
			1.0m
Test Pit Nova Betano East IV (TPNB East IV)	20/12/2011	10:20 am	Topsoil
			0.5m
TPNB West V	20/12/2011	10:45 am	Topsoil
			0.5m*
			1.0m*

\* Test results for these samples are erroneously labelled TPNB East V in Appendix D.

### 6.3.2 Existing Environment

#### *Regional Topographic Setting*

The topography of Timor-Leste is dominated by the Ramelau mountain range located along the central axis of the island with heights up to 3,000 m above sea level. The mountain range is dissected by deep valleys prone to flash floods. Towards the northern side, the mountains almost extend to the sea without extensive coastal plains. However, on the south coast, the mountains gently slope towards the sea, leaving a wide littoral plain that is more suitable for agriculture. The plain is generally between 20 and 30 km wide, running almost the length of Timor-Leste, widening in the east. Plate 6-26 shows the typical flat coastal plain topography at the refinery site, where the coastal plain is uncharacteristically narrow compared to most of the south coast.

#### *Topography of the Betano Development Area*

The refinery and petrochemical site stretches from the high water mark above the beach, inland (northwards) along the narrow coastal plain, before intersecting a few low hills which occupy the northern part of the site (Plate 6-27). These low hills coincide with a change in the geology.

In contrast, Nova Betano (located approximately 5 km northwest of the refinery site) is draped over a pair of prominent hills, bisected by the road to Viqueque and separated into two sections; Nova Betano East and Nova Betano West by a prominent valley. Gradients in Nova Betano are generally moderate to fairly steep.



Source: Gavin Fisher, 2011



**Plate 6-26** A view of the typical flat coastal plain topography at the proposed refinery site

Source: Gavin Fisher, 2011



**Plate 6-27** Northern section of the refinery site





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Prominent valleys run through the hilly topography north of the coastal plain before flowing out over the coastal plain as a network of shallow rivers and streams (Plate 6-28), with a few swampy or marshy depressions.

### ***Regional Geomorphological and Geological Setting***

The geology of Timor-Leste comprises predominantly limestone and metamorphosed sediments overlying ancient Proterozoic basement rocks.

Several theories attempt to explain the tectonic and formational history of the island and discussion on the geological history continues. However, all theories are consistent in that the island is composed of contributions from both the north-north-easterly moving Australian continental plate and highly deformed rocks from the Banda Terrane of the southerly moving Eurasian plate. This suggests that Palaeozoic conditions similar to that shown in the Bonaparte Gulf Basin (Northern Australia) should be present. The carbonate sedimentary rocks deposited since the Permian and the lack of non-carbonate material indicate that the area has existed as an island for a long period of time.

The underlying geology of the island has resulted in soils that are of low fertility, relatively unproductive, and susceptible to erosion. The rapid decomposition of organic matter due to the tropical climate further compounds the low soil fertility.

Globally, Timor-Leste is one of the most significant contributors of sediment to the world's oceans (Milliman *et al.*, 1999). Transport of sediments to the marine environment via rivers represents an important process in the global geochemical cycle and is a key component of the global denudation system (Walling and Fang, 2003). Timor, along with other islands of the Indonesian region (Sumatra, Java, Borneo, Sulawesi, and New Guinea) contributes  $4.2 \times 10^9$  tonnes of sediment to the ocean via rivers annually (Milliman *et al.*, 1999). Despite only representing 2% of land area, these islands contribute 20% to 25% of global sediment input (Milliman *et al.*, 1999). The magnitude of fluvial sediment flux has significant implications for the structure, function and susceptibility of surrounding near-shore coastal marine environments.

### ***Geology of the Betano Development Area***

Published data shows that the proposed Betano development area is underlain by a number of different geological units, including; the Wai Luli Formation, the Wai Bua Formation, the Bobonaro Scaly Clay Formation, the Viqueque Formation, the Baucau Limestone Formation and the Suai Formation (see Figure 6-12).

At the refinery and petrochemical site, the coastal plain is underlain by the Suai Formation, with the hills emerging to the northwest comprising the Wai Bua Formation and the hills to the north and northeast comprising the Wai Luli Formation.

The central core of Nova Betano East is underlain by the Baucau Limestone Formation and the central core of Nova Betano West is underlain by the Bobonaro Scaly Clay Formation. Around the lower southerly and westerly fringes of both Nova Betano East and Nova Betano West, the Suai Formation is encountered, with the Viqueque Formation occupying the northern fringe of Nova Betano East and the Wai Bua Formation also occupying the eastern fringe of Nova Betano East (Figure 6-12).



Source: Gavin Fisher, 2011



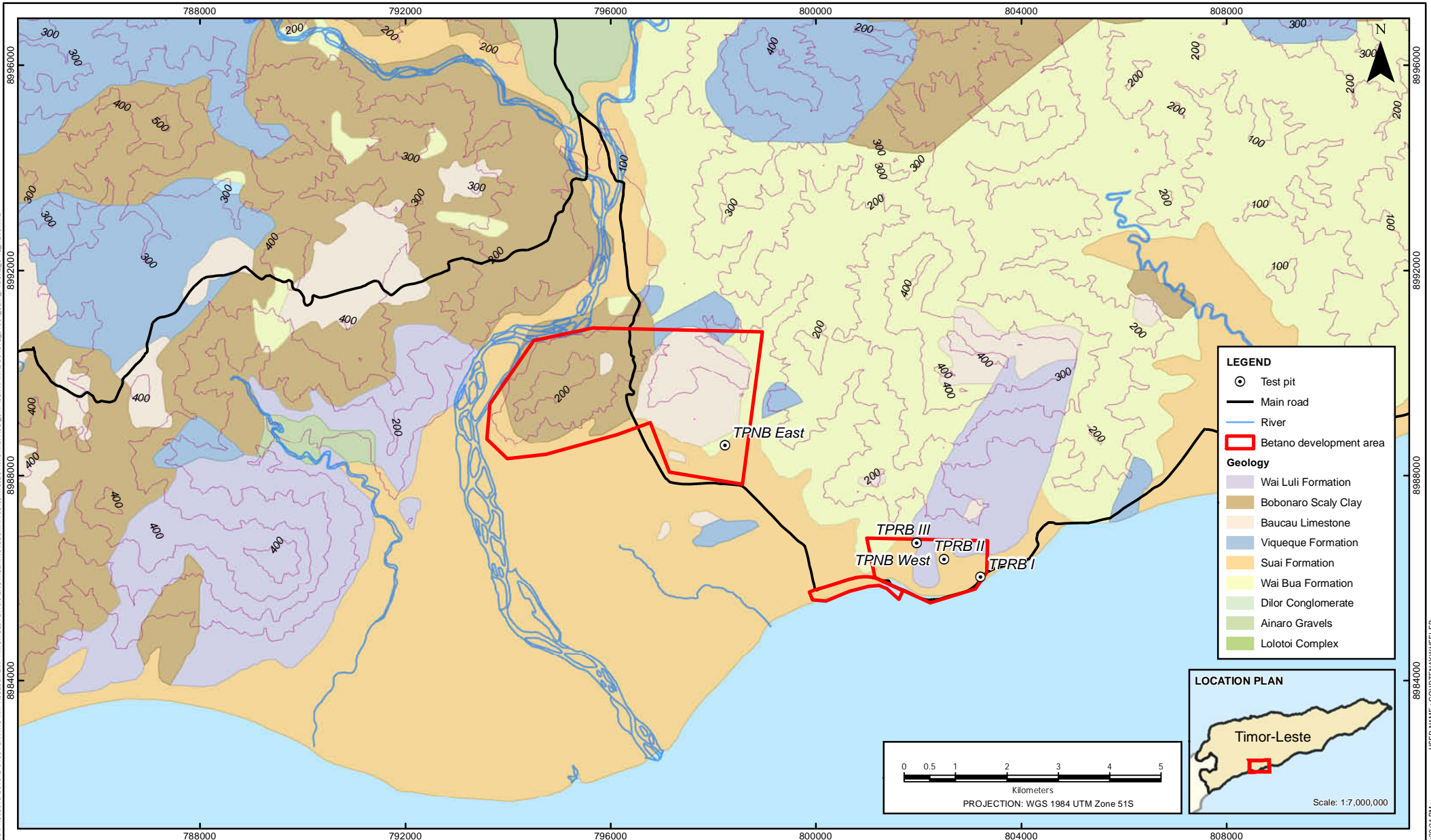
**Plate 6-28** Shallow rivers and streams traversing the development site

Source: Gavin Fisher, 2011



**Plate 6-29** Bobonaro Scaly Clay develops 'jigsaw fractures' due to shrinkage on drying





NOTES:  
 This map consists of:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. Geology: Geographic Information Group TimorLeste (2010)  
 3. Roads: DivaGIS (2010)

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**Figure 6-12**  
 Betano geology map

LOCATION: \\PFRWDRHILL\INFSTRUC\LIB\PROJECTS\301012-01504\ENVIRO\IMP\_ASSESSMENT\TIMORLESTE\100\_ENGINEERING\GEMOAT\CS\301012-01504\ENVIRO\IMP\_ASSESSMENT\FIGURE\_6-12\_REV01.MXD

PLOT DATE & TIME : 29 MAY 2012, 5:29:24 PM USER NAME : COURTNEY WHEELER



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### *Wai Luli Formation*

Throughout Timor-Leste, shales form approximately 70% of the Wai Luli Formation. Plant remains (i.e., leaf cuticles, pollen and spores) are common in these shales. Towards the top of the formation, sequences of red shales occur (Audley-Charles, 1968).

The base of the Wai Luli Formation is composed of well-bedded, spotted blue-grey marls and calcilutites with ammonites. Above the marls, micaceous shales and thinly-bedded calcilutites occur, which become less common upwards and give way to marls, shales and quartz-arenites. Towards the top of the formation, coarse conglomerates containing pebbles (some well-rounded) up to 25 cm in diameter occur. Most of the pebbles are either calcilutites or calcarenites, closely resembling those of the Aitutu Formation. Other clasts in these conglomerates are algal pisolites, calcareous algal fragments, oolites, angular quartz grains (medium sand to silt grade) and altered feldspar. Calcite cement forming a granular mosaic, binds the various clasts together.

The type locality for the Wai Luli Formation is the valley of the Wai Luli where these rocks follow the strike of the Aitutu anticline. The Wai Luli Formation is estimated to be about 800 m to 1,000 m thick, and appears to be entirely of marine origin.

Stratigraphically, the Wai Luli Formation is conformable upon the Aitutu Formation and it is overlain unconformably by rocks of Cretaceous or younger age.

### *Wai Bua Formation*

Exposure of the Wai Bua Formation is poor and generally confined to the hills north of Betano and in the small creeks between the rivers Sui and South Lacro.

The Wai Bua Formation consists of a succession of brittle radiolarites, radiolarian marls and shales, most of which have been subjected to intense folding and faulting. The principal rock-types are finely laminated radiolarian shales, multi-coloured bedded cherts, brightly coloured brittle radiolarites, bio-calcarenites composed essentially of Foraminifera and Radiolaria with a micrite matrix, and calcilutites.

The type locality for the Wai Bua Formation is near the village of Wai Bua, situated about 5 km north of Betano. It is difficult to estimate the thickness of this formation, but field and photo-geological evidence suggests that it is about 500 m thick. The fauna fossils present within this formation imply deposition in an open sea or basin at least 200 m deep.

It is likely that the Wai Bua Formation rests unconformably upon Jurassic or Triassic strata, even though the base is never seen. The Wai Bua Formation is overlain unconformably by various Miocene sedimentary formations.

### *Bobonaro Scaly Clay Formation*

Lithologically, the Bobonaro Scaly Clay Formation has two principal constituents, namely a scaly clay matrix, and a wide variety of unsorted, angular, and sub-angular exotic blocks derived from older formations.

- Scaly clay matrix: The matrix is remarkably uniform in character, being always soft, scaly, and variegated. The clay is generally dark reddish-brown in colour, but a dark olive-green variety is also common, along with black, grey, yellow and bright red clays. Slickensiding is abundantly evident. Montmorillonite is the predominant clay mineral, forming up to 35% of the whole.



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- Exotic blocks: More than 90% of the exotic material seems to have been derived from formations that outcrop in Timor-Leste. The size of the exotic blocks is highly variable, most of which are angular to sub-angular in shape, and chaotically distributed with random orientations.

The type locality for the Bobonaro Scaly Clay Formation occurs beside the River Lomea, east of Bobonaro village, where steep cliffs provide an almost continuous outcrop for about 8 km. The Bobonaro Scaly Clay is more widespread and crops out over a larger area than any other formation in Timor-Leste.

The presence of montmorillonite as the main constituent indicates that a large part of the clay was probably derived from submarine weathering of volcanic ash. The obvious source of ash is the volcanic arc north of Timor. The indigenous microfauna of the clay matrix suggest that deposition occurred in a relatively shallow open basin.

Since the Bobonaro Scaly Clay is unstratified and no marker-horizons have been recognised, an accurate determination of its thickness is not possible. The base of the formation is a highly irregular unconformity generally resting on most of the older formations. Beneath the south coastal plains, the thickness may locally exceed 3,000 m, and in general the formation increases in thickness from north to south across the island.

It appears as if the Bobonaro Scaly Clay was emplaced in its present position by sliding or slumping, and is therefore an allochthonous formation. Due to the high proportion of montmorillonite (bentonite) in the Bobonaro Scaly Clay, it would have flowed very easily as bentonitic clays are generally highly colloidal and plastic. Tectonic activity and earthquake shocks would provide a trigger mechanism to initiate the sliding of the unstable sediment downslope.

The erosion of this formation under tropical conditions, during the rapid elevation of the island since the beginning of the Pliocene, has been severe. It gives rise to a characteristic topography of deep gullies, landslips, and rugged, knobby hillsides where the more resistant exotic blocks protrude above the soft clay matrix. The high proportion of montmorillonite (bentonite) in the scaly clay gives it a waxy appearance when fresh, and after it has weathered, it develops a characteristic 'jigsaw puzzle set of fractures' due to shrinkage on drying (Plate 6-29).

### *Viqueque Formation*

The Viqueque Formation has a highly characteristic appearance which makes it readily identifiable in the field and on aerial photographs, where it is light-toned and has well-defined ridges. Most of the rocks in this formation weather white, forming a white puggy soil. This formation is also characterised by a rugged relief owing to deeply dissected valleys.

The type locality for the Viqueque Formation is the hilly country surrounding Viqueque village. The formation is well exposed in the banks of the River Cua where it cuts through the Viqueque anticline north of Viqueque village.

At the type locality, the basal 130 m consists of massive white marls and grey claystones interbedded with a few chalky limestones and two beds of vitric tuff. These rocks pass up into a succession that is well bedded and becomes gradually more silty and sandy. Silty marls and silty claystones, siltstones, and sandstones dominate the upper part of the formation.

In the type locality the formation is about 500 m thick, although the maximum thickness is probably about 800 m under the wide southern coastal plain.



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The Viqueque Formation generally rests unconformably on the Bobonaro Scaly Clay, and is overlain with apparent conformity by the Seketo Block Clay and the Dilor Conglomerate. These two formations and the Viqueque Formation itself are overlain with angular unconformity by both the Baucau Limestone and the Suai Formation.

The fossil fauna of the Viqueque Formation is entirely marine and the composition and textural immaturity of the silty and sandy rocks indicate rapid deposition. The prevalence of graded bedding and graded cycles, the scarcity of current-bedding, along with the frequency of sedimentary slump structures, all indicate a molasse type of sedimentation deposited during the emergence of Timor as an island.

### *Baucau Limestone Formation*

This formation generally comprises hard, vuggy, cavernous, massive, white coral-reef limestone, which weathers to a pale grey colour, often characterised by karst topography and a dark reddish soil. Four main lithologies are recognised:

- Coral reef limestones: These are massive, dense *in situ* growths of coral with subordinate amounts of calcareous algae.
- Calcirudites: These are massive, poorly bedded conglomerates, composed of reef debris cemented by micrite and sparry calcite, forming lenticles with the *in situ* coral.
- Calcarenites: These are interbedded with the *in situ* reefs and calcirudites. They consist almost entirely of sand grains composed of coral fragments, bryozoans, Foraminifera, calcareous algae, molluscs and echinoderms.
- Sub-mature greywacke and pebbly sandstone: These are essentially poorly sorted gravels, sands, and silts composed mainly of quartz, with lesser amounts of eruptive rock and limestone fragments. These rocks are interbedded with calcirudites and calcarenites.

The type locality for the Baucau Limestone is the series of terraced reef limestones that crop out around the town of Baucau. The formation is widespread, and forms two prominent topographical features, the Baucau plateau and the Lautem plateau. In the southern foothills of Timor-Leste, the Baucau Limestone forms scattered remnant outcrops, an example of which occurs beneath Nova Betano East.

The thickness of this formation is difficult to estimate because it is composed of a series of terraces that are either horizontal or dip at approximately 2 degrees. The terraces rise from sea-level to approximately 500 m.

The Baucau Limestone is unconformable at the base and, it generally overlies the Viqueque Formation, where its base transgresses the eroded late Pliocene folds of the Viqueque Formation.

### *Suai Formation*

The Suai Formation overlies the Viqueque Formation and the Dilor Conglomerate. Although not studied in detail, it is expected that the base of the Suai Formation is of late Pliocene age, ranging up through to the Quaternary. This formation is developed in the wide coastal plain that extends from Aliambata in the east to the frontier with Indonesia in the west. This plain is only interrupted in the Betano area.

The Suai Formation is in excess of 600 m thick, and like the Viqueque Formation, probably thickens rapidly to the south, reaching its maximum offshore. The maximum thickness attained within the present





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limit of Timor is probably under the plain between Betano and Aliambata, where it may be approximately 1,000 m thick. The base is difficult to define accurately on the information available.

The presence of Foraminifera indicates that the Suai Formation was deposited in a marine environment. Like the upper part of the Viqueque Formation, the Suai Formation may be considered to be a molasse deposit, a regressive facies formed during the emergence of Timor.

The type locality for the Suai Formation is the coastal plain surrounding Suai village. Water bores to the north of Suai village have revealed that most of the sediments are largely unconsolidated rudites and arenites ranging from pebbly gravels to fine silts, often rich in Foraminifera. The Suai Formation is similar to the upper part of the Viqueque Formation except that consolidated sediments are absent from the Suai Formation.

The Suai Formation is generally poorly exposed and typically without relief. The beds are either horizontal or gently dipping to the south (seawards) and outcrop is mostly covered by dense vegetation.

### Soil Profile

A total of five test pits were excavated in the Betano development area, three at the refinery and petrochemical site and one each at the Nova Betano East and Nova Betano West sites. The locations of the test pits were pre-selected during the site reconnaissance phase and placed in accessible areas deemed to be representative of the local geology. The test pits were excavated by hand to a depth of 1.5 m below surface and generally confirm the published geology. Test pit positions are indicated on Figure 6-12. The soil profiles are summarised in Table 6-9 and depicted in Plate 6-30 to Plate 6-34.

**Table 6-9 Summarised soil profiles – Betano**

Test pit number and coordinates	Depth	Description
<b>TPRB I (Betano Refinery)</b> X = 803207 Y = 8986015	0 to 1.35 m	SAND: Medium to coarse-grained sand with some fine to medium-grained gravel, and trace clay, light brown, medium dense to dense, wet.
	1.35 to 1.5 m	SANDY GRAVEL: Medium to coarse gravel in a matrix of fine to medium-grained sand with trace clay, grey-brown, dense to very dense, wet. Trace calcareous concretions evident.
<b>TPRB II (Betano Refinery)</b> X = 802499 Y = 8986365	0 to 0.75 m	SAND with GRAVEL: Fine to coarse-grained sand with fine to medium-grained gravel, and trace clay, brown, dense to very dense, moist with wet patches.
	0.75 to 1.5 m	SANDY CLAY: Medium plastic clay, dark brown, firm to stiff. Sand is medium to coarse-grained. Trace of fine to medium gravel and calcareous concretions. Wet.
<b>TPRB III (Betano Refinery)</b> X = 801959 Y = 8986685	0 to 0.35 m	CLAY: Medium plastic clay, dark grey-brown, firm to stiff, with some fine to coarse gravel and trace fine-grained sand. Moist with wet patches.
	0.35 to 1.5 m	CLAY with GRAVEL: Low to medium plastic clay, light brown, becoming darker with depth, firm to stiff. Gravel is fine to medium, with the gravel content diminishing with depth. Trace fine to coarse sand. Moist with wet patches.





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**Table 6-9 Summarised soil profiles – Betano (cont'd)**

Test pit number and coordinates	Depth	Description
<b>TPNB East IV (Nova Betano East)</b> X = 798224 Y = 8988584	0 to 0.4 m	SANDY CLAY: Medium to highly plastic clay, dark grey, firm to stiff. Sand is fine to medium-grained, with trace fine gravel (mostly calcareous concretions). Moist.
	0.4 to 1.5 m	CLAY: Medium to highly plastic clay, dark grey-brown, stiff to very stiff, with some fine to coarse-grained sand and trace fine gravel (mostly calcareous concretions). Moist with wet patches.
<b>TPNB West V (Nova Betano West)</b> X = 801959 Y = 8986685	0 to 0.4 m	SANDY CLAY: Medium plastic clay, dark brown mottled red-brown, firm to stiff. Sand is fine to medium-grained, with trace fine gravel (mostly calcareous concretions). Moist with wet patches.
	0.4 to 1.5 m	CLAY: Medium plastic clay, grey-brown mottled yellow-brown, firm to stiff, with some fine to coarse-grained sand and trace fine gravel (mostly calcareous concretions). Moist with wet patches.

Source: Joana Fernandes, 2011



Plate 6-30 Test pit TPRB I

Source: Joana Fernandes, 2011



Plate 6-31 Test pit TPRB II

Source: Joana Fernandes, 2011



Plate 6-32 Test pit TPRB III

Source: Joana Fernandes, 2011



Plate 6-33 Test pit TPNB East IV - Nova Betano East







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### ***Geology/Vegetation Associations***

Teak (*Tectona grandis*) found in the Betano region is an indicator species for the presence of limestone or calcrete. Teak usually grows on limestone outcrop or where the limestone and/or calcrete occur at a shallow depth.

Limestone underlies most of Nova Betano East and calcareous sediments are fairly common at Nova Betano West and the hills emerging in the northern part of the refinery site. As a result, teak is commonly encountered in these areas. Although calcareous material is generally absent from the coastal plain, the occurrences of teak in this area appear to coincide with minor accumulations of calcium carbonate within the Suai Formation.

### ***Geohazards***

Significant geohazards which could impact on the Betano development area are discussed in the following section. These may influence the economics and performance of certain infrastructure or may result in environmental impacts. It should be noted that these conclusions are based on a desktop assessment referencing available published geological information and a brief fieldwork phase. Detailed geotechnical investigation will ultimately be required to confirm the presence, extent and severity of these geohazards.

#### *Expansive Clay*

Expansive clays exhibit large volume changes corresponding to changes in moisture content (swelling when wet and shrinking when dry). Such volume changes are often seasonal and can result in differential movement beneath structures. Expansive clays can also have poor handling characteristics during moisture conditioning and compacting.

The Bobonaro Scaly Clay Formation is characterised by a soft, scaly, and variegated matrix. Montmorillonite, which is generally highly colloidal and plastic, is the predominant clay mineral, forming up to 35% of the whole formation. Slickensiding is abundantly evident, as are characteristic fissures due to shrinkage on drying. This clay is clearly expansive and likely falls in the 'highly expansive' category, implying significant volume changes from a wet to a dry state. This is particularly significant, bearing in mind the distinct wet and dry seasons experienced in Timor-Leste.

The Bobonaro Scaly Clay Formation underlies most of Nova Betano West, and is likely to impact significantly on development in this area. The formation gives rise to highly expansive clay, which loses all cohesion when, becomes highly compressible, is dispersive, and is very unstable in slopes when saturated. Where possible, development in these areas should be avoided or curtailed. Plate 6-35 shows the typical clay profile at Nova Betano West.

Weathering of the Viqueque Formation also produces clayey soils, and although potentially expansive, they do not appear nearly as difficult as the clays produced by the Bobonaro Scaly Clay Formation.

The Suai Formation includes well-developed clayey horizons, some of which underlie the refinery site, as noted in some of the test pits. The clay, which occurs at varying depths, appears to range from low to medium plasticity, and construction will need to consider the potential effects of soil shrinkage and swelling on foundation design in this area. These clayey horizons are; however, not as severe as the Bobonaro Scaly Clay Formation.





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The presence of clayey horizons beneath the coastal plain also results in perched water table activity and causes water to pond after rainfall events. The resultant perched water tables and marshy conditions could hamper construction activities during the wet season.

To assess the potential risk from expansive clay, ground investigations in this area should include soil plasticity (Atterberg Limits), and natural moisture content determinations to assess soil behaviour in response to changes in the moisture content. These may be supplemented with more advanced swelling tests.

### *Collapsing Soils*

Silty sands with relatively low densities and high void ratios can be susceptible to collapse when inundated after loading, which can result in excessive settlement of structures. In the Betano development area, unconsolidated silts, sands and silty sands have been recorded within the Suai Formation. These soils, which underlie parts of the refinery site, may be prone to collapse settlement and should be investigated during future ground investigations.

### *Erodible/Dispersive Soils*

#### Soil Erodibility Potential

Soil erodibility potential is the likelihood that erosion will occur when soils are exposed to water (and/or wind) during, or as a result of, land-disturbing activities. Erodibility potential is highest on slopes, and when low-plasticity, silty soils or fine sands are disturbed. Nova Betano East and Nova Betano West, as well as the upper reaches of the refinery site, are potentially vulnerable to soil erosion in this manner. In addition, even though the coastal plain is fairly flat, areas along the fast flowing rivers and streams will be susceptible to erosion after significant rainfall events.

#### Soil Dispersion Potential

Soil dispersion potential is the likelihood that soils will release a cloud of fine clay particles when brought into contact with water. These clay particles may remain suspended for an indefinite period of time, resulting in turbid, 'dirty' water, which can affect plant and animal life. Soil dispersion can occur without the influence of slope, mechanical action or run-off velocity i.e., in 'still water'. It is therefore, imperative that run-off from dispersive soils is retained and treated on-site wherever practicable, before release into the natural or constructed stormwater system. This can be achieved through use of sedimentation ponds during the construction period.

Dispersive soils usually contain significant amounts of clay, with at least moderate levels of chemically exchangeable sodium, if they are not buffered by salinity.

Initial analysis using the simplified Emerson Crumb Test in the field on selected clayey samples indicates that the Bobonaro Scaly Clay Formation is moderately to highly dispersive, whilst the Viqueque Formation is moderately dispersive. The areas underlain by these formations are also fairly undulating, compounding soil erosion problems.

The Suai Formation may contain slightly to moderately dispersive soils in certain clay dominated horizons. This potential phenomenon should also be thoroughly investigated during future geotechnical investigations.



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### *Compressible Soils*

As previously mentioned, the Bobonaro Scaly Clay Formation produces clay which is expected to be highly compressible when saturated. The Viqueque Formation may also produce similar compressible clays. Careful consideration and thorough investigation should precede development in these areas.

Soils deposited in the vicinity of the river mouths within the refinery site appear to range from silty and clayey fine sands to sandy silts and clays. Soils deposited in such environments are also typically of low strength and are compressible, requiring further investigation.

### *Acid Sulfate Soils*

Acid sulfate soils are naturally occurring soils and sediments that contain iron sulphides, predominantly in the form of the mineral pyrite. These soils are most commonly found in low-lying land bordering the coast or estuarine and saline wetlands. In an anoxic state, these materials remain benign, and do not pose a significant risk to human health or the environment. However, the disturbance of ASS, and its exposure to oxygen, causes these soils to release acidity and dissolved inorganic contaminants, resulting in significant human health, environmental and economic impacts.

The high probability/high risk areas for acid sulphate soils (ASS) correspond to the river mouths and estuarine areas in the Betano region. Thorough ASS investigation should precede any development in these areas. The field and soil chemical data also indicate the potential for ASS at the site.

### *Saline/Sodic Soils*

Soils that contain sodium salts can become dispersive when wetted with fresh water (such as rainfall), as the dissolved sodium weakens the electrochemical bonds between clay particles. Such soils are also often prone to erosion and the formation of subsurface erosion 'pipes' if affected by earthworks (Plate 6-36). Saline soils often contain recrystallised gypsum and high void ratios that can increase the potential for collapse settlement to occur when inundated after loading. A saline environment also produces aggressive groundwater and increases the corrosion rates of steel.

Vegetation has varying degrees of tolerance to saline and sodic soil and therefore, prior to disturbance, it is important to characterise and, if necessary, segregate soil intended to be used for site rehabilitation.

Parts of the Betano refinery site directly adjacent to the coast may contain these types of soils and soil samples should be taken along the coastline during any future site investigation program in order to confirm this initial assessment.

### *Dissolution Voids (Karst)*

Rocks potentially giving rise to karst topography are well developed within the Betano development area, the Baucau Limestone Formation being the most prominent (Plate 6-37). However, the Wai Luli, Wai Bua and Viqueque formations also comprise in part, rocks and sediments of calcareous composition. In addition, the intertidal zone adjacent to the refinery site is characterised by a continuous calcarenite outcrop (Plate 6-38), much of which displays dissolution channels on the surface (Plate 6-39), with pitted and voided patches. A fault zone can also be traced in the calcarenite wave cut platform over a distance of a few kilometres (Plate 6-40).



Source: Gavin Fisher, 2011



**Plate 6-36** Piping features noted along the paved road bisecting Nova Betano

Source: Gavin Fisher, 2011



**Plate 6-37** Dissolution features in the Baucu Limestone at Nova Betano





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Identifying the presence of karst features by geophysical investigation in conjunction with boreholes is recommended where key infrastructure straddles any of the aforementioned formations, or the coastal calcarenite.

### ***Asbestiform Materials***

Asbestos minerals are unlikely to be encountered within the sedimentary and metamorphic rocks of Timor-Leste, and even less likely to be found within the sedimentary succession of the Suai Formation, the clayey succession of the Bobonaro Scaly Clay Formation or the slightly older calcium carbonate rich rocks of the other documented formations within the Betano development area.

### ***Slope Instability***

Nova Betano West is exposed to the most significant risk of slope instability as the underlying clay succession is fairly thick and appears highly expansive. The clay is also dispersive with numerous piping features evident along the slopes, and erosion appears to easily take hold where vegetation is disturbed. When saturated, the clay appears to lose all cohesion, which has resulted in small scale landslides all over the site. To compound the above geohazards, the site is proposed to be located on fairly steep gradients. Ongoing slope instability problems can thus be expected, especially when vegetation is removed and roads and development platforms are cut into the slopes (Plate 6-41).

Whilst Nova Betano East and the northern parts of the refinery site also consist of moderate to steep gradients, these areas are less prone to slope failure than Nova Betano West. In these areas, bedrock occurs nearer to the surface, and the overlying soil successions are less difficult. However, the possibility of slope failure cannot be entirely ruled out.

In contrast, the flat coastal plain implies an insignificant risk of natural slope instability. However, cuttings and excavations within the unconsolidated Suai Formation will be susceptible to collapse, further exacerbated by the presence of shallow perched water tables. Test pits were limited to a depth of 1.5 m for this reason during the recent investigations.

### ***Shallow Bedrock***

Although shallow bedrock is generally a positive attribute for the founding of heavy structures, it could be classed as a geohazard where roads will be cut into the landscape, or where excavations must be made for underground services.

The Suai Formation underlying the coastal plain will not pose problems in this regard, but the Wai Luli, Wai Bua, Viqueque and Baucau Limestone formations may result in localised excavation difficulties. Most of the bedrock is; however, fairly weathered (Plate 6-42) with the well-cemented limestone posing the greatest risk of excavation refusal.

### ***Flooding and Inundation***

The rivers flowing off the mountainous terrain to the north of the Betano development area are all prone to high-velocity, flash flooding. These flash floods are; however, generally confined to the incised river channels and associated wide flood plains. Flood studies will nevertheless be imperative to ensure that proposed development is not impacted by flooding.





Source: Gavin Fisher, 2011

**Plate 6-38** The wave cut platform at Betano



Source: Gavin Fisher, 2011

**Plate 6-39** The calcarenite is characterised by dissolution channels across the surface



Source: Gavin Fisher, 2011



**Plate 6-40** A geological fault is visible in the calcarenite running parallel to the beach

Source: Gavin Fisher, 2011



**Plate 6-41** Slope failure at Nova Betano West behind a retaining wall along the road to Same



Source: Gavin Fisher, 2011



**Plate 6-42** Weathered bedrock in the hilly northern part of the refinery site



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Low-lying areas adjacent to the coast could also be affected by extreme tides and storm surges. Cyclonic activity, which is common off the southern coast of Timor-Leste, would generally be the catalyst for inundation of this nature.

According to data released by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), Timor-Leste has a moderate to high exposure to tropical storms and storm surge.

### *Seismic Conditions*

According to data released by the OCHA, Timor-Leste has a high to very high exposure to seismic activity and tsunamis, with potential earthquake intensity reaching Degree VIII on the Modified Mercalli Scale. Degree VIII implies slight damage to well-built structures; poorly-built structures are heavily damaged, whilst walls, chimneys and monuments fall.

Earthquakes have been recorded in the area around Betano (onshore and offshore), four of which have been recorded in the period from May 1998 to July 2010. Details (localities and magnitude) are provided on Figure 6-13.

Associated with the seismic risk is liquefaction of the soil. Liquefaction typically occurs where deep sandy or silty sand successions are found in conjunction with shallow water table conditions. These conditions are plausible on the coastal plain underlain by the Suai Formation.

### **Soil Chemistry**

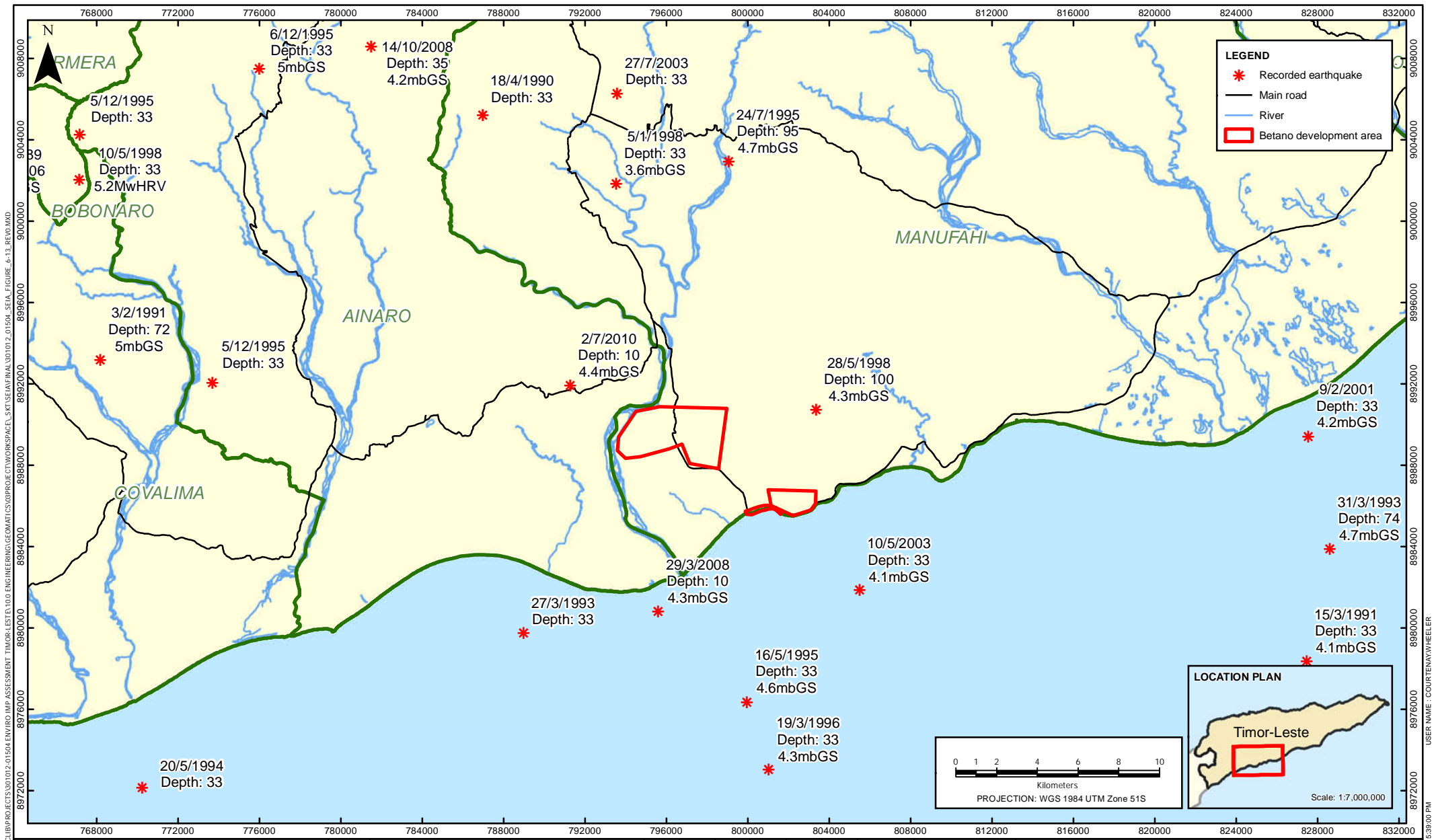
The laboratory analysis results are summarised in Table 6-10 and Table 6-11.

The soil test results from both the Betano refinery site and the Nova Betano sites indicate consistently alkaline pH values and relatively low electrical conductivity in all samples. Total organic carbon of approximately 2 to 3%, and elevated nitrogen and potassium were reported in topsoil samples. These results are consistent with the natural soil chemistry associated with well-drained soils derived from calcareous materials with low salinity, and low levels of organic matter and nutrient accumulation and cycling in the topsoil, typical of tropical soil conditions where rates of organic decomposition are high.

The only exception is the Nova Betano West location, where samples are reported with consistently elevated moisture contents throughout the profile. The deepest sample at 1.0 m BGL had a reported total sulfur value of 0.03%. In addition, mottled clay was recorded at this location. The field and soil chemical data also indicate the potential for acid sulfate soils.

### **Soil Contamination**

During the site investigation, no obvious evidence of soil contamination was noted in the field and no indication of soil contamination is interpreted from the soil test results, although it should be noted that the field and laboratory programs were not designed for a full investigation of contamination.



**NOTES:**  
 This map consists of:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. District boundaries: Geographic Information Group TimorLeste (2010)  
 3. Roads: DivaGIS (2010)  
 4. Earthquakes: US Geological Survey (2011)

0	5/06/2012	FINAL FOR ISSUE	MW	CS	-	-	GH		A4 SHEET	SCALE 1:250,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
										Copyright © WorleyParsons Services Pty Ltd

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**Figure 6-13**  
**Betano earthquake map**

LOCATION: \\PFRM01\IT\INFRASTRUCTURE\PROJECTS\301012-01504\EMIRO\IMP\_ASSESSMENT\TIMORLESTE\100\_ENGINEERING\GEMAT\CS\30PROJ\CTWORKSPACE\SP\USE\FINAL\301012\_01504\_SEIA\_FIGURE\_6-13\_REV0.MXD  
 USER NAME: COURTNEY WHEELER  
 PLOT DATE & TIME: 05 JUN 2012 5:38:00 PM





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**Table 6-10 Summary of soil chemical analysis (Betano refinery area)**

Compound	LOR <sup>1</sup>	Test Pit	Unit	TPRB I				TPRB II				TPRB III			
				Sample Depth											
				Topsoil	0.5 m	1.0 m	1.5 m	Topsoil	0.5 m	1.0 m	1.5 m	Topsoil	0.5 m	1.0 m	1.5 m
				20/12/2011	21/12/2011	21/12/2011	21/12/2011	20/12/2011	20/12/2011	20/12/2011	20/12/2011	20/12/2011	20/12/2011	20/12/2011	20/12/2011
<b>Physical Parameters</b>															
Moisture content	1.0	%		20.0	9.0	22.5	4.2	23.1	16.9	18.8	20.0	28.8	17.8	10.2	24.7
pH value	0.1	pH unit		7.7	7.7	8.5	8.9	8.2	8.6	8.4	8.6	8.0	8.7	7.9	8.5
Electrical conductivity	1	µS/cm		133	16	121	64	150	89	165	123	185	83	19	110
<b>Nutrients</b>															
Total nitrogen <sup>2</sup>	20	mg/kg		1950	320	450	110	1860	240	560	430	2160	320	380	560
Total Kjeldahl nitrogen <sup>2</sup>	20	mg/kg		1910	320	450	110	1840	240	560	430	2120	320	380	560
Ammonia <sup>2</sup>	20	mg/kg		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Nitrate <sup>2</sup>	0.1	mg/kg		38.5	0.9	0.9	0.2	20.2	0.6	0.4	0.3	33.7	0.7	1.1	0.3
Nitrite <sup>2</sup>	0.1	mg/kg		0.7	<0.1	0.3	<0.1	<0.1	0.2	0.1	0.2	1.4	0.2	<0.1	0.2
Nitrite and Nitrate <sup>2</sup>	0.1	mg/kg		39.2	0.9	1.2	0.2	20.2	0.8	0.5	0.5	35.1	0.9	1.1	0.5
<b>Extractable Cations</b>															
Bicarbonate extractable P	2	mg/kg		97	36	16	17	22	<2	37	34	15	<2	9	10
Bicarbonate extractable K	10	mg/kg		710	250	820	<200	770	590	310	230	980	920	790	670
Total sulfur <sup>3</sup>	0.01	%		0.02	<0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
<b>Organic Carbon</b>															
Total organic carbon	0.02	%		2.18	0.24	0.31	0.09	2.01	0.20	0.45	0.26	2.14	0.17	0.40	0.46

<sup>1</sup> Limit of Reporting

<sup>2</sup> as N

<sup>3</sup> as S



**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

**Table 6-11 Summary of soil chemical analysis (Nova Betano)**

Compound	LOR <sup>1</sup>	Test Pit	TPNB EAST IV			TPNB WEST V		
			Sample Depth					
			Topsoil	0.5m	1.0m	Topsoil	0.5m	1.0m
Unit		20/12/2011	20/12/2011	20/12/2011	20/12/2011	20/12/2011	20/12/2011	
<b>Physical Parameters</b>								
Moisture content	1.0	%	28.8	16.7	20.2	24.7	24.4	25.7
pH value	0.1	pH Unit	8.3	8.3	8.3	8.3	8.3	8.3
Electrical conductivity	1	µS/cm	142	117	115	117	118	128
<b>Nutrients</b>								
Total nitrogen <sup>2</sup>	20	mg/kg	2400	920	1020	1660	700	520
Total Kjeldahl nitrogen <sup>2</sup>	20	mg/kg	2380	920	1020	1640	700	520
Ammonia <sup>2</sup>	20	mg/kg	<20	<20	<20	<20	<20	<20
Nitrate <sup>2</sup>	0.1	mg/kg	14.9	0.4	0.5	15.6	0.2	0.1
Nitrite <sup>2</sup>	0.1	mg/kg	0.7	<0.1	0.1	0.2	<0.1	<0.1
Nitrite and Nitrate <sup>2</sup>	0.1	mg/kg	15.6	0.4	0.6	15.8	0.2	0.1
<b>Extractable Cations</b>								
Bicarbonate extractable P	2	mg/kg	54	6	9	15	14	16
Bicarbonate extractable K	10	mg/kg	810	550	770	550	<200	<200
Total sulfur <sup>3</sup>	0.01	%	0.02	<0.01	<0.01	0.01	<0.01	0.03
<b>Organic Carbon</b>								
Total organic carbon	0.02	%	3.17	0.87	1.18	1.85	0.45	0.38

<sup>1</sup> Limit of Reporting

<sup>2</sup> as N

<sup>3</sup> as S



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 6.3.3 Environmental Impacts

#### *Contamination of the Soil and Underlying Geological Strata*

Contamination of the soil can be caused by a number of development activities and can range from direct environmental and human health impacts from spills of chemicals, to secondary and tertiary environmental effects arising from the acidification of the soil.

One of the most common soil contamination risks is spillage of chemicals or waste, particularly when stored and/or transferred in liquid form. Chemicals stored for industrial purposes or as chemical waste can leak from improperly maintained above- or below-ground tanks and fuelling stations, contaminating both the underlying soil profile and groundwater.

Soil acidification can produce adverse environmental impacts on soils and groundwater. In addition, it can also adversely affect the agricultural value of the soil due to increased heavy metals and other inorganic toxins mobilised by the acidified groundwater. The primary cause of soil acidification is the oxidation of ASS. Acid sulfate soils are naturally-occurring soils that exist near the groundwater level when the organic content of the soil is high. Anoxic conditions below the groundwater level can produce high concentrations of sulphides that will readily oxidise when exposed to the atmosphere. Soil exposure to the atmosphere can occur from both direct excavation of the soil or lowering of the water table during dewatering activities for construction.

The oxidation of the sulphides in the soil results in a significant lowering of the soil pH and can cause deterioration in the health of vegetation and the surrounding ecosystem. In addition, heavy metals and other inorganic toxins stored in the soil matrix can be dissolved into the acidified groundwater and mobilised to different areas, poisoning native plant life and crops. Mangroves are known to occupy regions where both potential and actual ASS are prolific.

The extent and severity of the expansive clay and dispersive soils will also need to be established through detailed geotechnical investigation before the impact of developing these areas can be accurately determined. At this stage, results would suggest that infrastructure will require engineering measures to counter these geohazards and that this would likely result in increased development costs.

### 6.3.4 Avoidance, Management and Mitigation Measures

Avoidance of soil contamination is by far the most effective method to reduce the environmental and human health impact of the project. Methods to avoid direct contamination of soils via chemical spills are in engineering design and management measures. It is recommended that, whenever practicable, above-ground storage tanks for liquid chemicals and appropriate storage containers for non-liquid chemicals are used with containment bunds that are ISO 14001 compliant. Management plans that include training and procedures to prevent spillage during fuel and other chemicals transfer, and to address spills appropriately, are also critical for avoidance of soil and water contamination.

It is also recommended that a spills register should be established that lists at a minimum: the date and time of the spill; the quantity of the spilled material; and a description of the spilled material. Material safety data sheets (MSDS) and a dangerous goods list should be kept on site for all chemical



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materials used. The MSDS should specify the appropriate containment and clean-up methods for each chemical in the event a spill occurs.

For acid sulfate soil management, it is recommended that an investigation is conducted into the presence of ASS in regions identified in a desktop study as having an increased risk of potential or actual ASS being present. This investigation should be conducted in general accordance with the *Guidelines for sampling and analysis of lowland acid sulfate soils in Queensland* (Ahern et. al., 1998) and is likely to focus on regions around mangroves and waterways where acidification impacts would be increased. Whenever possible, it is recommended that ASS is not disturbed as it is naturally occurring and only impacts the surrounding environment when influenced by exposure to the atmosphere.

In the event that either actual or potential ASS is present in areas where excavation or dewatering cannot be avoided, it is recommended that an ASS management plan is developed specifying the management and/or treatment of ASS such that the impact to the surrounding environment is minimised. The management plan should be developed in general accordance with (Ahern et. al., 1998) or an equivalent guideline.

### 6.3.5 Residual Impacts

The recommended avoidance and management measures are known to be effective if fully implemented; however, until the plant design and environmental management measures have been confirmed it is not possible to specify any residual impacts at this time.

### 6.3.6 Further Work

Detailed engineering geological and geotechnical work are required to fully assess ground conditions across the Betano development area. Such investigations will be aimed at fully understanding the geology and potential impacts on the sub-surface environment. In addition, these investigations would provide firm inputs for preliminary designs during the successive phases of the project. Two phases of investigation are recommended.

#### **Phase 1**

The first phase should consist of further site reconnaissance, followed by detailed geological mapping of the Betano development area. Geological units should be assessed and their surface properties visually confirmed. A seismic risk study should also be included. This process would ensure optimal investigation during the next investigation phase.

#### **Phase 2A (Onshore)**

The second phase (onshore) would encompass penetrative investigation in conjunction with soil and rock testing. The following would be undertaken:

- The excavation of test pits with the aim of:
  - Identifying general subsurface conditions across the development footprint.
  - Confirming the presence and extent of geohazards within the development area.





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- Providing shallow foundation and pavement design parameters.
- Providing information on typical excavation conditions.
- Delineating and investigating potential sources of construction material identified during the desktop study. This will include collection of representative soil and rock samples for laboratory testing.
- Conducting hand-held Dynamic Cone Penetrometer (DCP) tests adjacent to some of the test pits. DCP testing has the advantage of being quick and is used as both a profiling tool and to determine strength properties of underlying soils to a depth of roughly 3 m BGL.
- Drilling of geotechnical boreholes in strategic locations in order to obtain an understanding of the nature of the various geological formations encountered within the Betano development area.
- Limited hand augering may be suitable for the ASS investigation in high-risk areas.
- Geophysical studies are also recommended where structures are to be founded on any formation susceptible to karst problems (including limestone and coastal calcarenite), and to provide a non-intrusive indication of the presence and extent of any saline soil which may require characterisation.
- A detailed laboratory testing program (soil and rock).

Once the locations of the various structures have been finalised, a second, more detailed investigation phase should be undertaken, in order to obtain final design parameters for detailed design purposes.

### ***Phase 2B (Offshore)***

The second phase (offshore) would encompass a geophysical study (seismic survey), followed by a detailed drilling program in conjunction with extensive soil and rock testing. Based on the geophysical information, the drilling program would be tailored to provide accurate sub-surface data for dredging and piling (amongst other things).

### ***Soil Chemistry***

It is recommended that a detailed baseline study of the soil chemistry is conducted in regions where extensive excavation is proposed to occur. Further work related to soil chemistry required for the project is as follows:

- Additional baseline investigation of the soil chemistry highlighting the potential presence of ASS across the study area in general accordance with (Ahern et. al., 1998) or an equivalent guideline; and to verify and characterise any soil salinity and/or sodicity that may be present.
- If ASS are identified in regions where soil excavation or dewatering is to be conducted, an acid sulfate soils management plan is to be developed detailing management procedures and/or soil treatment measures to be implemented.
- If soil salinity and/or sodicity is present in areas where disturbance is planned, a soil management plan addressing segregation and storage of saline soil is to be developed. If any



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areas of the development site are planned to be rehabilitated, then a rehabilitation plan is to be developed prior to the disturbance of these areas to ensure that rehabilitation is not adversely affected by the presence of acidity, salinity and/or sodicity.

Engineering design for storage of chemicals on the proposed developments is to be compliant with ISO 14001 to enable management of potential spills/leaks.



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### 6.4 Air Quality

This section considers the potential air quality impacts associated with the construction and operational phases of the Betano Refinery and Petrochemical Complex.

Air pollution is commonly defined as the introduction into the atmosphere of chemicals, particulate matter or biological materials that can cause adverse impacts on human health or other aspects of the environment. The proposed Betano development could affect the local and regional air quality and the purpose of the study is to assess these potential impacts.

#### 6.4.1 Study Method

This study was designed to establish the baseline air quality within the Betano study area. The study method adopted for this assessment is as follows:

- Identify air quality sensitive receptors (i.e., residences, schools) in the Betano study area.
- Collect existing (baseline) ambient air samples in the Betano study area for laboratory analysis.
- Measure baseline particulate matter concentrations in the study area via the use of a DustTrak™ Aerosol Monitor and dust deposition gauges.
- Assess the baseline ambient concentrations of particulates and gas pollutants against the assessment criteria.
- Determine the maximum allowable increase in ground-level concentration for pollutants likely to be emitted by the Betano development<sup>2</sup>.
- Provide recommendations of management measures to minimise local and regional air emissions.

#### **Study Scope**

The scope of this study incorporates the entire Betano development area as described in Chapter 4. It also incorporates existing settlements in the Betano region and the proposed residential area of Nova Betano. The power plant that is to be located adjacent and immediately west of the Betano refinery development area has been considered in the assessment of cumulative impacts although, it should be noted that it is the subject of a separate environment assessment and approvals process, currently being managed by the EDTL (Electricity Authority).

#### **Assessment Criteria**

Currently, the Government of Timor-Leste does not have specific legislation regarding air quality assessment and regulation. In these circumstances, it is common practice in air quality investigations to adopt assessment criteria from other applicable jurisdictions or recognised international organisations. Three internationally recognised authorities on air quality have standards or guidelines that have been adopted for this assessment: the World Health Organisation (WHO); the United States

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<sup>2</sup> This was to be conducted by computer modelling but there was insufficient data to create a model.



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Environmental Protection Agency (US EPA); and the Australian National Environment Protection Council (NEPC).

The WHO has developed a series of assessment guidelines for the most common airborne pollutants. These guideline values are listed in *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide. Global update 2005. Summary of risk assessment* (WHO, 2005).

The US EPA has a set of National Ambient Air Quality Standards listing a similar set of airborne pollutant standards (US EPA, 2011). In addition, the US EPA provides a list of chemical compounds classified as 'Air Toxics' with chronic inhalation exposure values for screen risk assessment indicating concentrations where long-term exposure would likely result in adverse health impacts (US EPA, 2010). However, the inventory of US EPA air toxics is too numerous to list in this document.

The Australian NEPC developed the *National Environment Protection (Ambient Air Quality) Measure* (OLD, 2003) which lists a series of 'desired environmental outcomes' that 'allows for the adequate protection of human health and well-being'.

These three sets of ambient air quality standards have been adopted in this assessment for regions outside of industrial premises. Table 6-12 lists the assessment criteria for air quality standards based on these standards including comments regarding how they are to be assessed.

The occupational health and safety impacts of air quality have not been investigated in this assessment. Typically, the recommended occupational exposure limits are greater than the criteria used for environmental impact assessments.

**Table 6-12 Sensitive receptor air quality assessment criteria**

Pollutant	Guideline/ Standard	Averaging Period	Value *	Comments
Carbon Monoxide (CO)	US EPA	1-hour	35 ppm	One allowable exceedance per year
		Rolling 8-hour	9 ppm	
	NEPM	8-hour	9.0 ppm	
Lead (Pb)	US EPA	Rolling 3-month	0.15 µg/m <sup>3</sup>	Not to be exceeded
	NEPM	Annual	0.50 µg/m <sup>3</sup>	
Nitrogen Dioxide (NO <sub>2</sub> )	WHO	1-hour	200 µg/m <sup>3</sup>	Not to be exceeded
		Annual	40 µg/m <sup>3</sup>	
	US EPA	1-hour	100 ppb	98 <sup>th</sup> percentile over 3 years
		Annual	53 ppb	
	NEPM	1-hour	0.12 ppm	One allowable exceedance per year
		Annual	0.03 ppm	Not to be exceeded
Ozone (O <sub>3</sub> )	WHO	8-hour	100 µg/m <sup>3</sup>	Not to be exceeded
	US EPA		0.075 ppm	Annual 4 <sup>th</sup> highest daily max 8-hour, over 3 years
	NEPM	1-hour	0.10 ppm	One allowable exceedance per year
		Rolling 4-hour	0.08 ppm	





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**Table 6-12 Sensitive receptor air quality assessment criteria (cont'd)**

Pollutant	Guideline/ Standard	Averaging Period	Value *	Comments
PM <sub>2.5</sub>	WHO	24-hour	25 µg/m <sup>3</sup>	Not to be exceeded
		Annual	10 µg/m <sup>3</sup>	
	US EPA	24-hour	35 µg/m <sup>3</sup>	98 <sup>th</sup> percentile over 3 years
		Annual	15 µg/m <sup>3</sup>	Averaged over 3 years
	NEPM	24-hour	25 µg/m <sup>3</sup>	Goal is to gather data for review
		Annual	8 µg/m <sup>3</sup>	
PM <sub>10</sub>	WHO	24-hour	50 µg/m <sup>3</sup>	Not to be exceeded
		Annual	20 µg/m <sup>3</sup>	
	US EPA	24-hour	150 µg/m <sup>3</sup>	One allowable exceedance per year on average over 3 years
			50 µg/m <sup>3</sup>	Five allowable exceedances per year
	NEPM	24-hour	50 µg/m <sup>3</sup>	Five allowable exceedances per year
Sulfur dioxide (SO <sub>2</sub> )	WHO	10-minute	500 µg/m <sup>3</sup>	Not to be exceeded
		24-hour	20 µg/m <sup>3</sup>	
	US EPA	1-hour	75 ppb	99 <sup>th</sup> percentile, over 3 years
		3-hour	0.5 ppm	One allowable exceedance per year
	NEPM	1-hour	0.20 ppm	One allowable exceedance per year
		24-hour	0.08 ppm	
		Annual	0.02 ppm	Not to be exceeded

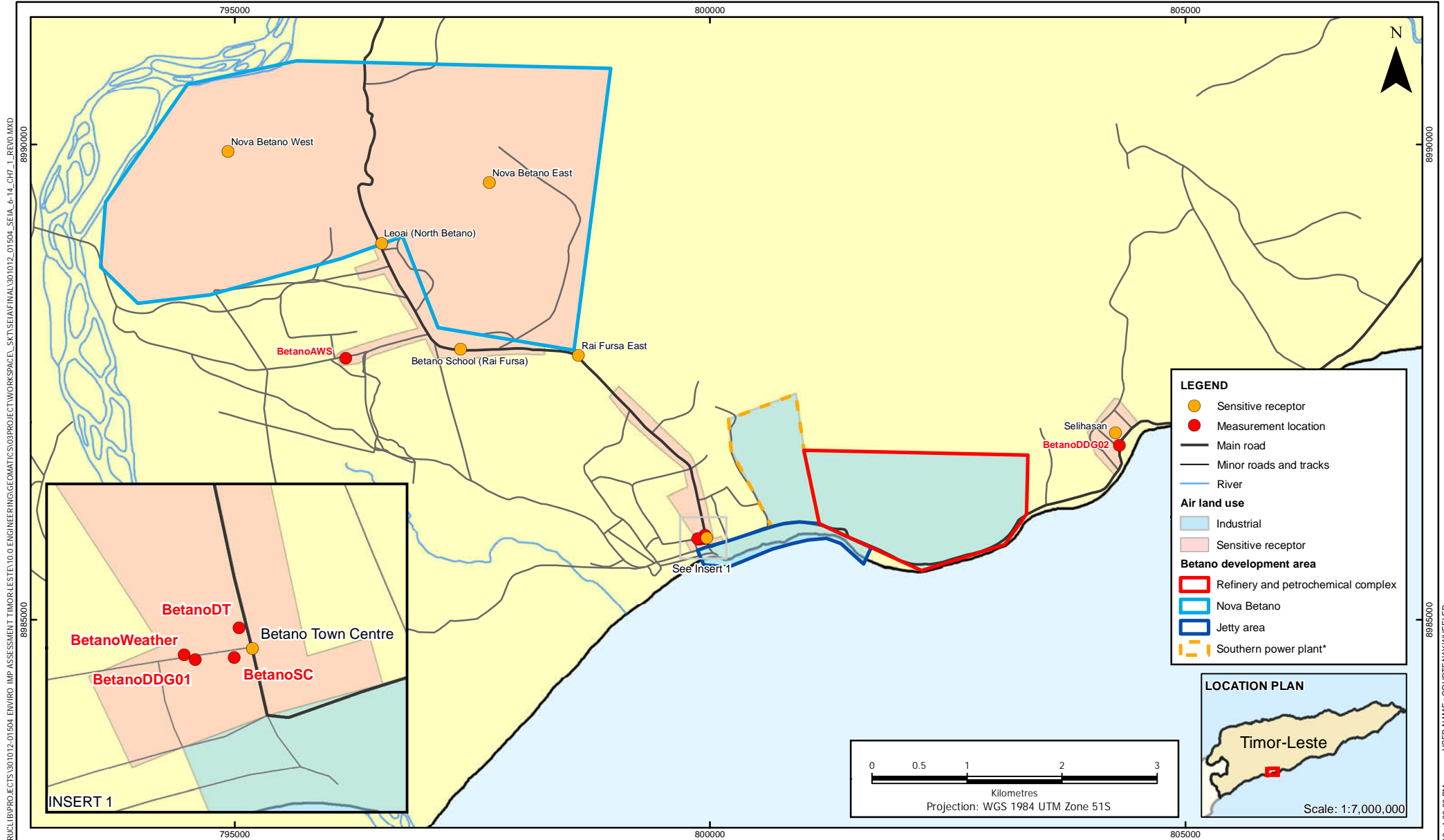
Note: \* – Values in µg/m<sup>3</sup> assume standard temperature and pressure.

### Sensitive Receptors

The location of sensitive receptors was identified in a desktop assessment of aerial photography and onsite visual inspection of the local area. Based on the desktop assessment, the region surrounding the Betano development area is primarily used for agriculture. Some residential premises were also identified. Both residential and agricultural premises are considered sensitive receptors. The onsite visual inspection focussed on locations that sensitive members of the public, for example; children and the elderly, tend to congregate (i.e., schools and hospitals/medical clinics). One school was identified in Rai Fursa, which was located on the road that runs south from the eastern section of the Nova Betano area.

The specific sensitive receptor locations where air quality can be assessed against the criteria are listed in Table 6-13.

The Betano study area with land use zoning and identified sensitive receptors is shown in Figure 6-14.



NOTES:  
 This map consists of:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. Roads: DivaGIS (2010)  
 3. Landuse zoning: RDTL (2011a)

\*Not part of this scope

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resources & energy			TIMOR GAS & PETROLIO			REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS			Copyright © WorleyParsons Services Pty Ltd	

TASI MANE PROJECT - BETANO AND BEACO  
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**Figure 6-14**  
 Betano air quality study area

LOCATION: \\PERWORLD\TIMES\TRUCLIP\PROJECTS\301012-01504-ENVIRO-IMP-ASSESSMENT\TIMOR-LESTE\10-ENGINEERING\GEO\MATIGS\03\PROJECT\WORKSPACE\_S\KTS\SE\FINAL\301012-01504\_SE\A\_5-14\_C\1\_1\_REV0.MXD

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**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT****Table 6-13 Air quality sensitive receptors**

Location	Relevant Project Area	Centroid Coordinates	
		Latitude	Longitude
Betano town centre	Existing settlement	9° 09' 51.0" S	125° 43' 45.6" E
Selihasan	Existing settlement	9° 09' 14.0" S	125° 46' 06.0" E
Nova Betano East	Nova Betano	9° 07' 50.0" S	125° 42' 30.0" E
Nova Betano West	Nova Betano	9° 07' 40.0" S	125° 41' 00.0" E
Betano School (Rai Fursa)	Existing settlement/school	9° 08' 47.0" S	125° 42' 20.5" E

**Baseline Measurement Methods**

The baseline air quality monitoring comprised of three separate measurements:

- Ambient air sample collection using a Summa canister for laboratory analysis.
- Monitoring of ambient airborne particulate matter less than ten micrometres in aerodynamic diameter (PM<sub>10</sub>) using a DustTrak™ aerosol monitor.
- Settled dust sample collection using dust deposition gauges for laboratory analysis.

The locations for each of the measurements and equipment are listed in Table 6-14.

**Table 6-14 Air quality measurement and equipment locations**

Label	Type	Location	Coordinates	
			Latitude	Longitude
BetanoSC	Summa canister	Betano town centre	9° 09' 51.4" S	125° 43' 44.8" E
BetanoDDG01	Dust deposition gauge	Betano town centre	9° 09' 51.5" S	125° 43' 43.1" E
BetanoDDG02		Selihasan	9° 09' 18.1" S	125° 46' 07.4" E
BetanoDT	DustTrak™	Betano town centre	9° 09' 50.1" S	125° 43' 45.0" E

**Chemical Compound Samples**

The baseline ambient air sample was collected in a National Association of Testing Authorities (NATA) – accredited laboratory supplied, six-litre capacity, Summa canister. The canister included a uniquely numbered flow regulator and inflated over a two-hour period. Once the sampling period was complete, the canister serial number and resulting pressure difference was recorded along with the date and time of the sample.

The location of the collected sample was determined in general accordance with Australian/New Zealand Standard AS/NZS 3580.1.1:2007 Methods for sampling and analysis of ambient air Part 1.1: Guide to siting air monitoring equipment (AS/NZS 3580.1.1:2007). A summary of these requirements are as follows:

- The sample location is deemed a 'peak site' where it is likely that the highest concentrations of pollutants, currently present in the study area, are expected to occur.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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- The Summa canister was placed greater than 10 m from the adjacent roadway as is required for sampling of gaseous compounds adjacent to roads with a volume of traffic less than 10,000 vehicles per day.
- The Summa canister inlet was exposed to a minimum clear sky angle of 120° during the sampling period.

The samples were packaged and sent to ALS Environmental, a NATA accredited laboratory, under full chain of custody protocols. Copies of the chain of custody, sample receipt notification, certificates of analysis and quality control reports are provided in Appendix E. Laboratory analysis of the sample was conducted for the following chemical compounds:

- Oxides of nitrogen (NO<sub>x</sub>).
- US EPA air toxics suite.

For the air toxics suite, analysis method TO-14A was used. This method uses a Nafion® drier to selectively remove water vapour from the sample. The sample gas is passed through Nafion® tubing removing water and other light polar compounds.

Concentrations of chemical compounds were reported at standard atmospheric conditions and are summarised in Table 6-15.

### *Airborne Particulate Matter Measurements*

The baseline ambient airborne PM<sub>10</sub> measurements were conducted outside of buildings or structures using a DustTrak™ 8520 Aerosol Monitor housed in a portable environmental enclosure. The DustTrak™ was calibrated within a two year period, prior to the measurements by a NATA accredited laboratory. Determination of the sampling location of the DustTrak™ was in general accordance with AS/NZS 3580.1.1:2007 and focussed on areas anticipated to have the highest concentrations of PM<sub>10</sub>. The monitoring was conducted over a 24-hour period with one-minute interval logging to capture the particulate matter trends throughout a typical day.

Zero concentration checks and air flow rate checks were conducted prior to each monitoring event. The DustTrak™ was calibrated to a flow rate of 1.7 L/min as is required for peak performance in the instruction manual.

The following information was recorded for each particulate matter measurement:

- Date.
- Location coordinates.
- Measurement start and end times.
- Measurement duration.
- Notable factors relating to the condition, operation or environment surrounding the DustTrak™.

### *Deposited Dust Samples*

The baseline settled dust samples were collected using dust deposition gauges. The sample collection was conducted in general accordance with AS/NZS 3580.10.1:2003 Methods for sampling





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and analysis of ambient air Method 10.1: Determination of particulate matter – Deposited matter – Gravimetric method (AS/NZS 3580.10.1:2003). These requirements are summarised below:

- The dust deposition gauge bottles were supplied by a NATA-accredited laboratory and pre-dosed with 10 mL of a copper sulfate solution to inhibit algal growth.
- When collecting the dust deposition gauge bottles, any particulate matter remaining within the funnel was washed into the bottle to ensure the entire deposited particulate matter was collected.
- Determination of the locations of the dust deposition gauges was in general accordance with AS/NZS 3580.1.1:2007.

Two dust deposition gauges were established in the Betano study area, one at the Betano village centre and the other near the Chefe Suco's house in Selihasan. The gauges were left onsite to collect deposited particulate matter for a period of 57 days from 18 December 2011 to 13 February 2012.

Samples were collected, recording the following information:

- Dates of deployment and collection.
- Location coordinates.
- Funnel height above ground level.
- Funnel top diameter.
- Notable factors relating to the condition and contents of the gauge.

The samples were packaged and sent to ALS Environmental under full chain of custody protocols Appendix F. The samples were analysed for the following suite of parameters:

- Total solids (g/m<sup>2</sup>/month).
- Soluble matter (g/m<sup>2</sup>/month).
- Total insoluble matter (g/m<sup>2</sup>/month).
- Combustible matter (g/m<sup>2</sup>/month).
- Ash content (g/m<sup>2</sup>/month).

### ***Air Quality Impact Modelling***

Air quality impacts resulting from the construction and operational phases of the Betano development were to be predicted using the use of computer modelling software. The input information required to conduct this modelling includes detailed engineering design data, specifying the locations and composition of emitted exhaust plumes, with emission rates of various pollutants of potential concern. Currently, engineering design information is not available for the Betano development and as a result, air quality impact modelling could not be carried out as part of this assessment.

Similarly, a cumulative impact assessment was to be conducted, given the potentially additive effects of the air quality issues associated with the Southern Power Plant that is proposed to be located adjacent to the Betano Refinery Development Site. However due to the lack of available engineering



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data, this assessment could not be undertaken, The potential for cumulative effects from these two development projects should be further assessed prior to project approval.

### ***Data Assumptions and Limitations***

Several limitations to this investigation are acknowledged:

- Due to the availability of the equipment, the air quality measurements were not conducted concurrently and the air quality profile may potentially have changed between the measurements.
- A single Summa canister sample was collected for laboratory analysis for the Betano study area. Therefore potential variations in concentrations of chemical compounds across the study area may not have been identified. Due to the time requirements to conduct a DustTrak™ monitoring period, a single PM<sub>10</sub> baseline measurement was conducted across the study area. Therefore potential variations in concentrations of airborne particulate matter across the study area, and temporal variation, may not have been identified.
- A 24 hour period of particulate matter monitoring was not obtained due to power supply problems with the DustTrak™ equipment.
- Wind speed and direction data was not available for the DustTrak™ monitoring period. While meteorological data was collected during this time period (as reported in Section 6.1), problems with the weather station meant that wind speed/direction data could not be collected, which is important to PM<sub>10</sub> monitoring.
- Due to logistical and HSE limitations of site access, the length of time the dust deposition gauges were in the field was greater than the recommended 30 ±2 days and was not representative of the intended month-long period. To compensate for this, the daily particulate matter deposition results were averaged over the entire monitoring period, and likely include deposited particulate matter outside of the month-long period.
- Local people who were aware of the air quality monitoring may have altered their typical behaviour, potentially affecting the results.

Assumptions made during the assessment are as follows:

- Baseline measurements conducted during the fieldwork are representative of the 'typical' air quality in the region.
- There was minimal influence on the measurements by field personnel.

## **6.4.2 Existing Environment**

### ***Ambient Air quality***

Air pollutants are by nature primarily emitted from anthropogenic sources (i.e., related to human activity). These sources were identified during field work and are summarised below.



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In the Betano region, the primary observed sources of air pollutants are smoke produced from burning vegetation for agricultural clearing and refuse disposal, and vehicular traffic. To a lesser extent, the operation of electricity generators also contributes to air pollutants.

Non-anthropogenic sources are unlikely to be significant contributors to air pollutants in the Betano study area. The primary sources of non-anthropogenic air pollutants are volatilisation of volatile organic compounds (VOCs) from the surface of vegetation, methane emissions from livestock and to a much lesser extent, the generation of NO<sub>x</sub> via the ionisation of the atmosphere during lightning events.

Sources of particulate matter can be widespread, ranging from mechanical grinding of materials, wind-generated dust from stockpiles of material, to salt crystals from sea spray. In the Betano region, primary sources of particulate matter are likely to be from smoke from the burning of vegetation and refuse, dust generated from agricultural activities (e.g., ploughing fields, livestock movement, grading of roads and paths) and vehicle exhaust emissions. Vehicle wheel-generated dust was observed in the study area during the site inspection; however, this was likely due to the dry nature and poor quality of the roads in the region. The contribution of vehicle wheel-generated dust to ambient airborne particulate matter concentrations is likely to be highly variable and subject to seasonal variation.

### Baseline Air Quality Measurements

#### Chemical Compound Samples

The laboratory analytical results for the collected sample are presented in Table 6-15. With the exception of NO<sub>x</sub> and SO<sub>x</sub>, only concentrations of compounds greater than the limit of reporting are listed below. For the full list of results refer to Appendix E.

**Table 6-15 Laboratory analysis results of chemical compounds in Betano air sample**

Compound	CAS Number	Limit of Reporting	Assessment Criteria	Betano CSO
				05/01/2012 11:59
US EPA air toxics TO-14 (Chronic inhalation non-cancer)				
Freon 12	75-71-8	0.5 ppbv	---	0.8 ppbv
		2 µg/m <sup>3</sup>		4 µg/m <sup>3</sup>
Additional parameters				
Nitrogen Dioxide (NO <sub>2</sub> )	10102-44-0	0.0001%	Refer to Table 6-12	<0.0001%
Nitric Oxide (NO)	---	0.0001%	---	<0.0001%

All analysed compounds under the US EPA air toxics represent trace level concentrations in the atmosphere and are much less than the assessment criteria.

Freon 12 is a compound used previously as a refrigerant and is now under the banned list of chlorofluorocarbon compounds but in some cases is still used as a propellant for aerosols.

Nitrogen dioxide and nitric oxide are formed primarily during the combustion of fuels at high temperatures. In an air quality context, the primary sources of oxides of nitrogen are in the exhaust emissions from motor vehicles and power generation units. The concentrations of oxides of nitrogen were below the limit of reporting and can be considered to be absent from the air sample.



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Sulfur dioxide is also produced by combustion of fuels that contain sulphides, for example, diesel or 'sour' natural gas that contains hydrogen sulphide. The concentration of sulphur dioxide was not able to be determined by the laboratory due to a laboratory procedural failure.

*Airborne Particulate Matter Measurements*

The PM<sub>10</sub> monitoring results are presented in Figure 6-15. The average PM<sub>10</sub> concentration over the monitoring period is approximately 29 µg/m<sup>3</sup> which is less than the 24-hour average WHO and NEPM guidelines of 50 µg/m<sup>3</sup> and much less than the 24-hour average US EPA standard of 150 µg/m<sup>3</sup>.

The results show an increase in concentrations between approximately 7:30 p.m. and approximately 8:30 p.m.; however, in the short study period it was not possible to confirm the source of the particulate matter.

*Deposited Dust Samples*

The laboratory analysis results are summarised in Table 6-16. For the full laboratory report, refer to Appendix F.

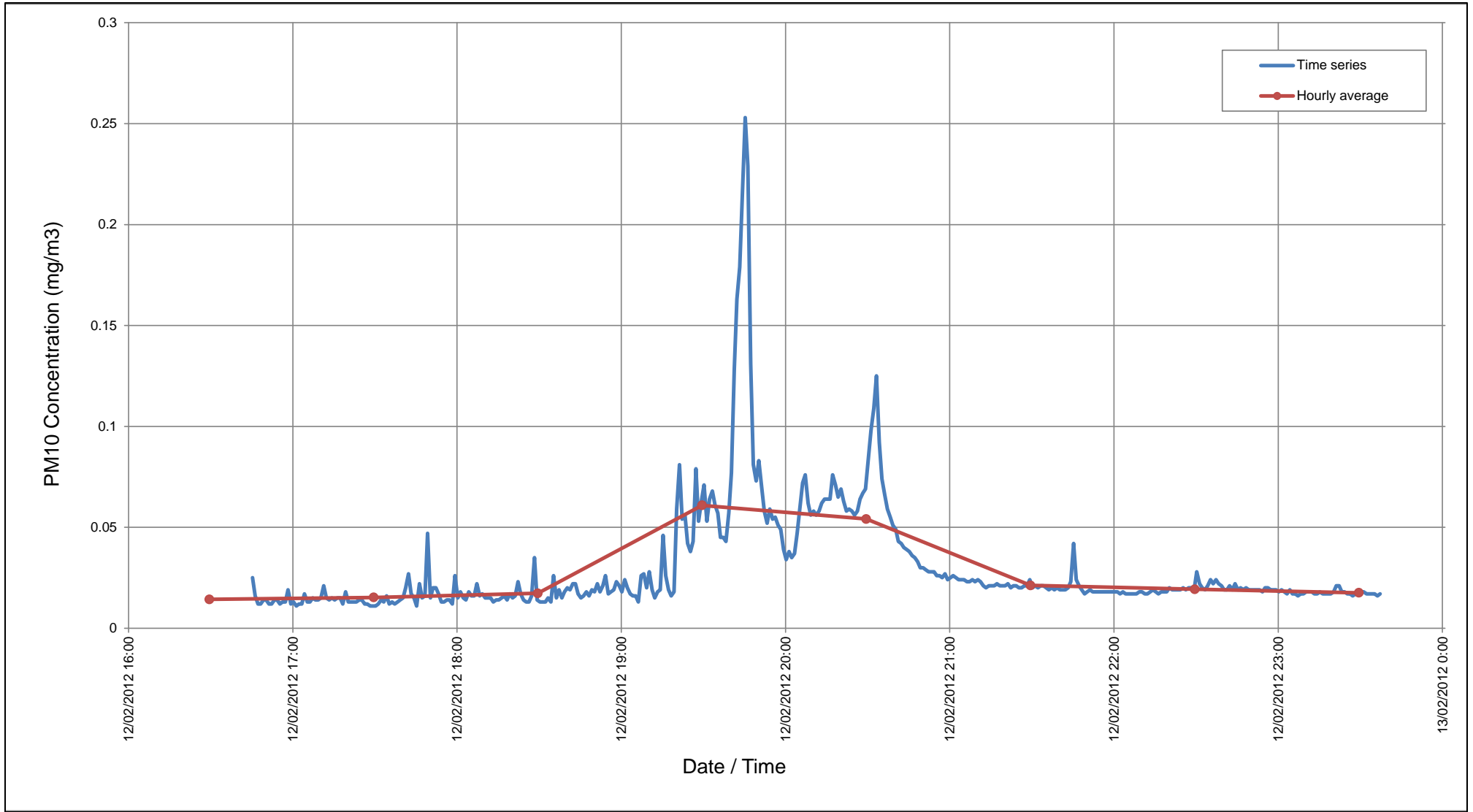
**Table 6-16 Betano Refinery Deposited Dust Samples – Laboratory Analysis Results**

Analyte	Limit of Reporting	Unit	Betano CSO <sup>1</sup>	Betano CSH <sup>2</sup>
			13/02/2012	13/02/2012
<b>Ash Content</b>				
Total	1	mg	9	13
Deposition Rate	0.1	g/m <sup>2</sup> .month	0.3	0.4
<b>Combustible Matter</b>				
Total	1	mg	16	14
Deposition Rate	0.1	g/m <sup>2</sup> .month	0.5	0.4
<b>Coarse Particulates</b>				
Total	0.1	g	<0.1	<0.1
<b>Total Soluble Matter</b>				
Total	1	mg	53	15
Deposition Rate	0.1	g/m <sup>2</sup> .month	1.6	0.4
<b>Total Insoluble Matter</b>				
Total	1	mg	25	27
Deposition Rate	0.1	g/m <sup>2</sup> .month	0.8	0.8
<b>Total Solids</b>				
Total	1	mg	79	42
Deposition Rate	0.1	g/m <sup>2</sup> .month	2.3	1.2

Note: 1 – CSO = Chefe Suco's Office  
2 – CSH = Chefe Suco's House



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				 REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				 to zero harm Copyright © WorleyParsons Services Pty Ltd		Figure 6-15 Betano particulate monitoring time series results

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As the purpose of the dust deposition samples is primarily to establish baseline deposition rates of particulate matter across the Betano development, the deposition rates are not compared to any specific assessment criteria. Instead, these values provide a measure of current conditions to compare against during future phases of the development. Continued monitoring of the parameters specified above will allow appropriate comparisons to be made and assist in establishing dust deposition rate trends.

The various categories of particulate matter provide further information relating to the probable source(s) of the deposited particulate matter. For example, the increased proportion of soluble matter in the Betano CSO sample and the proximity of the sampling locations to the beachfront suggest that the likely source of the soluble matter is salt spray which is a known common source of airborne fine particulate matter.

### 6.4.3 Environmental Impacts

In the absence of a quantitative analysis of air quality impacts, a qualitative impact assessment for the various development phases has been provided below.

#### ***Construction Impacts***

Construction of the Betano development will generate emissions to air primarily in the form of fugitive dust from the following sources:

- Excavation and earth moving activities.
- Infrastructure construction e.g., roadworks, electricity supply.
- Delivery of equipment.
- Vehicle and equipment movement.
- Vegetation and topsoil removal.
- Wind erosion from open/cleared areas or stockpile areas.

Dust emissions not only affect the environment, but can also affect human health due to the inhalation of fine particulate matter. PM<sub>10</sub> and PM<sub>2.5</sub> particulate matter is small enough to pass the human upper respiratory tract (nose and throat) and pass into the deepest recesses of the lung. This has the potential to exacerbate pre-existing respiratory and/or cardiovascular problems that are commonly present in 'at-risk' members of the community (e.g., children and the elderly). Studies conducted by the WHO have shown good correlations of increasing mortality rates with increasing PM<sub>10</sub> and ozone concentrations in urban areas (WHO, 2006).

The proximity of the construction areas to existing residential premises presents a potential human-health risk at the following locations:

- The residential Betano town centre.
- The residential region around Selihasan.

These locations will potentially be affected by construction at the refinery and the petrochemical complex differently, depending on the prevailing wind direction at the time. It is therefore, important to ensure that particulate matter generated by construction activities are kept to as low as reasonably practicable.



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### Operational Impacts

Operation of the Betano development is likely to affect air quality through the following activities:

- Gas processing, condensing and refining operations.
- Fuel combustion in boilers or for electricity generation.
- Flaring events to dispose of waste or excess gas.
- Vehicle and equipment use.

Gas or fuel combustion affects both human health and the environment due to emissions of chemical pollutants. Table 6-17 lists several known pollutants associated with the combustion of gas or fuel, and some of the known human health and environmental impacts associated with these pollutants.

**Table 6-17 Human health and environmental impacts of air pollutants**

Pollutant	Human Health Impacts	Environmental Impacts
Carbon monoxide (CO)	Toxic gas that is poisonous and can reduce the oxygen carrying capability of blood.	Can contribute to the production of photochemical smog by the oxidation of nitric oxide (NO).
Lead (Pb)	Poisonous metal that can be inhaled when exposed to humans in particulate form.	Can cause a deterioration of the condition of ecosystems and slow the rate of decomposition of organic matter.
Oxides of nitrogen (NO <sub>x</sub> )	NO <sub>2</sub> – Increased susceptibility to respiratory infections (e.g., asthma). NO <sub>3</sub> – Can change blood chemistry making it unable to carry oxygen.	NO <sub>x</sub> – Can retard growth rates of crops and increase O <sub>3</sub> production as photochemical smog. N <sub>2</sub> O – Greenhouse gas and can contribute to global warming.
Ozone (O <sub>3</sub> )	Irritation of the eyes and exacerbation of respiratory problems.	Strong oxidising agent and can retard growth of plant life.
Sulfur dioxide (SO <sub>2</sub> )	Exacerbation of existing heart and lung disease especially when attached to small particulate matter.	Primary contributor to acid production in the atmosphere (acid rain) that can damage crops and ecosystems.
BTEX	Acute exposure can lead to skin irritation and central nervous system depression. Chronic exposure to benzene is a likely human carcinogen.	Known to have toxic effects on aquatic plant and animal life in acute exposures.

### 6.4.4 Avoidance, Management and Mitigation Measures

#### Construction Impacts

The following control measures should be implemented during construction to ensure airborne particulate matter does not adversely affect sensitive receptors:

- Restrict operational hours in which construction is permitted.
- Establish appropriate separation distances between dust sources and sensitive receptors.



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- Apply water or wetting agents to roads and/or stockpiles of materials.
- Seal road surfaces.
- Implement low road speeds on all unsealed roads.
- Define occupational dust policies for construction workers (e.g., dust masks when working with materials likely to generate excessive dust).
- Establish a monitoring program to assess actual dust emissions and institute a remediation program to rectify problem areas.

### ***Operational Impacts***

The following control measures should be implemented during operation to ensure gaseous air emissions do not adversely affect sensitive receptors:

- Design the exhaust stacks and flares (e.g., heights, diameters, temperatures, gas conditions and exit velocities) to minimise the likelihood of exhaust plumes impacting sensitive receptors.
- Select machinery with high fuel combustion efficiency and low emission technology, to minimise the emissions of pollutants.
- Use lean-burn gas-fired engines (lower NO<sub>x</sub>) wherever practicable
- During the design phase, maximise the distance between the major emission sources (e.g., flares and electricity generators) and sensitive receptors to minimise the impacts.
- Regularly maintain vehicles and equipment to maximise their fuel efficiency.
- Fit vehicles and equipment with appropriate emission control devices (e.g., vehicle exhaust system, filters).
- Apply water or wetting agents to frequently trafficked roads and/or stockpiles of materials.
- Establish a compliance monitoring regime and define non-compliance incident investigation methods and rectification strategies.
- Seal roads with high traffic loads.

### **6.4.5 Residual Impacts**

Construction activities are typically temporary in nature and its impacts localised. Provided all dust control measures are implemented, residual impacts from the construction of the Betano development are likely to be minimal.

In contrast, gaseous air emissions from operational activities of the Betano development have the potential to cause in adverse human health or environmental impacts, considering the proximity of the development to existing and proposed residential areas. Consequently, residual impacts could be unacceptable and, without careful design and control measures and, as a result, this aspect requires further assessment and follow-up air quality monitoring. (see also Section 6.5.7). In the event that the severity of this residual impact cannot be reduced, relocation of the affected populace may need to be considered.

Proactive engagement with stakeholders is also recommended to keep them informed about the progress of the Betano development and reduce the likelihood of complaints.





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### 6.4.6 Monitoring and Reporting

The following recommendations have been made to assist in the development of an appropriate air quality monitoring and reporting program:

- Until air quality-related legislation is defined by the GoTL, it is recommended that the project adopts monitoring and reporting procedures and standards from other governmental jurisdictions where it is clearly defined, for example the AS/NZS 3580 series.
- Detailed monitoring of meteorological parameters as specified in Section 6.1.6.
- Continuous monitoring of ambient pollutants and particulate matter and deposited dust using equipment compliant with the AS/NZS 3580 series to assess compliance with the developed dust management plan and assessment criteria defined in Table 6-12. It is recommended that tapered element oscillating microbalances (TEOMs) or equivalent, are established at the Nova Betano and Selihasan areas. Monitoring data should be collated monthly and reported to SERN. AS 3580.9.8:2008 *Methods for sampling and analysis of ambient air Method 9.8: Determination of suspended particulate matter – PM<sub>10</sub> continuous direct mass method using a tapered element oscillating microbalance analyser* states the guidance methods to adopt when siting the apparatus, sampling temperatures, flow rates for the main and auxiliary inlets, averaging periods and the overarching procedure to follow when establishing a TEOM at a new monitoring site.
- Reporting on the monitored data should be conducted periodically, detailing the monitoring method, results and comparison to WHO, US EPA and NEPM guideline levels or equivalent.

### 6.4.7 Further Work

Further work related to air quality impacts required for the Betano development is as follows:

- Continued baseline monitoring across the study area to establish seasonal variations of chemical compound and particulate matter concentrations, and dust deposition rates.
- A detailed air quality impact assessment for both construction and operational activities including computer simulation of predicted pollutant and dust impacts across the project areas in accordance with a US EPA-approved method or equivalent.
- A human health risk assessment is recommended during FEED.

#### ***Detailed Air Quality Impact Assessment***

A detailed air quality assessment includes computer simulation modelling of predicted ground-level concentrations of pollutants of potential concern across the study area in accordance with a US EPA-approved method or equivalent.

It is recommended that air quality impact modelling is undertaken when proposed operational equipment and infrastructure specifications and locations have been confirmed. The aim of the air quality impact modelling will be to determine predicted ground-level concentrations of relevant pollutants of potential concern emitted by construction and operational activities. This modelling will enable the level of impact to be quantified across the study area and inform the project design in an iterative process to ensure compliance is built-in from the start. An air quality impact assessment will



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also assist in the development of a dust management plan, and ultimately, help to ensure that the potentially adverse impacts on human and environmental health are minimised.

The meteorological conditions of the region have a significant influence on the dispersion behaviour of pollutant plumes and need to be taken into account when predicting ground-level concentrations. Pollutant dispersion models use meteorological information as input data sets to simulate the impacts. For example, the lower humidity of the air and the lower frequency of rain events in the Betano region compared to other southern coastal regions may potentially increase the ambient concentrations of particulate matter due to increased wind erosion and vehicle wheel-generated dust.

In order to conduct computer simulation of the air quality impacts, emissions of both particulate matter and pollutants of potential concern need to be estimated. Particulate matter emissions can be estimated via calculations based on: the type of activity; activity rate; and any applied mitigation / control measure used. The Australian National Pollutant Inventory (NPI) Emission Estimation Technique Manuals (EETM) for Fugitive Emissions version 2.0 (DSEWPC, 2012a) and for Mining version 3.1 (DSEWPC, 2012b), based on the US EPA AP-42 5<sup>th</sup> Edition: Compilation of Air Pollutant Emission Factors (US EPA, 2009) calculation methods are effective methods to estimate the particulate matter emissions from construction and operational activities and are recommended to be adopted during the detailed air quality impact assessment.

The NPI EETM for Combustion Engines version 3.0 (DSEWPC, 2008) and the EETM for Combustion in boilers version 3.6 (DSEWPC, 2011) details methods in which to estimate the emissions of pollutants of potential concern for the assessment. These methods are recommended to be adopted in the assessment.

### **Greenhouse Gas Assessment**

Another aspect in relation to air quality is the assessment of greenhouse gas emissions. Under Timor-Leste environmental law, it is expected that a greenhouse gas assessment would be conducted for each new industrial development, including the Betano development. A greenhouse gas assessment is also necessary to meet the International Finance Corporation (IFC) requirements under the World Bank group. In addition, greenhouse gas emissions have been flagged as a key issue of concern by various non-governmental organisations in Timor-Leste for the project. WorleyParsons was not commissioned to undertake a greenhouse gas assessment as part of the Strategic EIA. In addition to this there is insufficient project data available to carry out such an assessment.

The World Bank has published a handbook to aid in the estimation of greenhouse gas emissions at a project level: *Greenhouse Gas Assessment Handbook – A Practical Guidance Document for the Assessment of Project-level Greenhouse Gas Emissions* (World Bank, 1998). This document details the required input information, formulae and calculation method to be used to determine the total greenhouse gas emissions from a facility and the methods are recommended to be adopted for any future greenhouse gas assessment.



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### 6.5 Noise

Construction and operational noise associated with the proposed Betano development have been identified as an environmental factor with the potential to adversely impact the surrounding environment and populace in the Betano study area.

Currently there are no specific environmental assessment standards or legislation addressing noise or acoustic emissions in Timor-Leste.

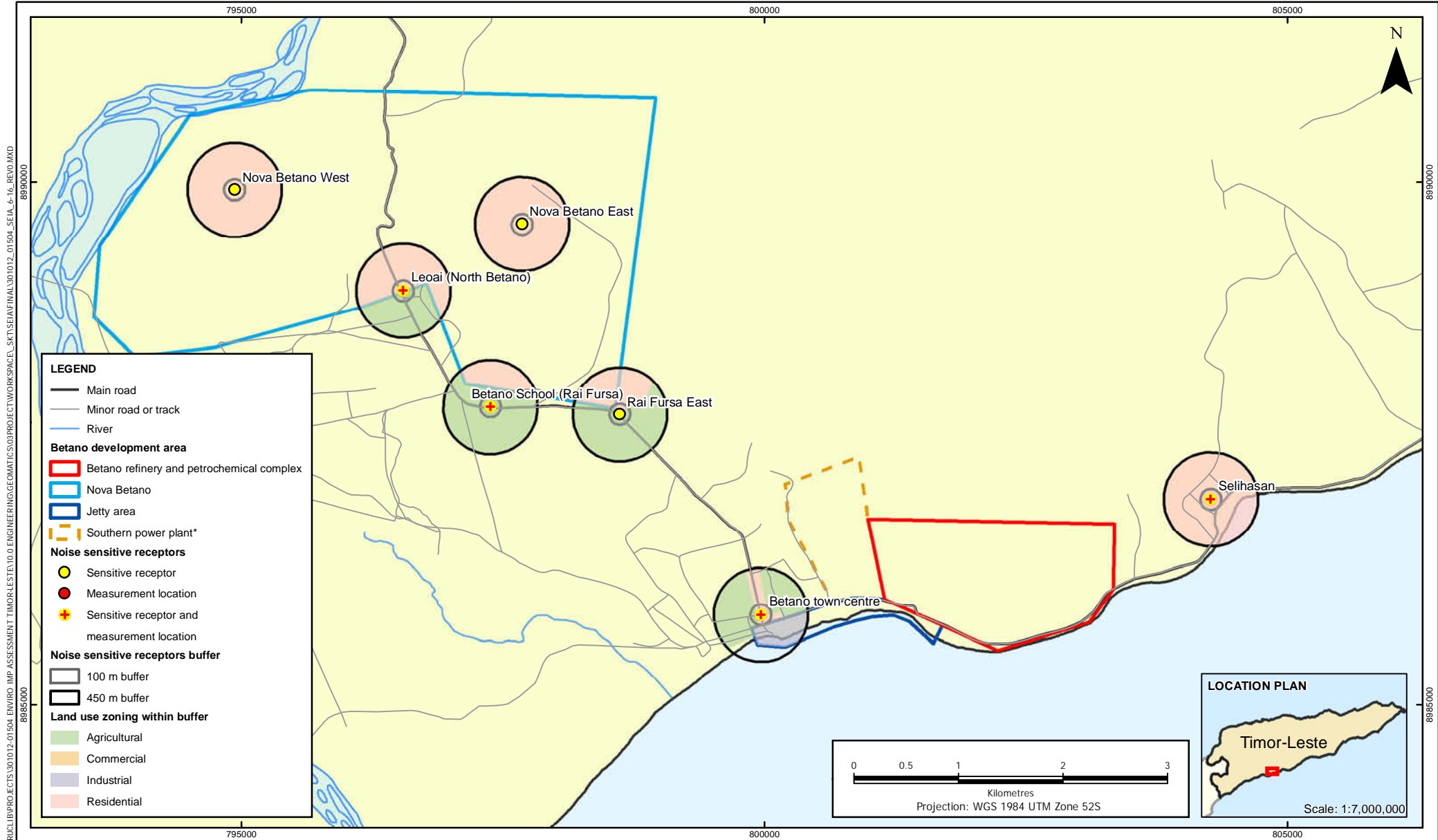
In the absence of specific noise-related legislation in Timor-Leste, the Western Australian Environmental Protection (Noise) Regulations 1997 (WA) (DEC, 1997), have been adopted to define the study method for assessing potential noise impacts of the Betano development. Regulation 7 of the regulations states that 'noise emitted from any premises when received at other premises must not cause, or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind'.

#### 6.5.1 Study Method

This study was designed to obtain a baseline of the noise profile for the Betano development area.

The study method proposed for this noise assessment is summarised as follows:

- Undertake a literature review to identify:
  - Existing noise monitoring and assessments undertaken with the Betano study area; and
  - GoTL or other relevant noise standards;
- Identify noise sensitive receptor locations in proximity of the Betano development area;
- Conduct baseline monitoring of ambient noise levels at the identified noise sensitive receptor locations in accordance with the Environmental Protection (Noise) Regulations 1997 (WA);
- Establish assigned noise levels for various noise sensitive premises in the study region ( $L_{Amax}$ ,  $L_{A1}$  and  $L_{A10}$ );
- Develop sound power level predictions for construction and operational sound power levels at the development sites accounting for meteorological conditions;
- Undertake a comparative assessment of baseline and predicted construction and operational noise levels from the Betano development; and
- Provide recommendations for any noise mitigation measures or buffer zones in relation to the Betano development area.



NOTES:  
 This map consists of:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. Roads: DivaGIS (2010)  
 3. Noise receptors: WorleyParsons (2012)  
 4. Landuse zoning: RDTL (2011a)

\*Not part of this scope

0	29/05/2012	FOR FINAL ISSUE	MW	GHi	CW	-	GH	-	A4 SHEET	SCALE 1:50,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
resources & energy		TIMOR GAS & PETROLEO		REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				Copyright © WorleyParsons Services Pty Ltd		

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**Figure 6-16**  
 Land use zoning across the Betano study area  
 near noise sensitive receptor locations

LOCATION: \\PERWORLETT\TIMES\TRUCLIB\PROJECTS\301012-01504\_ENVIRO\_IMP\_ASSESSMENT\TIMOR-LESTE\00 ENGINEERING\GEMATIC\03PROJECT\WORKSPACE\_S\KTS\SEINF\NAL\301012-01504\_SEIA\_05\_REV00.MXD  
 8895000  
 8895000

PLOT DATE & TIME : 29/MAY/2012, 12:34:19 PM  
 USER NAME : COURTENAY.WHEELER  
 8895000  
 8895000





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### **Study Scope**

The study area for this assessment includes the Betano development area, which comprises the locations listed below, as well as the surrounding existing and proposed residential areas as shown in Figure 6-16:

- Refinery and petrochemical complex area.
- Jetty areas.
- Nova Betano.
- The proposed area for the Southern Power Plant (not part of this project).
- Existing Betano settlements.

### **Literature Review**

As mentioned above, the Western Australian Environmental Protection (Noise) Regulations 1997 (WA) have been adopted in order to define the study method. The Western Australian regulations, under the *Environmental Protection Act 1986*, define a standard process to assign specific allowable noise levels for each category of land use zoning. This is considered an appropriate method to set the noise levels that the resulting noise impacts are to be assessed against across the study area.

The following noise guidance documents have also been referenced within this study:

- *Guidance for the Assessment of Environmental Factors No. 8 – Environmental Noise (Draft)* (WA EPA, 2007a).
- Australian Standard 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites* (AS 2436-2010).

### **Noise Sensitive Receptors Locations**

The identification of the sensitive receptor locations was conducted using a combination of desktop-level assessment from aerial photography and an on-site visual inspection of the existing local infrastructure.

The on-site visual inspection focussed on identifying the locations of noise sensitive receptors, as defined by the Environmental Protection (Noise) Regulations 1997 (WA). In addition, the locations to take baseline noise measurements included residential areas that are likely to be affected by the construction and operation of the Betano development.

The Environmental Protection (Noise) Regulations 1997 (WA) identify three premises categories as having different relevant assigned noise levels. These are: industrial and utility premises, commercial premises, and noise sensitive premises which are summarised in Table 6-18.

Table 6-19 shows the location of identified noise sensitive premises within the Betano study area for the purposes of this assessment. These identified receptor locations are shown in Figure 6-16.



**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

**Table 6-18 Noise related premises categories**

<b>Industrial and Utility Premises</b>	<b>Commercial Premises</b>	<b>Noise Sensitive Premises</b>
<ul style="list-style-type: none"> <li>• Premises used for providing water, electricity, communications, etc.</li> <li>• Premises used by aircraft or ships, as a freight yard or for passenger transport</li> <li>• Industrial premises</li> <li>• Mine sites and quarries</li> <li>• Waste disposal sites</li> <li>• Offices, grounds and caretakers' residences which are part of the above</li> </ul>	<ul style="list-style-type: none"> <li>• Offices and retail shops</li> <li>• Premises in or from which meals or food are sold to the public</li> <li>• Service stations</li> <li>• Indoor amusement centres e.g., theatres</li> <li>• Outdoor amusement centres</li> <li>• Hotels which don't provide accommodation</li> <li>• Health centres</li> <li>• Hospitals with 150 or more beds</li> <li>• Centres for community meetings</li> <li>• Testing laboratories</li> <li>• Veterinary clinics, kennels and the like</li> <li>• Offices, grounds and caretakers' residences which are part of the above</li> </ul>	<ul style="list-style-type: none"> <li>• Premises occupied solely or mainly for residential or accommodation purposes</li> <li>• Rural premises</li> <li>• Caravan parks and camping grounds</li> <li>• Hospitals with less than 150 beds</li> <li>• Rehabilitation centres, care institutions and similar</li> <li>• Educational institutions</li> <li>• Premises used for public worship</li> <li>• Hotels which provide accommodation to the public</li> <li>• Premises used for aged care or child care</li> <li>• Prisons and detention centres</li> <li>• Any other premises not referred to in industrial and utility or commercial premises</li> </ul>

**Table 6-19 Identified noise sensitive receptor locations at Betano**

<b>Location</b>	<b>Relevant Study Area</b>	<b>Centroid Coordinates</b>		<b>Measurement Taken at/Near Receptor</b>
		<b>Latitude</b>	<b>Longitude</b>	
Betano Town Centre	Resident settlement	9° 09' 51.0" S	125° 43' 45.6" E	Yes
Selihasan	Resident settlement	9° 09' 14.0" S	125° 46' 06.0" E	Yes
Nova Betano East	Primary Worker settlement	9° 07' 50.0" S	125° 42' 30.0" E	No*
Nova Betano West	Primary Worker settlement	9° 07' 40.0" S	125° 41' 00.0" E	No*
Betano School (Rai Fursa)	Resident settlement/Nova Betano	9° 08' 47.0" S	125° 42' 20.5" E	Yes
Rai Fursa East	Resident settlement/Nova Betano	9° 08' 49.0" S	125° 43' 01.0" E	No
Leoai (North Betano)	Nova Betano	9° 08' 11.0" S	125° 41' 53.0" E	Yes

\*Location was inaccessible preventing noise measurements to be undertaken.



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

#### Baseline Measurement Method

Seven baseline noise measurements were conducted at the locations listed in Table 6-20 over a period of three days: 10, 11 and 17 December 2011. The measurement locations are shown in Figure 6-16.

**Table 6-20 Betano noise measurement locations**

Location (Shown in Figure 6-16)	Centroid Coordinates	
	Latitude	Longitude
Betano Town Centre (Chefe suco's office)	9° 09' 51.0" S	125° 43' 44.6" E
Betano Town Centre (monument)	9° 09' 54.6" S	125° 43' 46.1" E
Betano Town Centre (western boundary)	9° 09' 57.3" S	125° 43' 36.9" E
Refinery western boundary	9° 09' 47.5" S	125° 44' 27.8" E
Leoai (Nova Betano southern boundary)	9° 08' 11.0" S	125° 41' 52.7" E
Rai Fursa School (Nova Betano)	9° 08' 47.0" S	125° 42' 20.5" E
Selihasan (Chefe suco's House)	9° 09' 17.8" S	125° 46' 07.3" E

Measurements were conducted in general accordance with the Environmental Protection (Noise) Regulations 1997 (WA). All measurements were conducted outside of buildings using a Brüel & Kjær 2238 Mediator Sound Level Meter. The sound level meter was calibrated by a National Association of Testing Authorities (NATA) accredited laboratory within the last two years and is considered appropriately calibrated to industry standards.

Where possible, measurements were conducted at the boundary of the premises, nearest to the primary proposed noise source. However, in the case where noise sources are likely to be from multiple locations, a measurement was conducted at a central representative location as shown in Table 6-20.

Measurements were conducted over 15 minute periods with the microphone positioned at a minimum of 1.2 m above the ground and greater than 3 m away from any sound reflecting surface.

Measurements were attended with field personnel noting the following information:

- Date of measurement.
- Location coordinates.
- Measurements start and end times.
- Measurement duration.
- Calibration field checks before and after measurement period.
- Noise reading values including, equivalent continuous A-weighted sound pressure level ( $L_{Aeq}$ ); and maximum linear peak sound pressure level ( $L_{linear,peak}$ ).
- Any identifiable sound sources during the measurement period including particular characteristics of the identified noise (e.g., tonality, modulation or impulsiveness). In the specific case of vehicle traffic noise, the times and frequency of the noise events were also noted.

Noise measurement data was unable to be collected at or near the proposed location for Nova Betano as this area was inaccessible to WorleyParsons field personnel during the field work.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

### Determination of Assigned Noise Levels

Three noise parameters are assigned to noise sensitive premises when determining the allowable noise levels in the Environmental Protection (Noise) Regulations 1997 (WA), these are:  $L_{A10}$ ;  $L_{A1}$ ; and  $L_{Amax}$ . As these parameters are calculated for each sensitive receptor location, the values are likely to differ between receptors. The definitions of these parameters are as follows:

- $L_{A10}$ : assigned level of noise not to be exceeded for more than 10% of the time (e.g., for more than 10 minutes in 100 minutes).
- $L_{A1}$ : assigned level of noise not to be exceeded for more than 1% of the time (e.g., for more than 1 minute in 100 minutes).
- $L_{Amax}$ : assigned noise level not to be exceeded at any time.

The  $L_{A10}$  and  $L_{A1}$  levels allow for brief louder noises experienced at the receptor locations, provided they remain below the  $L_{Amax}$  assigned level. As it is impractical to calculate assigned noise levels for each individual structure across the study area, the calculated values apply to the generalised zoned area of premises type. The Environmental Protection (Noise) Regulations 1997 (WA) are not applicable to traffic noise on roads and do not compensate for it.

To calculate compensation noise levels, an influencing factor must be determined and applied to the parameters in Table 6-21 for each noise sensitive receptor above.

**Table 6-21 Assigned noise levels**

Type of Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		$L_{A10}$	$L_{A1}$	$L_{Amax}$
Noise sensitive premises at locations within 15 m of a building directly associated with a noise sensitive use	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours All days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises at locations further than 15 m from a building directly associated with a noise sensitive use	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises	All hours	65	80	90



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To determine the influencing factor for each noise sensitive receptor location, the proportion of industrial and commercial areas within radii of 100 m and 450 m of each receptor location is calculated. The Transport Factor (*TF*) is then determined using the following rule:

- Major road (> 15,000 vehicles/day) within 100 m,  $TF = 6$
- Major road within 450 m,  $TF = 2$
- For each secondary road (6,000 to 15,000 vehicles/day) within 100 m,  $TF = 2$
- $TF$  cannot be greater than 6.

The influencing factor (*IF*) is then calculated by:

$$IF = I + C + TF$$

Where:  $I =$  (% industrial area within 100 m + % industrial area within 450 m)/10

$C =$  (% commercial area within 100 m + % commercial area within 450 m)/20

According to Regulation 9 of the Environmental Protection (Noise) Regulations 1997 (WA), if the generated noise cannot be free of annoying characteristics (i.e., tonality, modulation and/or impulsiveness), the noise source emissions are to be adjusted to compensate.

Adjustments to noise emissions are to be cumulative to a maximum of +15 dB as listed below:

- +5 dB, where tonality is present (e.g., whining or droning).
- +5 dB, where modulation is present (e.g., like a siren).
- +10 dB, where impulsiveness is present (e.g., banging or thumping).

### ***Sound Power Predictions and Comparative Assessment of Noise Levels***

Given the lack of detailed engineering specifications for the proposed noise sources, computer simulation of the predicted noise levels cannot be conducted at this stage of the project. As such, accurate prediction of noise impacts across the study area could not be determined or assessed against assigned noise levels.

### ***Data Assumptions and Limitations***

Several limitations to this noise study are acknowledged and listed below:

- Due to logistical and HSE limitations of the fieldwork, baseline noise measurements were only conducted between 08:00 and 18:00 hours;
- Due to the time requirements to conduct a measurement, a limited number of baseline measurements could be conducted across the study area;
- All conducted measurements were attended for security reasons;
- Unanticipated sources of noise from local onlookers were unavoidable in certain cases due to the presence of the field personnel (i.e., curious passers-by, sounding of vehicle horns, etc.);
- Local people who were aware of the measurements being conducted may have altered their typical behaviour to increase or reduce the noise emitted; and





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- Environmental sources of noise beyond human control (e.g., wind, thunder, rain and local fauna) were experienced during the baseline measurements.

Access to the sensitive receptor locations identified in the desktop-level assessment of the aerial photography Table 6-19 had to be taken into account when conducting the on-site visual inspections and measurements. As mentioned above, access to the areas of land proposed for Nova Betano in particular was limited, and as such, baseline measurements were conducted at the nearest noise sensitive location along the main road Figure 6-16.

The following assumptions were made during the noise assessment:

- That the baseline measurements conducted during the fieldwork are representative of 'typical' noise sources at each location.
- That the influence by field personnel on measured noise levels is minimal.
- Predicted vehicular traffic volumes are not greater than 6,000 vehicles/day for all relevant roads in the study area.

### 6.5.2 Existing Environment

#### ***Baseline Noise Measurements***

The baseline noise measurements conducted at each location provides a measure of the existing noise source profile across the Betano study area. The measurement results are summarised in Table 6-22.

For all measurements, the results show the primary noise source was associated with vehicle traffic as the measurement locations were situated adjacent to roads. In addition, for all measurements the  $L_{\text{linear,peak}}$  values were above 96 dB and were associated with vehicles passing the sound level meter in close proximity.

These short-term, high noise events have influenced the  $L_{\text{Aeq}}$  value and as such are disproportionately high. Therefore the  $L_{\text{Aeq}}$  values do not represent the 'background' noise profile across the Betano study area. Considering that the  $L_{\text{linear,peak}}$  values for each measurement are greater than 30 dB above the  $L_{\text{Aeq}}$  values, the incremental change in noise levels during the construction and operational phases of the development cannot be assessed when incorporating vehicle-related noise sources. It is inappropriate to incorporate traffic noise into the cumulative impact from the development works at Betano.

Further noise monitoring is required to establish a representative 'background' noise profile for the Betano study area. It is stated in (WA EPA, 2007a) that noise levels should be logged continuously 'over a reasonably representative period, including a weekend where relevant'. The  $L_{\text{A90}}$  value, where 90% of all logged noise values are above, will be calculated and taken to be representative of the 'background' noise.



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**Table 6-22 Baseline noise measurement results (Betano study area)**

Label	Date	Coordinates	Time			Calibration (dB)		Measurements (dB)		Primary Noise Source	Traffic Counts
			Start	End	Duration	Before	After	L <sub>Aeq</sub>	L <sub>linear,peak</sub>		
Betano01	10/12/2011	9° 09' 51.0" S 125° 43' 44.6" E	1514	1529	15 mins	94.0	94.0	47.2	101.8	Vehicle Traffic	MB: 5 Car: 0 Truck: 0
Betano02	10/12/2011	9° 09' 54.6" S 125° 43' 46.1" E	1540	1555	15 mins	94.0	94.0	56.1	96.9	Vehicle Traffic	MB: 3 Car: 0 Truck: 3
Betano03	10/12/2011	9° 09' 57.3" S 125° 43' 36.9" E	1614	1629	15 mins	94.0	94.0	45.5	97.4	Wind/Animals	MB: 0 Car: 0 Truck: 0
Betano04	10/12/2011	9° 09' 47.5" S 125° 44' 27.8" E	1640	1655	15 mins	94.0	94.0	54.7	100.7	Ocean/Vehicle Traffic	MB: 3 Car: 1 Truck: 0
Betano05	11/12/2011	9° 08' 11.0" S 125° 41' 52.7" E	1414	1429	15 mins	94.0	94.0	53.8	101.2	Farm Animals/Vehicle Traffic	MB: 2 Car: 0 Truck: 0
Betano06	11/12/2011	9° 08' 47.0" S 125° 42' 20.5" E	1440	1455	15 mins	94.0	94.0	62.4	104.9	Vehicle Traffic	MB: 14 Car: 1 Truck: 3
Betano07	17/12/2011	9° 09' 17.8" S 125° 46' 07.3" E	1518	1533	15 mins	94.0	94.0	48.2	99.7	Weather/Vehicle Traffic	MB: 2 Car: 1 Truck: 1

Note: MB - Motorbike or other powered two-wheel vehicle.



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### Existing Noise Sources

As stated above, the primary source of high-intensity noise observed during the baseline measurements is vehicular traffic. Other noise sources observed included:

Anthropogenic:

- Local populace talking/playing;
- Small-scale construction work (i.e., use of hand tools and power tools);
- Music (primarily played through electronic devices); and
- Electricity generators.

Non-anthropogenic:

- Weather effects (i.e., wind, thunder and rain); and
- Animals (e.g., chickens, roosters, ducks, dogs, pigs and cattle).

### 6.5.3 Environmental Impacts

#### Assigned Noise Levels

The calculated proportions of industrial and commercial zoned areas within the 100 m and 450 m radii of each noise sensitive location/receptor are listed in Table 6-23. The land use zonings near the sensitive locations/receptors are presented in Figure 6-16.

**Table 6-23 Land use zoning near noise sensitive receptor locations**

Location	Industrial and Utility Premises		Commercial Premises	
	100 m radius	450 m radius	100 m radius	450 m radius
Betano Town Centre	2%	19%	0%	0%
Selihasan	0%	0%	0%	0%
Nova Betano East	0%	0%	0%	0%
Nova Betano West	0%	0%	0%	0%
Betano School (Rai Fursa)	0%	0%	0%	0%
Rai Fursa East	0%	0%	0%	0%
Leoai (North Betano)	0%	0%	0%	0%

It is assumed that the volume of vehicular traffic during construction and operation will not be greater than 6,000 vehicles/day for any relevant roads in the Betano study area. Therefore the Transport Factor (*TF*) for all receptors is considered zero. The calculated parameters for each influencing factor are listed in Table 6-24.

The resulting allowable noise levels for each premises zone type is listed in Table 6-25.



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**Table 6-24 Influencing factor calculation parameters**

Location	Calculation Parameter			
	Industry (I)	Commercial (C)	Transport Factor (TF)	Influencing Factor (IF) <sup>1</sup>
Betano Town Centre	2.1	0	0	2
Selihasan	0	0	0	0
Nova Betano East	0	0	0	0
Nova Betano West	0	0	0	0
Betano School (Rai Fursa)	0	0	0	0
Rai Fursa East	0	0	0	0
Leoai (North Betano)	0	0	0	0

Note: 1 – Influencing Factor rounded to the nearest whole number.

**Table 6-25 Calculated allowable noise levels for the Betano study area**

Type of Premises Receiving Noise	Time of Day	Location	Assigned Level [dB(A)]		
			L <sub>A10</sub>	L <sub>A1</sub>	L <sub>Amax</sub>
Noise sensitive premises at locations within 15 metres of a building directly associated with a noise sensitive use	0700 to 1900 hours Monday to Saturday	Betano Town Centre	47	57	67
		Selihasan	45	55	65
		Nova Betano East	45	55	65
		Nova Betano West	45	55	65
		Betano School (Rai Fursa)	45	55	65
		Rai Fursa East	45	55	65
		Leoai (North Betano)	45	55	65
	0900 to 1900 hours Sunday and public holidays	Betano Town Centre	42	52	67
		Selihasan	40	50	65
		Nova Betano East	40	50	65
		Nova Betano West	40	50	65
		Betano School (Rai Fursa)	40	50	65
		Rai Fursa East	40	50	65
		Leoai (North Betano)	40	50	65

**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT****Table 6-25 Calculated allowable noise levels for the Betano study area (cont'd)**

Type of Premises Receiving Noise	Time of Day	Location	Assigned Level [dB(A)]		
			L <sub>A10</sub>	L <sub>A1</sub>	L <sub>Amax</sub>
Noise sensitive premises at locations within 15 metres of a building directly associated with a noise sensitive use	1900 to 2200 hours	Betano Town Centre	42	52	57
		Selihasan	40	50	55
	All days	Nova Betano East	40	50	55
		Nova Betano West	40	50	55
		Betano School (Rai Fursa)	40	50	55
		Rai Fursa East	40	50	55
		Leoai (North Betano)	40	50	55
		2200 on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	Betano Town Centre	37	47
	Selihasan		35	45	55
	Nova Betano East		35	45	55
	Nova Betano West		35	45	55
	Betano School (Rai Fursa)		35	45	55
	Rai Fursa East		35	45	55
	Leoai (North Betano)		35	45	55
Noise sensitive premises at locations further than 15 m from a building directly associated with a noise sensitive use	All hours	N/A	60	75	80
Commercial premises	All hours	N/A	60	75	80
Industrial and utility premises	All hours	N/A	65	80	90

The relevant assigned noise levels for each land use zone within the study area are presented in Figure 6-17.







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### **Construction Noise**

In the absence of a quantitative analysis of estimated noise emissions, computer simulation of the predicted noise levels cannot be conducted at this stage. As such, accurate prediction of noise impacts across the Betano study area could not be obtained and a qualitative impact assessment has been provided below.

It is likely that noise associated with construction activities for the refinery and petrochemical facilities and jetty areas would have tonal, modulated and/or impulsive characteristics associated with them. Piling activities for foundations in particular have either tonality or impulsiveness depending on the method of installation. For sheet piling installed by vibration methods, tonality is the primary characteristic. For piles driven into place by a conventional pile driver, impulsiveness is the primary characteristic. In addition, vibrational impacts from piling activities have the potential to affect the structural integrity of adjacent buildings. Foundations and binding materials, for example, mortar, are especially susceptible to excessive vibration.

Excavation activities, including drilling, are known to be consistently high noise contributors. It is anticipated that extensive earthwork and excavation activities would be required for the construction of all the development areas, in particular Nova Betano. The use of power tools, in particular impact hammers or 'jackhammers', have the potential to have adverse noise impacts on both construction personnel and the local populace at the sensitive receptor locations. The impulsive nature of the emitted noise from these tools and the tonality associated with other tools, for example, circular saws, would require the additional adjustment factors mentioned above to be applied.

The proximity of proposed construction areas to existing residential premises is a major factor to the potential noise level impact at the following locations:

- Betano Town Centre; and
- Selihasan.

These locations will potentially be impacted by construction at the refinery and petrochemical complex. In addition, impacts may potentially occur at existing and/or proposed residential regions across the Betano study area.

In the absence of an effective noise mitigation program, construction noise impacts may adversely affect the public in ways ranging from annoyance/complaints to loss of sleep.

### **Operational Noise**

Operational noise associated with the refinery and petrochemical complex and jetty areas may potentially adversely affect existing noise sensitive receptors and noise sensitive receptors proposed as a component of the development (e.g., the new settlement at Nova Betano). However, similar to the construction phase, at the time of writing, there is no project-specific engineering data regarding the operation of the Betano development. Therefore, accurate prediction of the noise impacts via computer simulation is not possible at this time.

It is anticipated that tonality would be present within the noise profile emitted from operational activities, particularly for power generation and gas compression. In contrast, it is less likely that



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tonality or modulation will be present in the noise profile emitted by the refinery and petrochemical complex. Flaring activities, although short in duration and infrequent, are high in intensity and may need to be assessed separately to standard operating conditions. Residents of the Betano Town Centre to the west of the proposed refinery and petrochemical complex may experience adverse health impacts and nuisance impacts from prolonged operational noise exposure.

Based on the assessment undertaken at this stage, it is also likely that operational noise would impact the surrounding regions on a long-term basis which will include existing and proposed noise sensitive receptors (for example, the existing settlements and Nova Betano). However, given the unavailability of any engineering design specifications for the refinery and petrochemical complex, the long-term noise impacts cannot be quantified and therefore determined if it is 'significantly contributing to ambient noise levels' at this stage.

### ***Decommissioning Noise***

Given the project lifespan, the decommissioning phase of the project has not been assessed. It is recommended that a decommissioning and closure plan be developed approximately 10 years prior to commencement of decommissioning, and the associated environmental impacts related to noise are assessed as part of the development of this plan.

## **6.5.4 Avoidance, Management and Mitigation Measures**

### ***Detailed Noise Impact Assessment***

Given the lack of detailed design information of the refinery and petrochemical complex, a baseline field investigation has been undertaken at this stage. The most effective management measure that should be implemented is a detailed investigation into the environmental and occupational noise impacts, including computer simulation modelling of predicted noise levels across the study area in accordance with the *Guidance for the Assessment of Environmental Factors No. 8 – Environmental Noise (Draft)* (WA EPA, 2007a).

It is also recommended that noise modelling is undertaken when proposed operational equipment specification and locations for the refinery and petrochemical complex are confirmed. The aim of the noise modelling should be to determine accurate sound power levels generated from operational activities. This modelling would enable the magnitude of potential noise impacts to be determined and inform noise impact management measures that should be implemented during the operations managing noise to acceptable levels.

A detailed impact assessment can only be conducted once detailed engineering design information for the major noise sources is available. Therefore, only generalised management and mitigation measures are provided below.

As part of a detailed assessment, in accordance to Regulation 9 in Environmental Protection (Noise) Regulations 1997 (WA), an adjustment to the emitted sound levels associated with construction or operational events should be considered (refer to Section 6.5.1). This would be to account for any identified characteristics that may be present in the emitted noise (e.g., tonality, modulation or impulsiveness).



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### **Construction Noise**

Construction noise does not have as many established avoidance or mitigation measures as other types of noise. By nature, noise associated with construction activities cannot be avoided. It is also impractical to implement noise mitigation measures, for example noise barriers, for construction activities as they are more suited to longer-term or permanent installations or operations. As such, the primary method to minimise noise impacts from construction activities at sensitive receptor locations is to implement an appropriate noise management plan. It is recommended that a noise management plan specify the following:

- Construction operation hours in which construction-related noise can be emitted;
- Appropriate environmental buffer zones from noise sources;
- Occupational noise policies for construction workers;
- Recommendations for construction methods (e.g., vibrational piling versus pile driver, etc.); and
- The compliance monitoring regime and non-compliance incident investigation methods and rectification strategies.

Regulation 13 of the Environmental Protection (Noise) Regulations 1997 (WA), states that construction noise falls under the 'special case regulation' category. As an example of management measures that could be implemented, the following excerpt from the regulations describes how the noise impacts are regulated in Western Australia:

*Under the special case regulation dealing with construction sites –*

- *A “construction site” is defined as a premises or public place on which the sole or principal activity is the carrying out of construction work;*
- *“Construction work” is clearly defined as in the Occupational Safety and Health Act 1994;*
- *The assigned noise levels set in regulations 7 and 8 do not apply to noise emitted from a construction site as a result of construction work on Mondays to Saturdays, under certain conditions; and*
- *Work may be done between 7 pm and 7 am and on Sundays and public holidays, under a stricter set of conditions.*

### *Daytime Construction*

*For construction work carried out between 7 am and 7 pm on any day which is not a Sunday or public holiday –*

- *The construction work must be carried out in accordance with control of noise practises set out in section six of Australian Standard 2436-2010 “Guide to noise and vibration control on construction, demolition and maintenance sites” (AS 2436-2010);*
- *The equipment used for the construction work must be the quietest reasonably available; and*
- *The chief executive officer (CEO of the Department of Environmental Protection) may request that a noise management plan be submitted for the construction work at any time.*



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### *Construction Out of Hours*

*For construction work done outside the hours shown above –*

- The work must be carried out in accordance with section six of AS 2436-2010;
- The equipment used must be the quietest reasonably available;
- The builder must advise all nearby occupants of the work to be done at least 24 hours before it commences;
- The builder must show that it was reasonably necessary for the work to be done out of hours; and
- The builder must submit to the CEO a noise management plan at least seven days before the work starts and the plan must be approved by the CEO.

*If a builder failed to comply with these conditions, or with the approved noise management plan, the noise from the construction site would be treated the same as noise from any other premises and would need to meet the assigned levels.*

### **Operational Noise**

Mitigation measures for noise associated with the operation of machinery are more established than for construction noise. The *Guidance for the Assessment of Environmental Factors No. 8 – Environmental Noise (Draft)* (WA EPA, 2007a), lists the following generic noise mitigation measures commonly used in construction and operational noise management:

- Procurement specifications for new equipment;
- Retrofit treatments for existing equipment or groups of items (e.g., enclosures, silencers, etc.);
- Adjustments to site layouts to increase separation between sources and receivers and to provide shielding;
- Provision of noise barriers; and
- Management procedures to control the types of equipment or operating conditions at certain times of the day or under certain weather conditions (for example, flaring events).

The procurement of appropriate equipment will have a significant effect on the anticipated noise emissions from the project areas. Selection of low-noise equipment wherever possible will assist in reducing noise impacts at the sensitive locations/receptors.

In the event that equipment is deployed in the field and subsequently determined to be excessively noisy, retrofitting equipment with noise reducing measures can significantly reduce their noise emissions. In the case of stationary noise sources like power generation turbines, enclosures can be created around the source tailored to the specific mitigation requirements. Shielding of noise sensitive locations on-site, for example site offices, via noise barriers can be effective mitigation measures for occupational impacts; however, the design of each barrier should be specific to the location and requirements.





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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As for the consideration of potential construction noise impacts, a detailed assessment of the predicted operational noise impacts to both existing and proposed noise sensitive receptors by computer simulation should be undertaken to provide information on what mitigation measures would be the most effective for the Betano development.

### ***Decommissioning Noise***

Given the project lifespan, the decommissioning phase of the project has not been assessed. It is recommended that a decommissioning and closure plan be developed approximately 10 years prior to commencement of decommissioning, and the associated environmental impacts related to noise are assessed as part of the development of this plan.

### ***Noise Management Plans***

Separate noise management plans should be prepared for the construction and operation phases of the Betano development, detailing the implementation of the proposed noise mitigation measures and operational policies. The noise management plans should refer to relevant legislation and standards for guidance, for example (DEC, 1997), (WA EPA, 2007a) and (AS 2436-2010).

### **6.5.5 Residual Impacts**

As the residual impacts cannot be quantified at this stage, a qualitative assessment of the residual impacts is provided below. With the implementation of a detailed noise impact assessment, predicted noise levels can be determined across the Betano study area, therefore specific and appropriate mitigation and management measures can be determined and recommended in noise management plans. The implementation of suitable management plans for both construction and operational phases of the development are likely to result in residual noise impacts kept to reasonable levels and times of the day.

As stated in Section 6.5.4, construction noise is by nature not easily avoided or mitigated, hence the implementation of an effective management plan is crucial to ensure that noise impacts at sensitive receptors are minimised. This can be achieved by conducting the construction work in accordance with standardised guidelines, for example the Environmental Protection (Noise) Regulations 1997 (WA) (DEC, 1997).

Although operational noise can be mitigated more effectively than construction noise, it is still likely to measurably affect the noise environment at sensitive receptors across the Betano study area in the long term due to the proximity of the receptors to the sources. Complaints may occur on occasion as perception of noise levels are subjective by nature and vary between individuals. It is recommended that all complaints are investigated and actioned appropriately. If the investigation reveals the complaint to be valid, the contributing noise source should be addressed by applying appropriate management measure(s).

In the event that noise mitigation and management measures have been implemented to the maximum extent practicable and the local populace still consider the noise impacts from the development to be unacceptable, relocation of the affected people may need to be considered.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 6.5.6 Monitoring and Reporting

A noise monitoring and reporting program should be prepared to ensure compliance with the developed management plan. The following recommendations have been made to assist in the development of an appropriate monitoring and reporting programme:

- Until noise-related legislation is defined by the GoTL, it is recommended that monitoring and reporting procedures be adopted from other governmental jurisdictions where it is clearly defined, for example the *Environmental Protection Act 1986* for Western Australia;
- Conduct sound power level measurements, or obtain engineering specification sheets for anticipated major noise sources (e.g., major machinery, power generation turbines, etc.) prior to procurement;
- Conduct compliance monitoring of sound power levels at each of the identified sensitive receptor locations for both construction and operation phases of the Betano development. Compliance monitoring events are to be conducted at a frequency in accordance with (DEC, 1997) and (WA EPA, 2007a) spanning the different defined time categories list below:
  - 0700 to 1900 hours, Monday to Saturday;
  - 0900 to 1900 hours, Sunday or public holidays;
  - 1900 to 2200 hours, all days;
  - 2200 to 0700 hours, Monday to Saturday; and
  - 2200 to 0900 hours, Sunday or public holidays.
- Conduct compliance measurements over a period between 15 minutes and 4 hours in length to obtain a 'representative assessment period' for each time category.

Once both sound power measurements of machinery and compliance monitoring events have been completed, the level of contribution from the noise source at the receptor would be calculated by the method detailed in Environmental Protection (Noise) Regulations 1997 (WA). If the noise source(s) are deemed to be 'significantly contributing' to a level of noise greater than the assigned noise level at the receptor, noise management measures should be undertaken.

Reporting on the monitored data should be conducted periodically - after each monitoring event detailing the monitoring method, results and calculation of noise source contribution to measured values.

### 6.5.7 Further Work

The recommended further work related to noise-impacts that should be prepared to assess the Betano development is as follows:

- Conduct baseline monitoring at the identified sensitive receptor locations in accordance with (DEC, 1997) and (WA EPA, 2007a). This will supplement existing measurement data, establish 'background' noise levels at each sensitive receptor and incorporate seasonal variation in population behaviour, village growth and the development of additional new villages. Required



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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'background' noise levels are for the following time periods and at all sensitive receptor locations:

- 0700 to 1900 hours, Monday to Saturday;
  - 0900 to 1900 hours, Sunday or public holidays;
  - 1900 to 2200 hours, all days;
  - 2200 to 0700 hours, Monday to Saturday; and
  - 2200 to 0900 hours, Sunday or public holidays.
- A detailed noise impact assessment of both construction and operational activities including computer simulation of predicted noise impacts on existing and proposed noise sensitive receptors across the Betano study area in accordance with Guidance for the *Assessment of Environmental Factors No. 8 – Environmental Noise (Draft)*;
  - Development of separate noise management plans in accordance with (DEC, 1997), (WA EPA, 2007a) and (AS 2436-2010) for the construction and operation phases of the Betano development detailing management procedures and mitigation measures to be implemented; and
  - Compliance monitoring and reporting in accordance with management plans.

The detailed noise impact assessment requires the provision of detailed engineering design specifications for the proposed works to be able to simulate the impacts adequately.

The implementation of the above further work will facilitate noise from the construction and operation of the Betano refinery and petrochemical complex and associated infrastructure to remain within acceptable noise levels across the development area.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 6.6 Hydrology, Drainage and River Water Quality

A hydrological impact assessment of the proposed Betano Petrochemical Plant and Nova Betano was conducted based on a desktop review of existing data, previous reports and information obtained from a site visit in December 2011. This has allowed a limited, general description of current surface water conditions; an assessment of potential impacts due to the proposed development; a description of possible avoidance/mitigation measure and, development of an outline of future surface water investigation requirements.

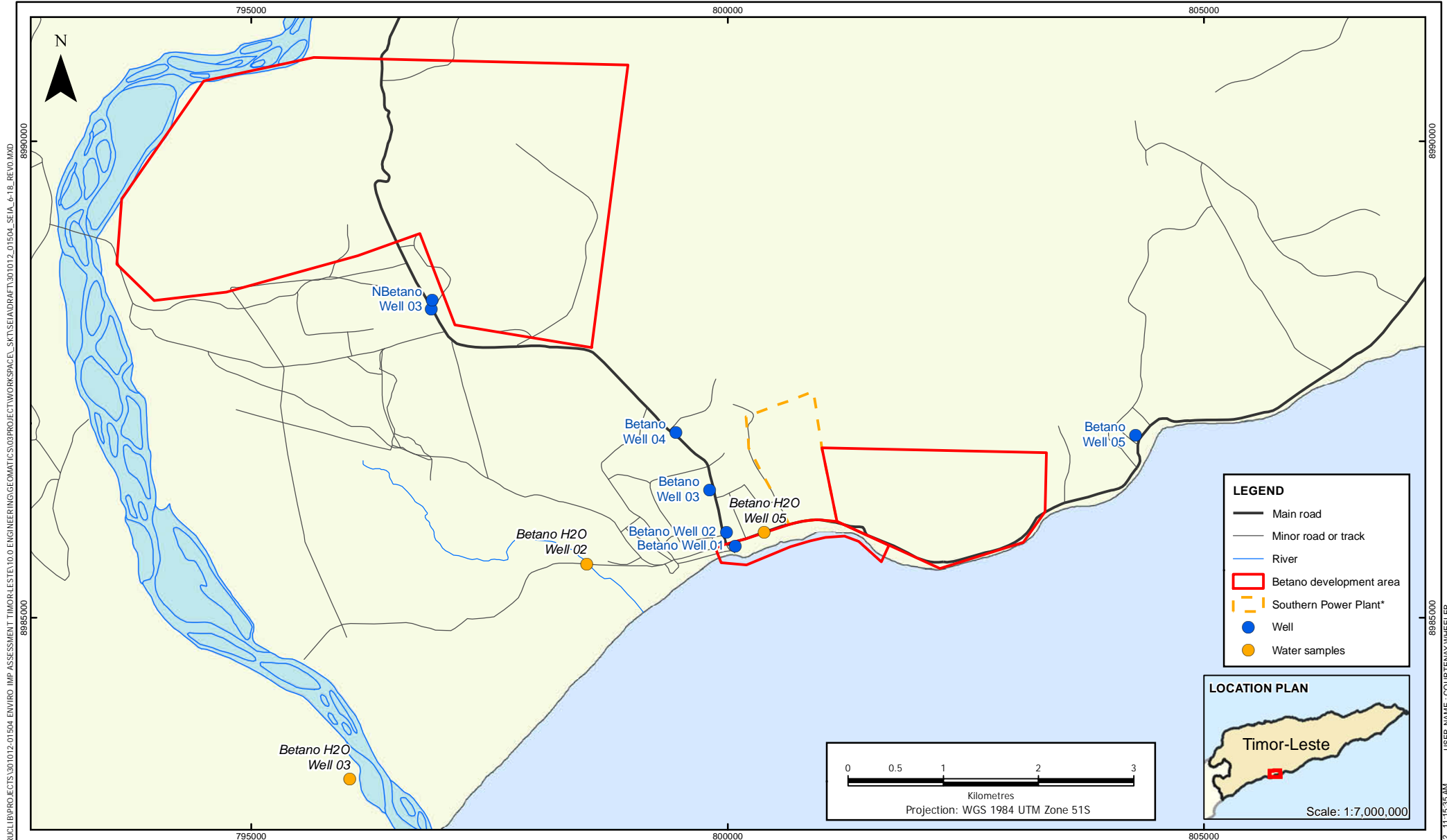
#### 6.6.1 Study Method

##### ***Baseline Assessment***

##### *Available Data*

Information incorporated into this assessment is listed below:

- GIS-based topographic information, which was used to delineate catchment areas for the major waterways.
- Continuous rainfall records from the Betano weather station Beaco meteorological station for a three week period from December 2011 to January 2012.
- Water quality samples taken during the site visit from three locations (refer to Figure 6-18) which were tested for the following physical properties:
  - Temperature.
  - pH.
  - Total suspended solids.
  - Total dissolved solids.
  - Turbidity.
  - Electrical conductivity.
  - Salinity.
- Map showing mean annual rainfall for Timor-Leste.
- Map showing flood risk areas in Timor-Leste.
- A report prepared in 2004 for the Asian Development Bank (ADB) which assessed water resource availability and demand in Timor-Leste titled, 'Assessment of Water Availability and Water Demand in Timor-Leste at River Basin Level' (ADB 2004).



**LEGEND**

- Main road
- Minor road or track
- River
- ▭ Betano development area
- - - Southern Power Plant\*
- Well
- Water samples

**LOCATION PLAN**

Timor-Leste

Scale: 1:7,000,000

0 0.5 1 2 3

Kilometres

Projection: WGS 1984 UTM Zone 51S

NOTES:  
 This map consists of:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. Roads: DivaGIS (2010)

\*Not part of this scope

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resources & energy		TIMOR GAS & PETROLEO		REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				Copyright © WorleyParsons Services Pty Ltd		

**TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT**

**Figure 6-18**  
 Water sampling sites near the Betano development area

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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### *Limitations of Available Data*

The surface water assessment was limited by a lack of suitable information. Ideally, an assessment of surface water hydrology would draw on the following data:

- At least 20 years of data from daily rainfall gauging stations spread across the region. This data would underpin assessments of long-term water availability for water supply purposes.
- Data from at least one continuous recording rainfall gauging station (pluviograph) in the region capable of giving rainfall at sub-daily time intervals (hourly or minutes). This data is essential for estimating flood behavior and design of drainage facilities.
- At least 10 years of data from one or more stream flow gauging stations in the region. This data is essential for estimating flood flows and would assist in assessing long-term water availability for water supply purposes.
- Topographic information to assist in delineating catchment areas.
- Details of historical flooding at the proposed site including the extent of inundation and frequency of flooding.
- Water quality sampling results for streams in the region addressing physical, chemical and biological properties to provide baseline water quality information against which the impact of any future development would be assessed. The samples should be taken over a long enough period to demonstrate variations in water quality throughout the year in response to seasonal and landuse behavior; as well variations in response to different flow rates. Samples should be taken at sufficient locations to demonstrate variations in water quality due to different catchment conditions and landuse patterns.

A comparison of the required data for the ideal study with that actually available shows significant shortfall:

### *Rainfall*

Only three weeks of pluviograph records were available, which is too short to be of value in determining design rainfall intensities or long term water availability.

### *Streamflow*

There are no stream flow records available for the study.

### *Water Quality*

The available water quality samples were for three sites only, taken on one occasion and only physical parameters were examined. Key chemical and biological parameters were not tested due to logistic issues<sup>3</sup>. This was not sufficient to draw any meaningful conclusions about the current water quality or to assess the likely water quality impacts arising from the planned works.

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<sup>3</sup> Special equipment is required to acquire the samples and store them for transport to testing laboratories in Australia. Note: Only some of the parameters of interest can be tested in Timor-Leste.



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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A detailed investigation into available data was made for the Assessment of Water Resource Availability (ADB, 2007). It found that there were 64 daily rainfall stations in Timor-Leste but, data for the period after 1974 was unreliable. As a result, ADB based its study on monthly rainfall data recorded for the period from 1952 to 1974, which it obtained from the Indonesian Meteorological and Geophysics Agency (BMG). Of the six stream flow gauging stations that had been established in Timor-Leste, four had automatic continuous water-level recorders and two had manually-read staff gauges. However, three of the automatic stations had equipment problems and had never recorded data and records for the other stations had been lost.

The current status of the rainfall and stream flow gauging stations is not known.

#### ***Study Method – Impact Assessment***

The study methods that have been adopted have taken into consideration the available data and are described below.

##### *Water Resource Availability*

The assessment of available water resources is based on information contained in ADB 2004. Water resource availability was assessed by the ADB using monthly rainfall runoff models that were established for each river valley and run over a 22 year period, using monthly rainfall data recorded for the period 1952 to 1974. There was no data in Timor-Leste to calibrate the models and so, a model was established and calibrated in a gauged catchment in West Timor and the derived model parameters applied in Timor-Leste.

##### *Flood Flows*

Design flows for the streams adjacent to the site have been estimated using the Rational Method and design rainfall intensities transposed from northern Australia. It is expected that design rainfalls in Timor-Leste will be lower than those that have been adopted for this report, hence the design flows are considered to be conservative estimates.

##### *Water Quality*

Only general comments on possible water quality impacts and mitigation measures could be made.

#### **6.6.2 Existing Environment**

Timor-Leste has a tropical climate dominated by the Asian monsoon. The North West (wet) monsoon occurs between November and May, whilst the South West (dry) monsoon occurs between June and October. Seasonal rainfall patterns vary between the north and south coast due to the central mountain range that generates orographic rainfall and rain shadow effects. As shown in Figure 6-19 mean annual rainfall varies across Timor-Leste from 500 mm to 3,000 mm.

The proposed site for the Betano Petroleum Refinery is located on the southern coast within the Manufahi district. Nova Betano is located approximately 7 km inland adjacent to Rio Caraulun. The Betano refinery and petrochemical complex (Figure 6-20) is located approximately 5 km to the east of the Rio Caraulun.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

The predominant landuse in the region is agriculture, although natural forests remain in the upper catchments and other areas that are too rugged for agriculture.

The three available water quality samples have high levels of turbidity, which is to be expected due to the high level of agriculture in the catchments. Also, as noted in Section 6.3, many soil types in Timor-Leste are generally highly erodible. Information on chemical and biological properties is not available but, it is expected that the water quality would exhibit elevated levels of nutrients, biological oxygen demand (BOD) and pathogens as a result of agricultural landuse and human occupation. Water quality is also expected to vary seasonally in response to agricultural practices and rainfall. Higher pollutants loads are expected during the wet season with high levels of rainfall generating erosion and mobilizing pollutants.

The Betano site is located within the Clere and Belulic Hydrologic Unit. The ADB study showed that irrigation was the dominant water use and that average flows greatly exceeded the average consumptive water demands. However, demands during periods of drought may approach, or exceed flows. Key hydrologic statistics describing water availability and demand are summarized in Table 6-26. While this information is useful in providing a general appreciation of water availability, caution should be exercised in applying the results to future projects, as the generated flows are based on rainfall recorded prior to 1974, which may or may not be representative of current or future climate. Furthermore, the rainfall runoff models used to generate the flows have not been calibrated to recorded streamflows and may be in excess of runoff.

**Table 6-26 Key hydrologic statistics for water availability and demand, Betano**

Month	Mean Monthly Rainfall (mm)	Mean Monthly Streamflow (ML/month)	1 in 5 year Monthly Low Flows (ML/month)	Mean Monthly Irrigation Demands (ML/month)
		Rio Caraulun <sup>1</sup>	Rio Caraulun <sup>1</sup>	Rio Caraulun <sup>1</sup>
Jan	177	24,600	11,600	2,100
Feb	151	46,900	24,200	1,600
Mar	124	66,600	33,900	700
Apr	99	62,800	42,800	4,700
May	197	54,800	37,900	4,900
June	150	39,700	24,600	3,600
July	109	25,900	15,800	1,500
Aug	58	16,500	10,300	2,100
Sep	19	10,500	6,900	2,500
Oct	23	6,900	4,700	2,500
Nov	67	8,400	3,400	900
Dec	213	21,200	7,100	5,400
<b>TOTAL</b>	<b>1387</b>	<b>385,000</b>	<b>223,000</b>	<b>33,000</b>

<sup>1</sup> From ADB 2007

Nova Betano could potentially be flooded by Rio Caraulun which has a catchment area of approximately 554 km<sup>2</sup>. A preliminary hydrologic assessment was undertaken to estimate peak flood flows for Rio Caraulun, which is shown in Table 6-27. Site survey information is not available to allow an assessment of the channel capacity or likelihood of flood inundation across Nova Betano.



**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

**Table 6-27 Estimated peak flows**

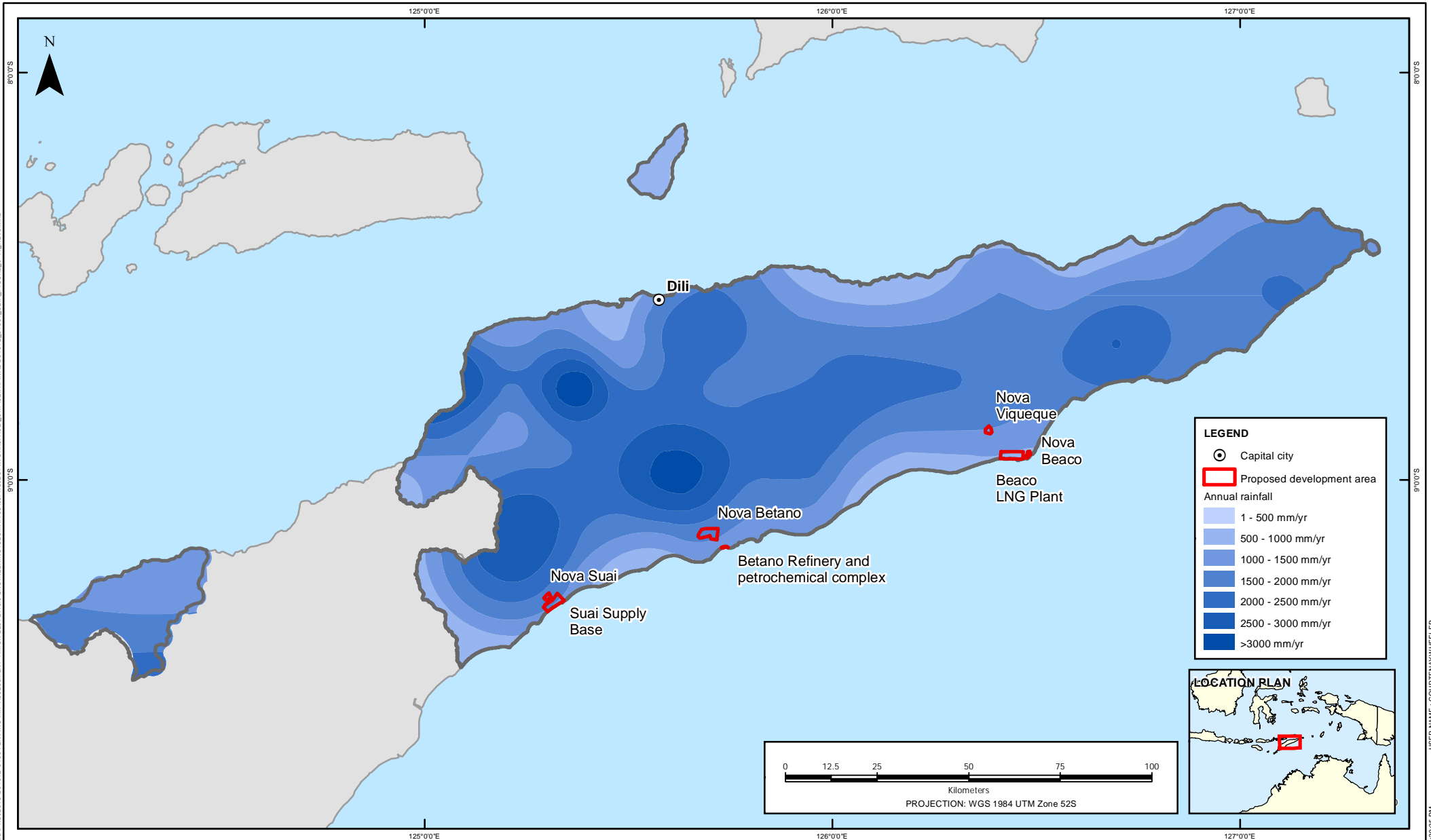
Waterway	10 Year ARI <sup>#</sup> (m <sup>3</sup> /s)	20 Year ARI (m <sup>3</sup> /s)	50 Year ARI (m <sup>3</sup> /s)	100 Year ARI (m <sup>3</sup> /s)
Rio Caraulun	800	1,010	1,256	1,502

# ARI: Average recurrence intervals in years

**6.6.3 Potential Environmental Impacts**

Potential environmental issues related to surface water include:

- Nova Betano could be affected by flooding from Rio Caraulun and may require flood protection works and/or a suitable setback.
- High rates of erosion could occur from exposed areas of soil during construction of project facilities.
- The development will require a water supply to meet commercial and industrial needs, as well as the domestic needs of the workforce. It is expected that the water supply will be sourced from the reverse osmosis of seawater; however, if a portion of the supply comes from surface water, then extraction will affect the flow regime, particularly during low flow periods. Any diversion structures or in-stream storage dams could impact migration of aquatic fauna and modify habitat conditions in the impounded area.
- Following development, runoff from the site may include contaminants including sediment, litter, heavy metals and hydrocarbons which could pollute receiving waters including the adjacent streams and the near shore. Without further treatment, disposal of sewage effluent from Nova Betano may also pollute receiving waters.
- Following development, the volume of runoff and peak discharge rate from the site is likely to increase due to the replacement of natural vegetation with impervious surfaces. This could potentially exacerbate downstream flooding but, it is not expected to be an issue due to the proximity of the site to the downstream end of the catchment.



NOTES:  
 This map consist of:  
 1. Rainfall data: Timor-Leste agricultural library and virtual library (2004)

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TASI MANE PROJECT - BETANO AND BEACO  
 STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT



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SECRETARIA DE ESTADO DOS RECURSOS NATURAIS



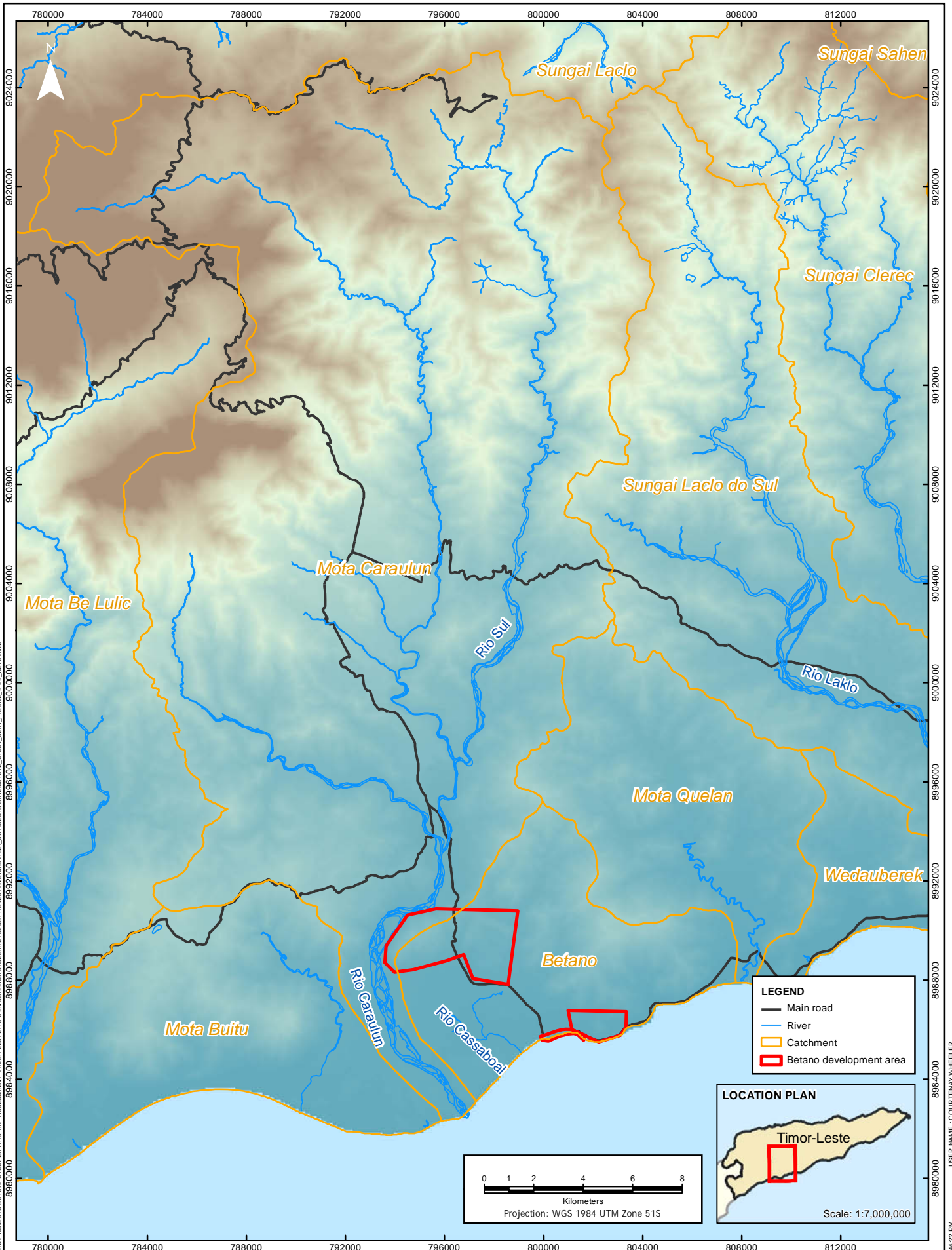
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**Figure 6-19**  
 Timor-Leste mean annual rainfall

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**LEGEND**

- Main road
- River
- Catchment
- Betano development area

**LOCATION PLAN**

Timor-Leste

Scale: 1:7,000,000

0 1 2 4 6 8  
Kilometers  
Projection: WGS 1984 UTM Zone 51S

NOTES:

- This map consists of:
1. Elevation model: SRTM (2011)
2. Rivers: Geographic Information Group TimorLeste (2010)
3. Catchment: Geographic Information Group TimorLeste (2010)
4. Roads: DivaGIS (2010)

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**Figure 6-20**  
Betano catchment map

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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 6.6.4 Avoidance, Management and Mitigation Measures

The following measures may be required to avoid, manage or mitigate surface water environmental impacts:

- Flood protection measures, such as flood levees and diversion channels, may be required to prevent inundation of Nova Betano by flood waters although, a suitable setback will most likely be sufficient.
- An appropriate soil management and erosion control plan should be prepared and implemented during the construction phase.
- In order to make the most informed decision of water supply environmental water requirements will need to be investigated and suitable extraction rules established, to ensure that the water supply of downstream water is protected during drought periods.
- Diversion structures and storage dams, if required, will need to be sited away from environmentally sensitive areas.
- Water quality control measures will be required to treat stormwater runoff prior to discharge from the site. This may include use of sediment and litter traps, water quality ponds, wetlands, grassed swales and oil separators (for specific areas such as car parks). The aquatic ecologist should identify if there are any sensitive aquatic environments that may be affected by polluted stormwater runoff or changed flow regimes. Care may need to be taken to ensure polluted site runoff is not directed towards these habitats. The aquatic ecologist should also provide target water quality (and flow) criteria to be achieved by the water quality treatment system, based on relevant international standards (such as the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC 2000*) taking into account the characteristics of the receiving waters (existence of threatened species, sensitivity to modified flows and water quality, current level of degradation, future use).
- Stormwater detention ponds may need to be installed to attenuate flows and ensure that peak discharges do not increase.

### 6.6.5 Residual Impacts

Following development and implementation of mitigation measures potential residual impacts include:

- A reduction in average flows and change to the flow regime as a result of any surface water extractions.
- A possible decline in water quality due to pollutants from the site not completely removed by the treatment system.



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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#### 6.6.6 Monitoring and Reporting

##### *Stormwater Quality*

Following construction of the township and petroleum refinery, a monitoring program should be implemented to assess the water quality of runoff from the site and the adequacy of the storm water treatment system. The monitoring program should persist for a period of at least two years to ensure that the system achieves the project water quality targets. If the system proves to be satisfactory then the monitoring program can be terminated. However, if the system does not achieve the target water quality standards then suitable augmentation measures will need to be implemented.

#### 6.6.7 Further Work

The following investigations are required to better understand surface water impacts and to design appropriate mitigation measures:

##### *Survey*

A survey of the proposed township should be undertaken to accurately define ground levels. The survey should also acquire cross sections of the Rio Caraulun for a reach that extends from the mouth to a distance of at least 2 km upstream of the site.

##### *Hydrologic Investigations*

Detailed hydrologic investigations should be undertaken to assess.

- Assess long term water availability for surface water supplies.
- Appropriate peak design discharges for the adjacent streams.
- Assess the flood liability of the site.
- Design any flood mitigation measures required.
- Determine suitable design rainfalls for site drainage design.
- Determine suitable environmental flow/water extraction rules to protect the aquatic environment<sup>4</sup>.

Rainfall and streamflow data should be recorded over a period of at least 12 months.

##### *Water Quality*

Water quality measurements should be collected to establish baseline water qualities for creeks and significant waterways potentially affected by the proposed development.

##### *Soil and Erosion Management Plan*

A soil and erosion management plan should be developed for the construction phase, to minimise soil erosion and transport of sediment from the site during construction.

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<sup>4</sup> this will require input by an aquatic ecologist.



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### 6.7 Hydrogeology

This section provides a general description of the regional hydrogeology, an assessment of potential impacts, a description of possible avoidance, management and mitigation measures and identifies areas for further groundwater investigations.

Groundwater is an important source of water for domestic and agricultural use in urban and rural areas across the island of Timor-Leste; however, little is known about either the quantity or quality of groundwater resources, including the extent of foreseeable impacts due to industrial development (UNDP, 2009).

The proposed Betano Refinery will involve a number of activities that could potentially impact groundwater resources both locally and regionally. In general terms, these can be classified in terms of groundwater quantity or flow, and groundwater quality. Groundwater is also an important component to surface water quantity and quality and linkages to surface water are discussed herein as appropriate.

#### 6.7.1 Study Method

Typically, the first stage in developing an understanding of the potential impacts of the project on groundwater resources is a conceptual understanding of the regional geologic and hydrogeologic framework is typically first developed. An understanding of the potential aquifer, groundwater flow patterns, geochemical distribution and groundwater recharge/discharge patterns is part of that study. A preliminary conceptual model of the hydrogeological system has been developed through a desktop assessment and a brief field program to collect groundwater samples from a number of water wells throughout the Betano development area.

Water wells were sampled opportunistically during a field visit in December 2011. Field parameters (pH, temperature and electrical conductivity) and water samples for laboratory analysis were collected at twenty wells throughout and adjacent to the proposed Betano Refinery. Samples were collected using 500 ml plastic bottles and were submitted to the Direcção Nacional Serviço de Agua e Saneamento (DNSAS) or National Directorate for Water and Sanitation for analysis of pH, electrical conductivity (EC), total dissolved solids (TDS), salinity, temperature and turbidity.

#### ***Assessment Criteria***

Currently, Timor-Leste does not have specific legislation to protect groundwater resources. A draft national water policy was finalized in July 2004 and is yet to be adopted by the Government of Timor-Leste (USAID, 2011). In the absence of drinking water guidelines or standards, the World Health Organization (WHO) drinking water guidelines will be used for assessment (WHO, 2011) to compare groundwater collected from the water wells to an international drinking water standard.

#### ***Data Assumptions and Limitations***

A limited understanding of the existing hydrogeological conditions in the project area currently exists and this current investigation was limited by the scope of work in particular the narrow study period. The following data gaps and limitations were identified during this desktop study:



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- Specific knowledge/data regarding local and regional aquifers within the proposed project area is not available; therefore no quantification of impacts has been made.
- A number of water wells have been located. However, current water users within and adjacent to the Betano development area have not been identified and local groundwater use has not been quantified.
- There is currently limited information available on the quality of groundwater within and adjacent to the Betano development area. Consequently, local groundwater quality and hydrogeochemical types have not been characterized.
- There is currently no data available to quantify surface water-groundwater interactions (including baseflow) within and adjacent to the proposed site.
- Estimates of groundwater extraction rates were not available and no aquifer testing was conducted at the collected water well samples.
- All assumptions are based on a brief review of existing material.

### 6.7.2 Existing Hydrogeological Concept

#### *Desktop Assessment*

Timor Island was formed by a collision complex between the Australian continent and the Banda Arc subduction systems. The peak of collision occurred during Late Miocene-Pliocene and resulted in wide-spread metamorphism. In late Pliocene time, Timor began to emerge as an island and four post-Pliocene units (the marine Baucau Limestone, the Poros Limestone, the Suai Formation and the Ainaro Gravels) were deposited. By the end of the Pliocene, Timor-Leste was covered with alluvial systems and local basins had developed.

At the refinery and petrochemicals cluster site, the coastal plain is underlain by the Suai Formation, with the hills emerging to the north-west comprising the Wai Bua Formation and the hills to the north and north-east comprising the Wai Luli Formation. The Suai Formation is generally poorly exposed and not well known.

The central core of Nova Betano East is underlain by the Baucau Limestone Formation and the central core of Nova Betano West is underlain by the Bobonaro Scaly Clay Formation. Around the lower southerly and westerly fringes of both Betano East and Betano West, the Suai Formation is encountered, with the Viqueque Formation occupying the northern fringe of Nova Betano East and the Wai Bua Formation, the eastern fringe.

Natural groundwater springs are considered the primary source of water for domestic and agricultural for approximately 60% of the population in Timor-Leste (ADB, 2001), (AusAID, 2009). Alluvial deposits and Cenozoic and Quaternary limestones are likely to constitute more productive aquifers than underlying metamorphic complexes and deformed Permian-Jurassic strata, although faulting may have a large impact on groundwater flow even in poorly permeable rocks (BGS, 2007). Studies indicate that the presence of groundwater along the southern coast is generally considered high relative to other areas of Timor-Leste (Monk *et al.*, 1997).





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### ***Baseline Groundwater Quantity***

Regionally, the Betano development area is situated within the hydrological region of Clere and Belulic (AWRF, 2006), which is estimated to have a total AGWR budget of 26 million cubic metres (MCM). Estimates of groundwater withdrawals per capita within the Clere and Belulic area were 57 m<sup>3</sup> per year, less than 0.5% of the total water resources per capita (12,486 m<sup>3</sup>; ADB, 2004) in an average year. However, during a dry (1 in 5 low flow) year, groundwater withdrawals can account for up to 1% of total water resources due to limited water availability (7,863 m<sup>3</sup> per year; ADB, 2004). At this time, estimates of groundwater recharge and discharge have not been conducted.

In 2004, the Asian Development Bank (ADB) Integrated Water Resources Management (IWRM) Project estimated annual groundwater recharge, storage and sustainable aquifer yield for each of the hydrologic units. Hydrogeological units from a map of West Timor were extrapolated to Timor-Leste and a recharge factor was applied based on rock type, estimated permeability, slope and vegetation cover (ADB, 2004). Within the Clere and Belulic hydrologic region, a total sustainable yield of 25.5 MCM/year (809 L/s) and a total storage of 6,800 MCM were calculated based on an average aquifer extent of 340 km<sup>2</sup> and 100 m in thickness. These values indicate an abundance of groundwater within the region. However, they should be considered very approximate estimates of deep (>100 m) aquifers which are likely to be difficult and expensive for local residents to access.

Shallow wells are used extensively in villages and rural areas, especially those near the sea or on river plains. Numerous shallow wells exist across Timor-Leste, both in urban and rural areas. However, many of these were damaged or contaminated during years of conflict. A small number of boreholes also exist, most notably in the southern alluvial plain (BGS, 2007).

### ***Baseline Groundwater Quality***

It is expected that concentrations of inorganic constituents in groundwater will be dependent on the pH and redox (reducing-oxidizing) conditions of regional and local aquifers, and current information and assessments of potential groundwater quality are made on the basis of available geological information. Site-specific groundwater quality characterization has not been performed, as collection of a geochemical suite of groundwater samples from water wells at the Betano development area has not been possible in the study period.

Regionally, reports of inadequate sanitation and waste management systems (Pederson and Arneberg, 1999) imply that shallow groundwater is potentially under threat from pollution, especially in urban and peri-urban areas. In rural areas, pollution from agricultural sources is also a potential problem although it is noted that limited industrial development to date in Timor-Leste would suggest that industrial pollution is currently a comparatively minor threat to water quality (UNDP, 2009).

Groundwater data, including laboratory analyses, are summarized in Table 6-28. Average temperatures of the groundwater samples ranged from 24.1 to 24.7°C, with pH values ranging from 7.10 to 7.70, which are within the WHO drinking water guideline range of 6.5 to 8.5 (WHO, 2011).

Groundwater samples were analyzed for total dissolved solids (TDS), salinity and turbidity and are summarized in Table 6-28. TDS values ranged from 234 to 605 mg/L, with all water samples below the WHO drinking water guideline criteria of 1,000 mg/L. Salinity values ranged from 0.2 to 0.6%. There is currently no WHO drinking water guideline for salinity. Turbidity values ranged from 2.2 to



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115 NTU; with half of the samples reporting values at or above the WHO drinking water guideline criteria of 5 NTU. Turbidity values reported above the WHO guideline value indicate the presence of silt, sand, mud, bacteria and/or chemical precipitates, which may adversely affect water treatment systems, such as sedimentors or gravel filters. Where chlorination of water is practiced, even quite low turbidity can prevent effective chlorination. It is also important to control turbidity in drinking water supplies for both health and aesthetic reasons (WHO 2011). Further baseline groundwater quality testing is required to appropriately characterise the conditions at the site.

**Table 6-28 Groundwater Quality Analyses: Physical Parameters**

Well Name	Physical Parameters Analysed						
	pH	EC (uS/cm)	TSS (mg/L)	TDS (mg/L)	Salinity (%)	Temp. (C)	Turbidity (NTU)
<b>WHO DWQG<sup>1</sup></b>	6.5-8.5	---	---	1000	---	---	5
<b>Betano Wells</b>							
Betano Well 01	7.7	1173	0.07	586	0.6	24.4	7
Betano Well 02	7.7	1210	0.07	605	0.6	24.3	115
Betano Well 03	7.5	913	0.06	456	0.5	24.4	2.8
Betano Well 04	7.6	1118	0.04	554	0.6	24.7	2.8
Betano Well 05	7.4	478	0.03	234	0.2	24.5	2.2
NBetano Well 01	7.1	930	0.06	465	0.5	24.5	2.4
NBetano Well 02	7.3	13.4 <sup>2</sup>	0.01 <sup>2</sup>	6 <sup>2</sup>	---	24.1	5
NBetano Well 03	7.3	1089	0.06	544	0.5	24.7	6.1

**Notes:**

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail row(s) denotes parameter not analysed.
3. ■ shading indicates parameter above applied guideline/criteria.
4. superscript <sup>1</sup> denotes value exceeding World Health Organization Drinking Water Guideline, 2011.
5. Superscript <sup>2</sup> denotes anomalous values and recommends resampling to confirm values.

**6.7.3 Environmental Impacts**

It is expected that impacts to groundwater during construction and operation phases of the Betano development will be similar.

Construction and operation of the Betano development has the potential to adversely affect groundwater and could potentially result in one or more of the following:



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- Localised changes in groundwater quality.
- Localised changes in groundwater flow patterns.
- Minimal effects on groundwater recharge and discharge.
- Site-dependent changes to surficial hydrology and water quality.

Likely sources of the groundwater impacts include:

- Construction and operation of surface facilities.
- Disposal of process water.
- Leachate from solid waste disposal (e.g., containment of wastes).
- Accidental spills or releases of chemicals and fuels.

An overview of potential impacts to groundwater resources has been provided. However, a more precise definition of impacts to groundwater quantity and/or quality cannot be quantified at this time due to the lack of sufficient information on local groundwater conditions.

### ***Impacts to Groundwater Quality***

A review of the geology within the Betano development area indicates that shallow sediments are primarily comprised of unconsolidated pebbly gravels, sands and fine silts of the Suai Formation. Depth to the water table is between 2 to 10 metres below ground surface (mbgs) and the unconsolidated material of the Suai Formation is expected to have a relatively high permeability. Consequently, mitigation measures will need to be undertaken to ensure the impacts of accidental releases of chemicals and fuels are identified in a timely manner such that they do not adversely affect shallow groundwater resources.

New surface facilities for the proposed development include a petroleum refinery and associated infrastructure, jetties, shore-based facilities, fuel tank farm, reverse osmosis system and water storage tanks, fire-fighting facilities and accommodation facilities. Accidental releases (including spills and leaks) from surface facilities could negatively impact shallow groundwater quality. The potential risk to receptors (e.g., groundwater users or surface water bodies) will depend on the spatial and temporal nature of the release, the materials released, the site-specific subsurface hydraulic conditions (e.g., depth to groundwater, groundwater flow velocity and adsorption capacity of the soil) and the effectiveness of mitigation measures at the release location.

Onsite disposal of process water also has the potential to introduce contaminants into groundwater and subsequently by groundwater discharge, to surface water systems (i.e., rivers, streams and/or creeks). In many rural to semi-rural areas of Timor-Leste, residents access water through shallow water wells or natural springs. The potential contamination of groundwater via disposal of process water may affect residents that use groundwater for drinking water purposes or as a potable water supply for agricultural purposes. If disposal of process-affected water is incorrectly handled, the potential to adversely affect the quality of baseflow (groundwater discharge to surface water) also exists. The disposal of process water is described in Section 6.12 Waste Management.



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During construction and operation phases, non-hazardous solid waste will be generated from accommodation facilities and during site preparation and construction of surface facilities as described in Section 6.12 Waste Management. Solid waste and effluent that are expected to be generated from the project development may adversely affect shallow groundwater if not properly contained. Domestic effluents are also anticipated during the construction phase. However, it is expected that domestic effluents will be diverted to the waste water treatment plant and as such considered to be non-significant.

Hazardous solid waste and medical waste are also expected to be generated during construction and operation activities. These wastes can potentially affect groundwater quality if not properly handled. Leachate of hazardous waste can potentially cause permanent deterioration of groundwater quality and should be considered a significant potential impact.

Chemicals used during the construction and operation phases of the project may contain a variety of constituents that have the potential to adversely affect groundwater quality if leaked or spilled from tanks/vessels, holding ponds, and/or malfunction of equipment (including pumps or piping). These constituents and their by-products may include various hydrocarbons, glycol, salts, metals, diesel, gasoline, hydrochloric acid, sodium hydroxide, and corrosion inhibitors.

### ***Impacts to Groundwater Flow, Recharge and Discharge***

The topography of the island of Timor-Leste is generally mountainous, characterised by rugged terrain and small narrow valleys, with decreasing elevation towards the coastline. It is expected that the topography of Timor-Leste influences the general direction of shallow groundwater flow and also influences groundwater recharge and discharge. It is expected that shallow groundwater recharge occurs regionally within mountainous areas into zones of saturation and generally follows the topography towards the coastline. Groundwater data indicates that shallow groundwater is generally considered fresh (<1,000 mg/L, expressed as TDS), which suggests precipitation is likely the main source of recharge.

The primary impact on the groundwater flow system at the Betano development would be expected from groundwater dewatering and extraction of groundwater for industrial or domestic (i.e., drinking water) purposes. Significant lowering of the groundwater table may adversely affect existing users of groundwater in the future, primarily during dry times (low flows) of the year. Natural springs are fed by groundwater and cannot be maintained if the groundwater table falls. A continued reduction in the water table level from groundwater mining may lead to land subsidence in geologically susceptible areas.

### ***Impacts to Groundwater - Surface Water Interaction***

Groundwater is recharged from surface water precipitation and infiltration. Surface water and groundwater interaction are complex events and are susceptible to changes in surface recharge, due to variations in surface features. Interaction may be described as occurring in four basic ways:

- Streams gaining water from inflow of groundwater through the streambed.
- Streams losing water to groundwater by outflow through the streambed.
- Streams that do both, gaining in some parts and losing in others.



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- Alternating between gaining and losing depending on relative stream and groundwater levels.

Adverse impacts to groundwater-surface water interactions may result in changes to surrounding surface water flow volumes due to changes (increases or decreases) in groundwater flow or impacts on surface water quality from contaminated groundwater (baseflow) contribution. Any adverse impacts on groundwater quality (noted above) could also impact surface water systems in which groundwater is the primary source of baseflow. Baseflow contributions have not been calculated as part of this study and therefore no quantification of impacts can be conducted.

### ***Decommissioning Impacts***

Given the project lifespan, the decommissioning phase of the project has not been assessed. It is recommended a decommissioning and closure plan will be developed approximately 10 years prior to commencement of decommissioning and the associated environmental impacts related to groundwater assessed as part of the development of this plan.

### **6.7.4 Avoidance, Management and Mitigation Measures**

To mitigate the potential of adversely affecting groundwater, control measures that can be implemented to minimise the potential adverse impacts on groundwater quantity and quality include:

- Development of groundwater monitoring plans to include a site assessment, baseline monitoring and continued groundwater monitoring, as outlined in Chapter 8 Environmental Management Framework.
- Development of a comprehensive spill response plan.
- Development of an environmental monitoring plan for surface and subsurface petroleum storage and distribution facilities.
- Development of a comprehensive sanitation system and waste disposal plan that complies with internationally-recognized best practice standards.

### **6.7.5 Residual Impacts**

At this time, there is not enough site-specific groundwater data to quantify residual impacts. However, if mitigation measures and proper management of groundwater resources are not implemented, the Betano development has the potential to adversely affect groundwater resources and these impacts could extend past the life of the project.

Mitigation measures and groundwater monitoring can be implemented in the vicinity of surface facilities and areas of potential groundwater impacts to identify releases and minimize potential impacts. Depending on the nature and volume of the releases, the impacts could extend past the operational life of the project. However, as the conditions of potential spills/releases are unknown the duration of impact can only be predicted as long-term. Effective mitigation measures, such as monitoring, would reduce any residual impacts.





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### 6.7.6 Monitoring and Reporting

The following recommendations are provided to assist in the development of an appropriate groundwater monitoring plan (GMP) for the groundwater monitoring and reporting program. The GMP should be developed in alignment with relevant legislation and regulations (as applicable) and international standards (e.g., WHO Drinking Water Guideline). Components of the GMP should include:

- Site Assessment
  - Identification of source, pathway and receptors.
  - Description of measures, activities and procedures that will be implemented to ensure groundwater quality and quantity is protected from potential impacts.
- Baseline Monitoring
  - Development of a groundwater monitoring well network to collect further data prior to construction of surface facilities and to establish site-specific baseline conditions for groundwater quality and quantity.
  - Establishment of site-specific triggers and limits for groundwater quality and quantity based on an established method.
- Groundwater Monitoring Plan
  - Rationale for proposed monitoring wells, including location, spatial coverage and target geological zones.
  - Selection of primary and secondary indicator parameters to be analysed at specified monitoring wells.
  - Proposal of monitoring frequency for specified monitoring wells.
  - A summary of the site-specific approaches for assessing and managing potential impacts (e.g., should an established groundwater trigger or limit be exceeded).

### 6.7.7 Further Work

Further work is required to further characterize groundwater quality and quantity within and adjacent to the Betano development. This work should include:

- An assessment of existing groundwater users in the vicinity of the Betano development area including drinking water and irrigation water users.
- A detailed site survey to identify groundwater recharge and discharge areas, potential groundwater dependent ecosystems (GDE) and current land uses.

Installation of a groundwater monitoring network to determine local groundwater conditions, including, current groundwater quality, groundwater surface elevation and flow direction, estimates of groundwater storage, potential hydraulic connection between surficial aquifers and underlying bedrock and groundwater-surface water interactions.



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### 6.8 Terrestrial Biodiversity

WorleyParsons undertook a flora and vegetation assessment, and a vertebrate fauna assessment of the Betano development area in December 2011 and February 2012. The full report is presented as Attachment 01.

Throughout this section, the following definitions apply:

- *Conservation status* refers to a species' status listed under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species or in the Convention on International Trade in Endangered Species (CITES).
- *Conservation significant species* refers to species that have a higher risk of extinction, i.e., those listed as Critically Endangered, Endangered, Vulnerable and Near Threatened under the IUCN Red List of Threatened Species.

The legislation relevant to environmental protection and biodiversity conservation in Timor-Leste includes the following laws and regulations:

- Law No. 5, 1990 on Conservation of Biological Resources and their Ecosystems.
- Law No. 5, 1994 Concerning Biodiversity.
- Government Regulation No. 28, 1985 on Forest Protection.
- Government Regulation No. 51, 1993 on Environmental Impact Analysis.
- United Nations Transitional Administration in East Timor Regulation No. 2000/17.
- United Nations Transitional Administration in East Timor Regulation No. 2000/19.

The United Nations Transitional Administration in East Timor (UNTAET) Regulation No. 2000/19 is particularly relevant to the Tasi Mane Project – Betano Refinery and Petrochemical Complex (the project) as it protects endangered species, wetlands and mangroves, historical and cultural sites, biodiversity conservation, and biological resources.

#### 6.8.1 Study Method

The flora and vegetation, and fauna study methods are summarised below. Further detail on the methods is provided in Section 3 of Attachment 01.

The field surveys were undertaken over nine days in December 2011 and seven days in February 2012 at the proposed Betano (the focus of this section) and Beaco (Section 7.8) development areas. The field surveys are discussed in more detail below.

#### *Flora and Vegetation*

##### *Desktop Review*

Historical information and data from previous surveys undertaken in the vicinity of the Betano development area was reviewed. Locally relevant information was also sourced from reference text



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and academic experts. Data from the IUCN Red List of Threatened Species and CITES was also reviewed.

A list was then compiled of the flora and vegetation species identified and the conservation status of these species, as listed under the IUCN Red List of Threatened Species. For species not listed on the IUCN Red List of Threatened Species, CITES was used to provide an indication of the relative global conservation status of the species.

### *Vegetation Field Survey*

WorleyParsons undertook a broad assessment of plant communities and their distribution, floristic composition and structure in the Betano development area. The assessment included sampling vegetation communities opportunistically at various observation points within the study area. It was not possible to complete a quadrat sampling design in the time available for the surveys.

Vegetation descriptions were adapted from those developed by Cowie (2006 and 2007) and presented in Table 2 of Attachment 01. The vegetation classes (lowland forest, highland forest, montane forest, wetland forest, coastal forest and man-made forest) and descriptions were used during the field survey to identify vegetation communities, structure and dominant species composition.

### *Flora Field Survey*

Within the Betano development area, a greater emphasis was placed on the flora survey than the vegetation survey. The flora field survey focussed on common and dominant species, and species of conservation and economic importance. Quantitative sampling and recording structural attributes was not undertaken given the limited timeframe for assessment.

During the field survey, WorleyParsons took photographs of live specimens and collected various samples of plant life forms including trees, shrubs, herbaceous species, vines, ferns, and epiphytes (non-ferns). WorleyParsons also recorded the conservation status of the flora species, and obtained their local Tetum names, where known.

All of the plant specimens collected were pressed for several days in a field press, before being preserved (for the short term) using a technique described by Forman and Bridson (1989) in Attachment 01. This technique is suited to the wet tropical conditions experienced at the time of survey. On return to Australia, the pressed plant specimens were submitted for gamma irradiation to meet Australian Quarantine Inspection Services (AQIS) regulations. This process took approximately four weeks for the plant species collected in December 2011, and three weeks for the plant species collected in February 2012. The species were then submitted to the Northern Territory herbarium for identification.

## ***Fauna***

### *Desktop Review*

Similar to the flora and vegetation survey, the vertebrate fauna survey involved a review of historical information and data from previous surveys undertaken near the Betano development area. Data from the IUCN Red List of Threatened Species, the Birdlife International Database and CITES was



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also reviewed. Locally relevant information was also sourced from reference text and academic experts.

Following review of this data, a comprehensive inventory of local fauna species was developed. This list will invariably include some species that do not occur in the study area, because some fauna have a limited or patchy distribution, high level of habitat specificity, are locally extinct or were erroneously identified in previous surveys. Some records, i.e., extinct species, were excluded from this inventory.

### *Fauna Field Survey*

The focus of the fauna field survey was to identify broad fauna habitats based on vegetation associations and known landforms. Once identified, the fauna habitats were assessed for their potential to support fauna, in particular species of conservation significance. Habitats were assessed on the basis of their complexity, the presence of microhabitats (including significant trees with hollows, loose bark, fallen hollow logs and leaf litter) and other habitat features likely to provide foraging opportunities and/or shelter for fauna, such as water bodies and rocky outcrops. Five vertebrate fauna habitat assessments were undertaken across the Betano development area.

Acoustic ultrahigh frequency equipment (Anabat) was used to record the presence of microbats. The equipment was placed in the study area to achieve a broad coverage but, is also designed to target potential maternal and breeding roosts. The location of the anabat recordings and the habitat assessment areas are shown in Figure 6-21.

Active searching for ground dwelling reptiles and mammals was also undertaken, which included searching and recording scats, tracks and other traces; digging up burrows; turning over rocks and logs; splitting fallen timber; raking soil and leaf litter; peeling off bark; and searching rock habitats (in cracks and caves, around water bodies and in holes in fence posts).

In addition, call play back was used for avian species which are known to respond to species calls for active identification in the study area.

### **Limitations**

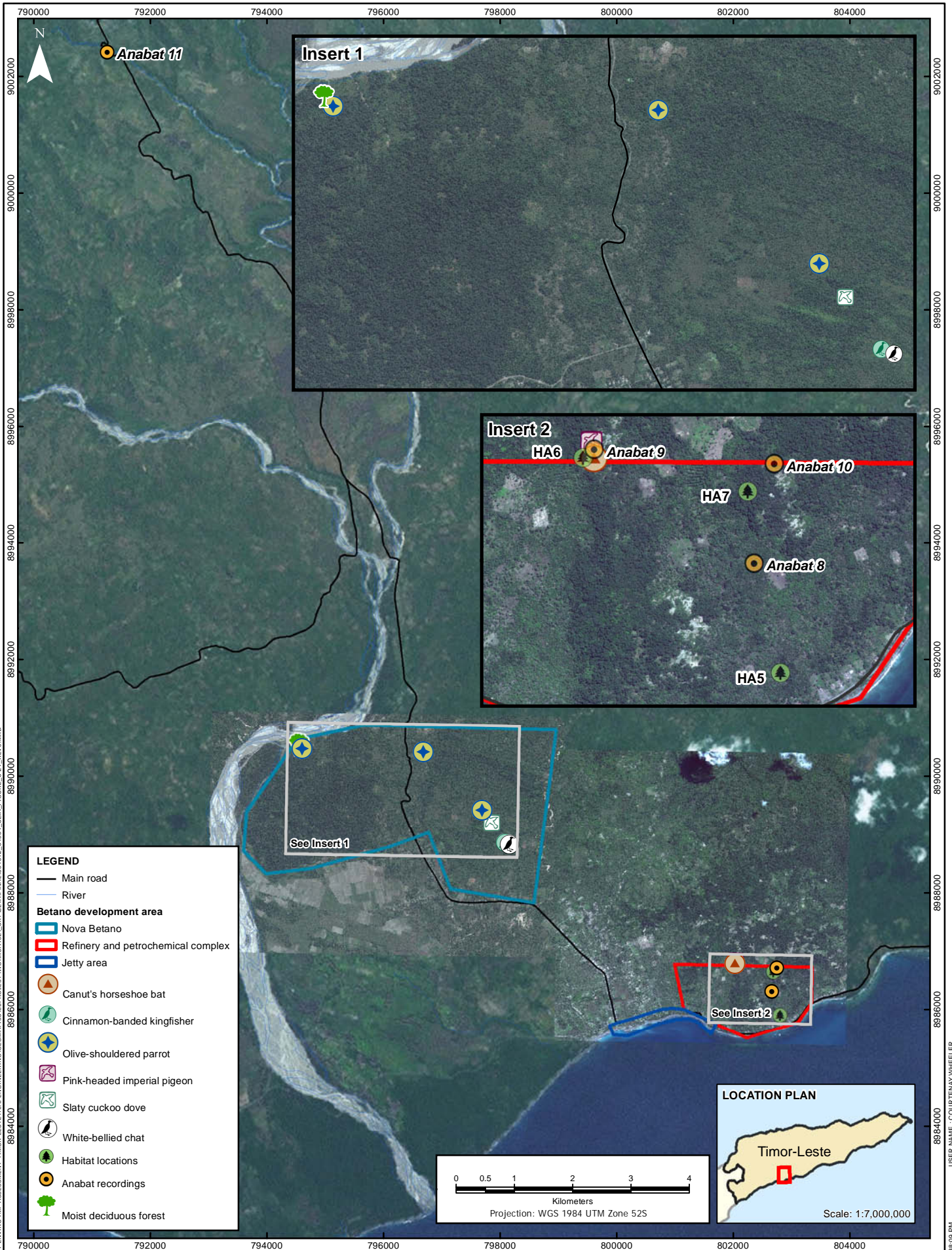
#### *Flora and Vegetation*

Due to the limited time available for field surveys, the flora and vegetation assessments were undertaken at the same time. The surveys focused on determining vegetation structure, dominant species and plants of interest. Less emphasis was placed on ferns, herbs and other non-dominant flora.

Detailed mapping of vegetation communities was not undertaken during the field surveys as extensive ground-truthing and detailed inventories from plots/quadrats is required for this level of assessment.

In addition, it was not possible to record all species present at the Betano development area given the limited survey period. Lichens, bryophytes (mosses and liverworts), epiphytes, and parasitic plants occurring high up in the tree canopy, were also not included in survey.





NOTES:

This map consists of:

1. Imagery: Digital Globe (2008-2011)
2. Rivers: Geographic Information Group Timor-Leste (2010)
3. Roads: DivaGIS (2010)
4. Vegetation communities: WorleyParsons (2012)

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								Copyright © WorleyParsons Services Pty Ltd	

**Figure 6-21**  
Betano study area biodiversity key sites

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Flora surveys are ideally undertaken at the best time of year for detecting the most plant species, and across multiple seasons in order to capture seasonal variation. As such, the timing of the field surveys, during the wet season, has limited the plant species that were able to be recorded at the site.

Further work recommendations, such as additional surveying and ground-truthing, have been made in Section 6.8.6 to address these limitations.

### *Fauna*

Similar to flora surveys, fauna surveys are ideally undertaken at the best time of year for detecting the most fauna species, and across multiple seasons in order to capture seasonal variation. As such, the timing of the field surveys, during the wet season, has limited the fauna species that were able to be recorded at the site. The length of the surveys (16 days) was also insufficient to accurately identify all species that potentially occur in the study area.

### **6.8.2 Existing Environment**

Timor-Leste is located in the Malay Archipelago and represents the largest and eastern-most of the Lesser Sunda Islands (World Bank, 2009 in Attachment 01). The island is in the Central Melesia (Wallacea) region and its flora is considered to be transitional between the main rainforest blocks of the Sunda (Peninsula Malaysia, Sumatra, Borneo, West Java) and Sahul (New Guinea) shelves (van Welszen *et al*, 2005 in Attachment 01).

The coastal plain of southern Timor-Leste has largely been cleared in association with swidden agriculture, sandalwood harvesting, plantation estates and timber plantations. Remnant vegetation exists as highly fragmented and secondary communities. Most of the understory within remnant vegetation and agricultural land is dominated by invasive species, particularly Siam weed (*Chromolaena odorata*) and cogon grass (*Imperata cylindrica*). Grasses are extensively grazed by cattle, water buffalo, pigs and goats.

#### ***General Overview of the Betano Development Area***

The Betano Refinery site is hilly with a medium to steep incline and flat foothills extending to the coast. Natural vegetation within the Betano Refinery site can be described as moist deciduous forest on the hills and secondary coastal vegetation on the foothills and coastal plain, with small areas of riparian vegetation on drainage lines. Recent aerial imagery (2010) indicates that much of the Betano development site is vegetated although it is not considered intact native vegetation due to the prevalence of weeds and absence of understory some minor areas have been cleared for agriculture.

Nova Betano is located within an extensive area of secondary moist deciduous forest on the hills, located 5 to 6 km northwest of the coastline. A proportion of the western area of the Nova Betano site is relatively undisturbed dense forest, although the majority of the central and eastern area is secondary open forest.

Tracks and small areas of land have been cleared for powerline construction at the Betano Refinery and Nova Betano sites.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### *Vegetation Communities*

#### *Moist Deciduous Forest*

The hills within the Betano Refinery site are vegetated with secondary moist deciduous forest with a canopy height of approximately 20 to 25 m. The overstorey and mid storey species included *Pterocarpus indicus*, *Tamarindus indica*, *Schleichera oleosa*, *Grewia* sp., *Ziziphus timoriensis*, *Z. mauritiana*, *Strychnos lucida* and *Mallotus philippensis*. The ground layer included a variety of shrubs and vines and a few understory herbs and ferns in undisturbed patches of forest where limestone outcropping was present. There were fewer weeds on the densely vegetated hilltops and hill slopes than in open vegetation of the foothills. This vegetation type, which was the dominant vegetation community recorded at the Betano site, is shown below in Plate 6-43 and in Figure 6-22.

Within the Nova Betano site, dense forest is characterised by a canopy height of approximately 20 to 25 m, with an understory of shrubs, vines, herbs and epiphytic ferns. Open forest is characterised by scattered trees and palms over a weed understory. Small areas of vegetation have been cleared and burnt for teak and corn gardens. Dominant trees within the Nova Betano site are *Schleichera oleosa*, *Pterocarpus indicus*, *Acacia nilotica* subsp. *indica*, *Tectona grandis*, *Casuarina* sp. *Ziziphus mauritiana* and scattered *Corypha utan* and *Borassus flabellifer* palms.

Nova Betano is adjacent to a government operated irrigation channel that comprises undisturbed forest in good condition and according to local guides, this area is 'lulik' or sacred. This undisturbed site has a canopy cover of 50% and a well-developed understory. Orchids and stag horn ferns (*Platyserium* sp.) were observed high in the canopy.

#### *Coastal Vegetation*

Three main types of coastal vegetation have been recognised in the Melasian regions; Pes-caprae formation, Barrington formation and vegetation of rocky shores [Whistler (1987) in Attachment 01].

The Barrington formation was observed to the west of the Betano refinery site; however, was not recorded in the study area. The rocky shore vegetation was also not recorded in the study area. A small area of highly degraded Pes-caprae formation was observed at the proposed jetty site (Plate 6-44). *Spinifex littoreus* grasses were also present on the beach within the proposed jetty area.

Coastal vegetation within the Betano development area is secondary vegetation and occurs on the foothills and lowland towards the beach. It comprises open forest dominated by tree species *Borassus flabellifer*, *Schleichera oleosa*, *Senna timorensis*, teak (*Tectona grandis*), *Pterocarpus indicus*, and *Peltophorum pterocarpum*. Other common species were *Broussonetia papyrifera* and *Lepisanthese rubiginosa*. The understory was dominated by Siam weed and bellyache bush. The majority of the trees appeared to be deciduous in the dry season, apart from the palms. Vegetation has largely been cleared for a road and village running alongside the shoreline. A narrow strip of roadside plantings was also present between the beach and the road.





Plate 6-43 Moist deciduous forest



Plate 6-44 Pes-caprae formation





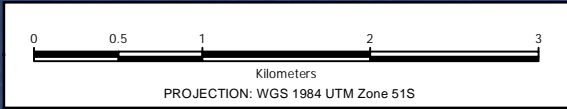
**LEGEND**

- Main road
- Minor roads and tracks
- River
- Betano development area**
- ▭ Refinery and petrochemical complex
- ▭ Nova Betano
- ▭ Jetty area
- ▭ Southern Power Plant\*
- Vegetation classification**
- ▭ Moist deciduous forest
- ▭ Secondary deciduous forest

**LOCATION PLAN**

Timor-Leste

Scale: 1:7,000,000



NOTES:  
 This map consists of:  
 1. Imagery: Digital Globe (2008-2011)  
 2. Rivers: GIGTimorLeste (2010)  
 3. Roads: DivaGIS (2010)  
 4. Vegetation communities: WorleyParsons (2012)

\*Not part of this scope

0	29/05/2012	FINAL FOR ISSUE	MW	CS	-	-	GH		A4 SHEET	SCALE 1:45,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
resources & energy		TIMOR GAS & PETROLEO		REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				Copyright © WorleyParsons Services Pty Ltd		

TASI MANE PROJECT - BETANO AND BEACO  
 TERRESTRIAL ENVIRONMENT TECHNICAL REPORT

**Figure 6-22**  
 Betano study area vegetation communities

LOCATION: \\PERVERM\H1\INFRASTRUCTURE\PROJECTS\301012-01504\ENVIRO\IMP\_ASSESSMENT\_TIMORLESTE\00\_ENGINEERING\GEMOAT\CS\303PROJ\CT\WORKSPACE\1\ST\SE\INDRAFT\301012\_01504\_SE1A\_BP194\_REV01.MXD

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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### *Riparian Vegetation*

Riparian vegetation was present on several drainage lines flowing towards the ocean within the Betano Refinery site. Several representatives of mangrove community species, including *Excoecaria agallocha* and *Lumnitzera racemosa* were recorded on the drainage lines. Tamarind (*Tamarindus indica*), *Pterocarpus indicus* and *Jatropha curcas* were common species on dry river beds.

### *Agriculture*

Within the Betano development area very small areas of land are used for agriculture or subsistence farming. The primary crops grown are corn, cassava, sweet potato, peanuts, long beans, papaya, watermelon and bananas. Grazing by cattle and pigs occurred in the refinery site.

### *Vegetation of Conservation Interest*

Remnant areas of moist deciduous forest are of conservation interest as they are poorly known and warrant further study. Within Nova Betano there is a large area of undisturbed forest with little disturbance and according to local guides this area is 'lulik' or sacred. Orchids and stag horn ferns (*Platyserium* sp.) were observed high in the canopy.

### **Flora**

These results focus on the dominant flora species, conservation significant flora, economically important flora species and weed species.

A total of 201 species were identified from collected material and photographs and a species list for the Betano development area is presented in Appendix 2 of Attachment 01.

A large number of species recorded in the Betano development area have a widespread distribution in the tropics. Several of these are weed species and several are considered to be naturalized species. Two species listed on the IUCN Red List as Vulnerable were recorded; *Pterocarpus indicus* and *Santalum album*.

### *Species of Conservation Interest*

Two Vulnerable listed flora species were recorded in the Betano development area, *Pterocarpus indicus* and *Santalum album*, which are both valuable timber species.

*Pterocarpus indicus* (Tetum ai-na) was present within the Betano development area on the banks of rivers and on hills slopes. It is a tall timber species, reaching 25 to 35 m, is a briefly deciduous tree and can be useful for soil stabilization and adding nitrogen to soil. Found in lowland primary and some secondary forest, native subpopulations have declined because of overexploitation of the timber and increasing general habitat loss. Cultivated subpopulations are widely distributed throughout the tropics.

Sandalwood (*Santalum album*) was present in very low numbers in the Betano development area as young trees only and not at the harvestable stage.

There are 36 plant species listed on the IUCN Red List as being of Least Concern for Timor-Leste, and these are considered to have a low risk of extinction (Appendix 3 of Attachment 01). One of these



**STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT  
BETANO PETROLEUM REFINERY AND BEACO LNG PLANT**

species was recorded during the field survey in the Betano development area, *Acanthus ilicifolius* (Holly Leaf Mangrove).

The low number of plant species listed for Timor-Leste as Least Concern on the Red List (compared to the number of plant species occurring in Timor-Leste) is likely to be a reflection of the limited assessment carried out on plants in the area.

*Casuarina* sp. trees were recorded at Betano; however, in a different vegetation community to that recorded in the Suai development area. *Casuarina* trees were recorded as scattered trees in open coastal vegetation at Suai, and in more dense secondary deciduous forest at Betano. It is likely that the *Casuarina* trees are only important habitat trees within the Suai development area where the Yellow-crested Cockatoo was recorded.

*Species of Economic Importance*

Eleven species were identified in the Betano development area as having local and economic importance. These species are listed below in Table 6-29.

Small plantations or estates of coconuts, bananas, and occasionally mango were present in the Betano development area. The ownership of trees within estates may be external to local villages.

**Table 6-29 Species of local importance and/or economic interest in the Betano development area**

Common Name	Scientific Name	Tetum Name	Use/Importance
Coconut	<i>Cocus nucifera</i>	nú	Food
Banana	<i>Musa</i> spp.	hudi	Food
Breadfruit	<i>Artocarpus altilis</i>	kulu modo	Food
Mango	<i>Mangifera</i> spp.	has	Food
Candlenut	<i>Aleurites moluccana</i>	Kemiri or cami	Food
Cinnamon	<i>Cinnamomum</i> sp.	ai-canela	Spice
Teak	<i>Tectonia grandis</i>	ai-teka	Timber
Gmelina	<i>Gmelina arborea</i>	Gmelina, ai-teka Malaysia	Timber
Cassod tree	<i>Senna siamea</i>	ai-johar	Timber
Sandalwood	<i>Santalum album</i>	ai-cameli	Timber
Rosewood, Narra	<i>Pterocarpus indicus</i>	ai-na	Timber

## Teak Plantations/Woodlots

Small plantations or woodlots of teak were observed at the Betano development area.



### STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

#### Weeds/Invasive Species

A total of nine major weed species were identified in the Betano development area, as listed below in Table 6-30.

**Table 6-30 Major weed species identified in the Betano development areas**

Weed Species	Common Name	Tetum Name
<i>Chromolaena odorata</i>	Siam weed	ai-funanmutik
<i>Imperata cylindrica</i>	Cogon grass	pae
<i>Leucaena leucocephala</i>	Coffee bush	ai-café
<i>Lantana camara</i>	Lantana	ai-funan meak
<i>Acacia nilotica</i>	Prickly acacia	bakuro malae, ai-tarak
<i>Chrysopogon aciculatus</i>	Golden false beardgrass	du'ut
<i>Jatropha gossypifolia</i>	Bellyache bush	miro
<i>Calotropis gigantea</i>	Crown flower	fuka
<i>Stachytarpheta cayennensis</i>	Snakeweed	-

Siam weed was the most widespread weed throughout the Betano development area. It is a highly invasive weed, estimated to cover more land than any other plant species in Timor-Leste (Cowie, 2006 and 2007 in Attachment 01), and affects about one-fifth of all cropland (World Bank, 2009 in Attachment 01).

#### Fauna

##### Fauna Habitat

Four broad habitat types were identified in the Betano development area and these include:

- Deciduous Woodland/Forest: Woodland is defined as trees and shrubs that are less than 30% of the tree canopy cover.
- Coastal: Includes three subclasses; Mangrove forest, Dune forests – mixed species and Coastal dunes and reef platforms.
- Riparian: Includes drainage lines (major and minor), drainage basins, creek lines and water catchments, associated vegetated banks.
- Swidden Agriculture: Includes man-made plantations and associated fringing vegetation and habitat.

##### Fauna Assemblages

Fauna assemblages were collated from the desktop review. Many of the species identified from the desktop assessment are unlikely to occur in the study areas on a regular basis since the desktop research considered a wide range of habitats. The vertebrate fauna list is presented in Appendix 5 of the Terrestrial Ecology Technical Report (Attachment 01).



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

Within the Betano development area, a total of 60 vertebrate fauna species were recorded, including 7 species of reptiles, 40 species of birds and 13 species of mammals. These are discussed below.

### Reptiles

Seven species of reptiles were identified in the Betano development area, including; Tokay (*Gekko gekko*), Asian house gecko (*Hemidactylus frenatus*), common wolf snake (*Lycodon capucinus*) and the saltwater crocodile (*Crocodylus porosus*).

### Birds

Forty species of birds were identified within the Betano development area. The most common species included the spotted dove (*Streptopelia chinensis*), the barred dove (*Geopelia maugei*) and the streak-breasted honeyeater (*Meliphaga reticulata*). The two most common families were the *Columbidae* (pigeons and doves) and the *Meliphagidae* (honeyeaters).

### Mammals

Thirteen species of mammal were recorded in the Betano development area, including: domestic dog/dingo (*Canis familiaris*), domestic pig (*Sus scrofa*), Bali cattle (*Bos javanicus*), domestic cattle (*Bos taurus*) and the domestic goat (*Capra hircus*).

### Bats

Five species of bats were recorded in the Betano development area, including the Canut's Horseshoe Bat (*Rhinolophus canuti*) which is listed as Vulnerable on the IUCN Red List, and the Little Long-fingered Bat (*Miniopterus australis*) which is listed as being of Least Concern. The bat analysis results are presented in further detail in Appendix 6 of the Terrestrial Ecology Report (Attachment 01).

### Conservation Significant Fauna

The desktop review identified 35 species of conservation significance that either had the potential to occur, or had been previously recorded, in Timor-Leste.

Six of these species were recorded in the Betano development area in the recent field survey, with the remaining 29 species either being 'Likely', 'Possible' or 'Unlikely' to occur in the development area (Figure 6-21). The conservation status of the six recorded species is listed in Table 6-31.

**Table 6-31 Conservation status of the fauna species recoded during the field survey**

Common Name	Conservation Status (IUCN Red List of Threatened Species)
Canut's horseshoe bat	VU (Vulnerable)
Slaty cuckoo dove	NT (Near Threatened)
Timor (white-bellied) bushchat	NT (Near Threatened)
Olive-shouldered parrot	NT (Near Threatened)
Cinnamon banded kingfisher	NT (Near Threatened)
Pink-headed imperial pigeon	NT (Near Threatened)



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### *Endemic Fauna*

Timor-Leste has the highest rates of endemism recorded in Indonesia (10.3%), especially for frogs, skinks and geckos. The yellow-crested cockatoo, Timor white eye and the black banded fly catcher are all endemic to Timor-Leste.

### **6.8.3 Environmental Impacts**

This strategic level assessment is focussed on the identification of existing ecological values at the proposed Betano development site. Whilst the area to be cleared for the proposed infrastructure is not known, it is intended that the areas of conservation significance and habitat value identified through detailed baseline assessment, could be avoided during the infrastructure design stage.

Potential environmental impacts for flora, vegetation communities and fauna as a result of construction and operations, include, but are not limited to:

- Loss of individuals of IUCN listed species; Santalum album (sandalwood) Pterocarpus indicus (rosewood), both valuable timber trees.
- Loss of floristic biodiversity that has not been documented.
- Secondary weed invasion after clearing, particularly Siam weed and cogon grass.
- Loss of forest and tree cover.
- Loss of remnant areas of undisturbed moist deciduous forest.
- Loss of agricultural land and subsistence gardens.
- Loss of food crops and estates e.g., coconuts, bananas.
- Loss of timber for fuel source.
- Loss of cash crops e.g., teak, rosewood and sandalwood.
- Loss of fauna habitat, specifically important habitat for species of conservation significance.
- Increased potential of vehicle strike due upon vertebrate fauna species.
- Increased potential of noise disturbance to vertebrate fauna species, particularly nesting and roosting individuals.
- Increased potential of habitat fragmentation.
- Increased erosion potential and sedimentation due to soil disturbance.

### ***Impacts to Conservation Significant Species***

Species listed as Critically Endangered, Endangered, Vulnerable and Near Threatened under the IUCN Red List constitute species as having conservation significance. A lack of baseline data of Timor-Leste's flora and fauna indicates that not all occurrences of conservation significant species have been assessed by the IUCN. There is a possibility that further species within the Betano development area may be considered to have conservation significance.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Two Vulnerable listed flora species have been recorded in the Betano development area to date, *Pterocarpus indicus* and *Santalum album*, which are both valuable timber species. Six fauna species of conservation significance were recorded in the study area as reported previously in Section 6.8.2, including Canut's horseshoe bat listed as Vulnerable and five birds listed as Near Threatened.

In addition, moist deciduous forest communities in the Nova Betano study area represent some of the only remnant vegetation in good condition and are considered to have conservation significance.

### 6.8.4 Avoidance, Management and Mitigation Measures

#### ***Retention of Native Vegetation and Habitat***

The loss of vegetation within the Betano development is a likely consequence of the construction process. The potential impact of these alterations can be further reduced by avoiding sensitive and high conservation value habitats when selecting the development location.

Mitigation measures should be developed for construction works to reduce the extent of vegetation clearance. A reporting and responses system will be implemented to ensure that vegetation clearing activities are controlled and monitored.

It is recommended that riparian vegetation be preserved and rehabilitated to reduce erosion and maintain current flow patterns of rivers. To reduce soil erosion, those areas not in use within the Betano development area can be rehabilitated and revegetated.

#### ***Moist Deciduous Forest***

Construction will unavoidably remove some areas of remnant moist deciduous forest and the faunal communities they contain. The potential impacts on vegetation communities will be limited through the control of vegetation clearance.

#### ***Weed Hygiene***

Weed hygiene practices should be adopted to reduce spread of weed seeds, and weed control measures to reduce the colonisation of weed species within the development area.

Protocols should be developed into an invasive weed management plan and incorporated as part of the environmental management system for the Betano development area.

#### ***Vertebrate Fauna***

While the habitats in the Betano development area are already fragmented and degraded, a lack of baseline data indicates that it is possible that not all habitats have been assessed and therefore, potential impacts to fauna could result. There is also a potential for impacts from increased vehicle traffic and noise disturbance. Additional fauna surveys are required (Section 6.8.6) to gain a detailed understanding of the habitats in the study area and the level of ecological linkage with the surrounding vicinity.





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 6.8.5 Monitoring and Reporting

The monitoring and reporting measures for flora and fauna during construction and operations include:

- A multiple season baseline flora, vegetation and fauna assessment of the remnant vegetation is recommended.
- Surveys undertaken at different seasons during the year to record different fauna species assemblages and to capture fruiting and flowering patterns.

### 6.8.6 Further Work

#### *Flora and Vegetation*

It is recommended that additional baseline flora and vegetation assessments are undertaken at the Betano development area, including:

- Quadrat sampling to define floristic composition and structural form of each vegetation community, particularly in mangrove and moist forest vegetation.
- Developing a checklist of flora species, including annual herbs, ferns, epiphytes, mosses, bryophytes and parasitic plants to record floristic diversity.
- Completing vegetation mapping to a scale of 1:10,000.
- Undertaking field work at other times of the year to detect a full range of species.

#### *Fauna*

It is recommended that additional fauna surveys are undertaken across seasons. It is also recommended that the duration of field trips are extended to ensure a more thorough survey. This will increase the likelihood that potentially critically endangered species are recorded.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### 6.9 Marine Ecology

WorleyParsons undertook a marine ecology assessment of the Betano development area in December 2011 and February 2012. The full report is presented as Attachment 2.

There are several laws and regulations from previous administrations (UNTAET and Indonesian) that concern environmental protection and biodiversity conservation in Timor-Leste:

- Law No. 5, 1990 on Conservation of Biological Resources and their Ecosystems.
- Law No. 5, 1994 Concerning Biodiversity.
- Government Regulation No. 28, 1985 on Forest Protection.
- Government Regulation No. 51, 1993 on Environmental Impact Analysis.
- United Nations Transitional Administration in East Timor (UNTAET) Regulation No. 2000/17.
- United Nations Transitional Administration in East Timor (UNTAET) Regulation No. 2000/19.

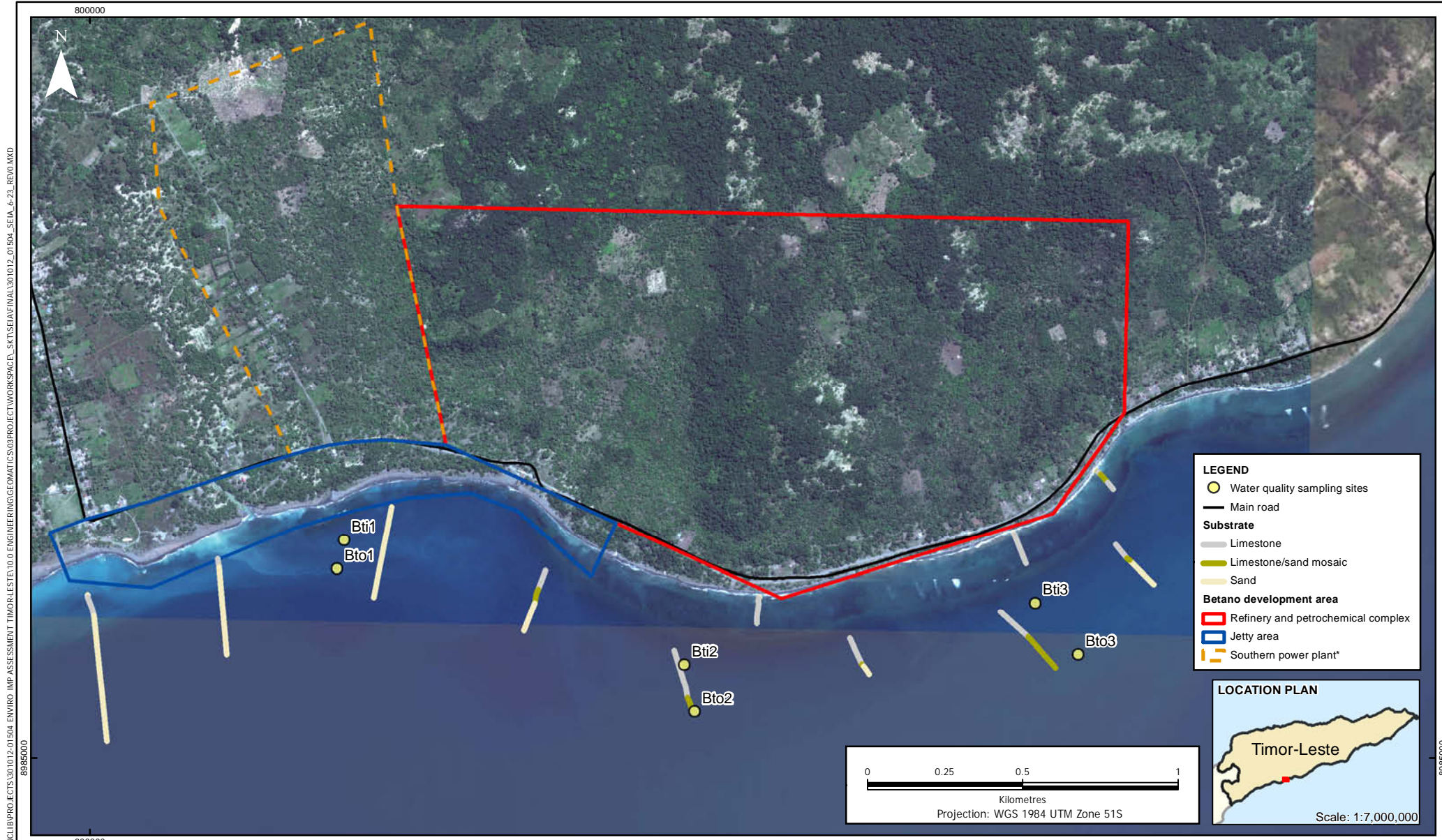
UNTAET Regulation No. 2000/19 on protected places (30 June 2000) was established for the purpose of protecting designated areas, endangered species, wetlands, mangrove areas, historic, cultural and artistic sites, conservation of biodiversity and protection of the biological resources of East Timor. Fifteen natural areas were protected under this regulation and have been designated as Protected Natural Areas (PNAs). The majority comprise primary forest areas, coral reefs, mangroves, wetland habitat and mountain summits above 2,000 m.

UNTAET Regulation No.2009/19 on protected places, and the following Indonesian Laws; Law Number 23/1997 on Environmental Management and Government Regulation No51/1993 on Environmental Impact Assessment are presented in Appendix G as requested by SERN, however it is understood that this legislation may have been superceded by Decree No.5/2011 on Environmental Licencing.

#### 6.9.1 Study Method

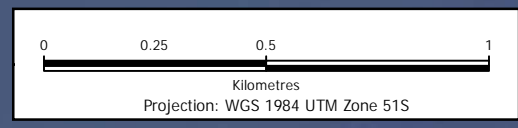
A total of three inshore and three offshore sediment and water quality samples were collected at sites adjacent to the proposed refinery and petrochemical complex at Betano (Figure 6-23). All sampling was undertaken on the 19 December 2011. Inshore sites were located between 8 to 10 m depth. Offshore sites were between 20 to 35 m depth.

Video footage was collected over a three day period between the 20 and 22 February 2012. Towed video footage was used to obtain information on the marine benthic habitat present at the study site.



**LEGEND**

- Water quality sampling sites
- Main road
- Substrate**
- Limestone
- Limestone/sand mosaic
- Sand
- Betano development area**
- Refinery and petrochemical complex
- Jetty area
- Southern power plant\*



NOTES:  
 This map contains:  
 1. Imagery: Digital Globe (2008-2011)  
 2. Imagery: Google Earth (2010)  
 3. Roads: DivaGIS (2010)  
 4. Substrate: WorleyParsons (2012)

\*Not part of this scope

0	29/05/2012	FINAL FOR ISSUE	MW	CS	-	-	GH		A4 SHEET	SCALE 1:17,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
				REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				Copyright © WorleyParsons Services Pty Ltd		

**TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT**

**Figure 6-23**  
 Betano water quality and marine tow locations

LOCATION: \\PERVORIEL\TIMES\TRUCLIB\PROJECTS\301012-01504\_ENVIRO\_IMP\_ASSESSMENT\TIMOR-LESTE\10\_ENGINEERING\GEO\MATIGS\03PROJECT\WORKSPACE\SKTS\SEINF\NAL\301012-01504\_SEIA\_6-23\_REV0.MXD  
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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### ***Water Quality***

A physicochemical water quality profile was obtained by recording measurements at 1 m intervals from the water surface to the seabed at each of the sampling sites. Two depth profiles were recorded at each sampling site.

The following parameters were measured:

- Temperature (°C).
- Salinity (parts per thousand (ppt)).
- pH.
- Conductivity ( $\mu\text{S}\cdot\text{cm}^{-1}$ ).
- Dissolved oxygen (DO; % saturation and  $\text{mg}\cdot\text{L}^{-1}$ ).
- Turbidity (nephelometric turbidity units [NTU]).

At each sampling site, a mid-water column sample was also collected using a 1L Van Dorn sampler. Each sample was transferred into parameter specific sample bottles and placed on ice. Parameters tested were:

- Total metals [cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), lead (Pb), nickel (Ni), zinc (Zn)].
- Dissolved metals (Cd, Cr, Cu, Hg, Pb, Ni, Zn), ammonia, total nitrogen, total phosphorus, TPH, PAH, BOD, TSS, E.coli, chlorophyll, nitrate, nitrite, TKN, reactive phosphorus.

As no water quality guidelines exist for Timor-Leste, ANZECC/ARMCANZ guidelines (2000) for marine environments (Tropical Australia) were adopted for water quality monitoring, analysis and reporting. All toxicants were compared to the 99% species protection trigger levels (Appendix H).

### ***Sediment Quality***

Surface sediment samples (0 to 0.3 m) were collected using a Van Veen grab sampler. The Van Veen sampler was lowered to the seabed before being retrieved with a grab sample. Sediment samples were then geophysically logged. Each sample was then stored at 4°C and couriered to a NATA – accredited laboratory for analysis.

Parameters identified for laboratory analysis were developed based on likely contaminants to be encountered during construction and operation of the jetty and associated facilities. Sediment samples were analysed for the following parameters:

- Metals (Al, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni and Zn).
- Nutrients (nitrate, nitrite, total nitrogen, total phosphorus and sulphate).
- Particle size distribution (PSD).

As no sediment quality guidelines exist for Timor-Leste, the interim sediment quality guideline (ISQG) found in ANZECC/ARMCANZ (2000) was used to assess sediment quality. Laboratory results were



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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collated, concentrations were tabulated and any spatial trends identified. All values were then compared with relevant sediment quality criteria.

As part of the NATA requirements, the laboratory analyses for water and sediment quality included quality control testing of samples, including duplicate samples (the same sample analysed more than once), blanks (containing no levels of the analytes to be analysed), spiked samples (containing known additions of the analytes to appropriate matrices) and standard samples (samples containing known concentrations of the analytes - also known as reference standards). All samples were analysed within laboratory holding times.

### ***Benthic Habitat***

Video transects ranging between 300 to 500 m extended vertically from the shoreline in order to characterise the marine benthic habitat present at the site (Figure 6-23). Each transect commenced in a depth of approximately 2.5 m extending out to the 10 m depth contour. A total of eight transects were completed distanced approximately 600 m apart, covering approximately a 6 km section of coastline.

For the purpose of generating a habitat map, biota was defined as:

- Hard coral.
- Invertebrates.
- Algae.
- Seagrass.
- Substrate was classified as sediment (soft) or reef (hard).

### ***Plankton***

A plankton net was towed behind a vessel travelling at <1 knot over a 100 m transect at each site. Once the sample had been collected in the sieve, the contents were then transferred to a sample vial. Ethanol (100%) was added to the vial to preserve the sampled larvae.

Following treatment, the entire sample was placed in a Ward Counting Wheel, with the corresponding site label. The Ward Counting Wheel was placed under a Stereo-Microscope (Olympus SZ61 Microscope) and slowly turned under the microscope allowing the fauna to be counted and identified. Taxonomy identification was conducted using the most up-to-date references available for the geographic region. The total sample volume was sorted for plankton, fish eggs and fish larvae.

### ***Infauna***

Surface sediment samples (0 to 0.3 m) were collected using a Van Veen grab. A total of three replicates were collected per sample location.

Macroinvertebrate samples were processed and fauna identified at Benthic Australia laboratories. Following washing and sorting, the specimens were placed into a small petri-dish for taxonomic identification under a stereo-microscope (Olympus SZ61 Microscope). Taxonomy was conducted using the most up to date references available for the geographic region.





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Statistical analysis of the plankton and marine benthic fauna was conducted using the methods and software packages as outlined in Section 3.5.3 of the Marine Ecology Technical Report (Attachment 2).

### ***Data Assumptions and Limitations***

The strategic level assessment is based on a draft conceptual layout of the proposed refinery and petrochemical complex. As the layout will be subject to further design, the assessment should be considered preliminary in nature and subject to further assessment as the proposed development, notably the configuration of the jetty, is further developed and additional baseline information is collected. As an example, dredging requirements were not known at the time of assessment.

Data collection is also based on a limited field survey undertaken during the wet season.

### **6.9.2 Existing Environment**

The southern Timor-Leste coastline consists of a combination of sandy beaches and limestone rock ledges that extend from the shoreline as intertidal reef flat areas that then slope down steeply towards the seabed. In some places along the southern coastline, water depths of 200 m can be found less than 1 km offshore. The sandy beaches consist of medium to fine sand with silt. During heavy rains, sediments are mobilised from the surrounding catchment and enter the ocean causing large sediment plumes. Aerial photographs associated with the Betano area show turbid plumes moving from east to west along the coastline.

#### ***Water Quality***

Water quality assessment was based on a single sampling event on the 19 December 2011. Few trends were apparent at Betano, across sites or between offshore and inshore sites. This is indicative of well mixed waters and a relatively constant water quality.

Turbidity results obtained from 4 of the sampling sites show no apparent trends with all values falling within the ANZECC/ARMCANZ (2000) guidelines for turbidity (1-20 NTU).

Concentrations of nutrients were generally below the laboratory's limit of reporting (LOR) for all nearshore and offshore sites, with the exception of ammonia and total nitrogen. Ammonia levels were found to be in exceedance of the recommended ANZECC/ARMCANZ (2000) trigger level at all sites. These elevated levels are likely the result of fertiliser use within the predominantly agricultural catchment.

Concentrations of total and dissolved metals were generally low for most parameters across all sites and were mostly less than the limits of reporting, with the exception of total and dissolved copper concentrations which exceeded the ANZECC/ARMCANZ (2000) guidelines in a number of instances.

Copper is considered a naturally occurring metal in the marine environment, particularly from rivers and from ocean sediments, therefore high concentrations observed may indicate copper concentrations are likely to be naturally high.

It is important to note that anthropogenic activities such as land clearance, deforestation and land use change that exacerbate runoff and subsequent relative volumes of riverine particulate matter, can add to the total copper loads entering the marine environment. Such terrestrial activities are apparent in



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the catchments of Timor-Leste, including those of the Caraulun River catchment which is the major riverine system in the Betano region. Without further temporal and spatial investigations, no inference can be made as to the relative contribution of anthropogenic sources to naturally derived copper concentrations within marine waters.

Hydrocarbons within the water column were recorded at levels less than the LOR at both sites, and this is indicative of an environment largely free from human-induced hydrocarbon sources such as oil spillages (boats, tankers) or land-based runoff from built infrastructure.

### ***Sediment Quality***

Concentrations of total nitrogen and phosphorus were relatively high in coastal sediments. Total nitrogen concentrations observed at all sampling sites were comprised of 100% organic nitrogen (TKN) which indicates that nitrogen found in sediments within the study area are of organic origin. Nutrient levels within marine sediments at Betano are largely influenced by the accumulation of organic matter on the seabed, and this is most likely derived from particulate matter transported via riverine inputs as sediments fall out of suspension in the water column. Nutrient concentrations in sediment also tend to *increase* with *decreasing* grain size as the proportional surface area of finer sediments is greater and organic matter is more readily absorbable onto mineral surfaces.

All sedimentary metal concentrations were below the ANZECC/ARMCANZ (2000) sediment quality guidelines with cadmium, lead and mercury also below the LOR. No distinct trends were apparent between offshore and inshore sites.

Sedimentary hydrocarbons were also recorded at levels less than the LOR at both sites.

Particle size distribution of the sediments at Betano followed general expectations, with shallower inshore sites dominated by sand granules and deeper offshore sites containing a greater relative proportion of fines. Fine sediments are likely sourced from riverine inputs, with fines being transported further out to sea than coarser material and eventually settling in deeper areas offshore. The presence of gravel, particularly at inshore sites, suggests that these sites are located in close proximity to rock or reef systems.

### ***Fauna and Habitat Values***

The benthic habitat within the study area is dominated by sediment. Given the high elevation and seasonal rainfall in catchments draining to the south coast of East Timor, a natural high flux of fluvial sediments occurs. In addition, deforestation in the region, which is evident to varying extents in aerial photographs, is likely to have enhanced sediment supply.

The fringing reef identified adjacent to the Betano study area is typical of the fringing reef systems found in South East Asia (Burke et al. 2002). The reef generally consisted of a low diversity reef flat which falls steeply into deep water. From the reef flat, the substrate graded into a limestone/sand mosaic and then into unconsolidated sand with increasing distance from the shoreline. The profile of the substratum offshore from the reef flat was relatively steep, with a depth of 30 m found 200 m offshore.

The greatest coral diversity was generally found within 3 to 8 m of the surface which then gradually declines below 8 m as depth increases and light diminishes (Plate 6-45).



Plate 6-45 Coral reef adjacent to the Betano footprint area



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A wide variety of algae types also occur in the study area including turfing, brown, red, green and coralline species. Gorgonians, sea whips, sponges and crinoids were the dominant invertebrates present. The observed distribution of each of the biota classes along the surveyed transects is provided in Figure 6-24. This map also shows the distribution of substrates, demonstrating good correlation between the biota types and the occurrence of hard substrate, across the study area.

The macroinvertebrate communities during the baseline sampling event were species rich in polychaetes and crustaceans. It is common for either polychaetes or crustaceans to be the dominant benthic fauna in sandy sediments from the Australasian region (Long & Poiner, 1994; Currie & Small, 2005).

### 6.9.3 Environmental Impacts

Activities associated with construction and operation of the Betano Refinery and Petrochemical Complex that have the potential to adversely affect the marine environment include:

- Construction and physical presence of new marine structures within the marine environment.
- Dredging and reclamation activities.
- Operation of the desalination plant.
- Operation of the wastewater treatment plant.
- Construction and operational aspects associated with spills, discharges and runoff.

The activities outlined have the potential to impact marine communities through the following:

- Changes to local hydrodynamic and coastal processes.
- Changes to water quality.
- Changes to sediment quality.
- Direct and indirect changes to benthic habitats and infaunal communities.
- Changes to fisheries resources.

#### **Water Quality**

##### *Suspension of Sediments*

Many aspects of the construction process would disturb and resuspend benthic sediments, including:

- Rock placement for breakwater construction.
- Land reclamation and shore protection.
- Pile driving for jetties.
- Pipeline installation for discharge outlets.
- Dredging.
- Other in-water construction activities.









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During port operation, ship wash (waves) and propeller turbulence in shallow water can erode the shore and disturb the seabed, resuspending sediments, creating turbid water. Areas with intense vessel traffic, e.g., the harbour entrance and vessel turning basins, will be more heavily impacted.

Dredging may be required to achieve a safe navigation depth into the Betano jetty area. The volume, type of dredged material and dredging method have not yet been defined but will require further consideration to ensure that potential impacts are kept as low as reasonably practicable.

Impacts from dredging are primarily related to sedimentation and turbidity effects on benthic primary producers e.g., corals and seagrass, which can lead to indirect impacts on other species reliant on these habitat types for food, shelter and breeding. Ambient levels of turbidity and sedimentation are likely to be high along the Betano coastline, particularly during the wet season and will require further consideration in defining water quality trigger levels for dredging.

Maintenance dredging is expected to be required, although the frequency and volume are yet to be determined as they are dependent on the rate of sediment accumulation associated with the proposed jetty structure. The resuspension of sediments can arise due to seabed excavation, loss from the dredger whilst loading, loss of material during transport and the disposal of dredged materials. The intensity and extent of impact will depend on the frequency and volume of dredging and the method of dredging and material disposal.

The resuspension of sediments in the water column reduces water quality due to:

- Increased concentration of suspended solids.
- Reduced light penetration.
- Increased nutrient concentration through the mobilisation of organic material, biologically available nitrogen and phosphates from the sediment.
- Increased concentrations of toxicants including heavy metals and organic compounds from sediments.

These changes in water quality can have physical, chemical and behavioural effects on marine biota (Anchor Environmental C.A. L.P., 2003), including:

- Changes in respiration and clogging of respiratory structures.
- Changes in feeding rates and clogging of feeding structures in suspension feeding organisms.
- Reduced growth rates and reproductive success due to sediment loading.
- Increased growth due to higher nutrient availability.
- Contamination and poisoning from the accumulation of heavy metals and organic compounds.
- Slowed photosynthesis and primary production due to reduced light penetration in the water column.
- Altered behaviour, such as avoidance, altered schooling behaviour, cover abandonment, or attraction (as a potential food source or cover).



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Sediments within the study area are generally uncontaminated, with the levels of cadmium, chromium, copper, lead, zinc and mercury all well below ANZECC trigger values for sediment quality (ANZECC/ARMCANZ (2000)). No impacts from mobilised contaminants are expected.

Sediments within the study area have relatively high concentrations of nitrogen (up to 160 mg/kg) and phosphorus (up to 353 mg/kg). The mobilisation of nutrients may cause a rapid increase in phytoplankton abundance leading to depleted dissolved oxygen. In open waters, currents will rapidly replenish oxygen and any impacts will likely be short-lived. In areas of low water movement, mobilisation of nutrients may lead to eutrophication.

### *Discharges, Spills and Runoff*

Discharges, spills and runoff can all reduce water quality. During construction, discharges or spills may occur from construction vessels and runoff from land-based construction areas. During operation, vessels and cargo handling are sources of runoff, discharges and spills into the marine environment. Most reported oil spills occur within port and harbour areas, most are small and result from normal operations such as loading and refuelling (e.g., WA EPA, 2007b). They often arise due to faulty equipment, poor procedures and accidental or intentional discharges of wastes.

Discharges may include oily bilge and ballast water, sewage and other wastes. Spills may include lubricants, hydraulic oils, fuels and paints. Site runoff during construction would typically be sediment laden water, but may also be contaminated with concrete, paints and oils. Operational site runoff may be contaminated by spilt fuel, bulk product, paint residues and sediment.

Spills and discharges impact water quality and marine ecosystems. Spilt oils initially float, forming a thin surface layer that can quickly spread over a large area. Oils and other substances can be acutely toxic to marine biota and may contaminate fisheries resources. Repeated small spills and discharges lead to the accumulation of hydrocarbons in surface waters and sediments. Repeated small spills can have chronic effects on marine biota, including reduced growth and reproduction, ultimately reducing population viability (e.g., Dicks et al, 1982; Guzmán and Holst, 1993). The biodegradation of oil consumes dissolved oxygen from the water further reducing water quality and this can have additional impacts on marine biota.

### *Desalination Plant Operation*

The potential environmental effects of reverse-osmosis (RO) desalination plants have been widely studied and summarised (see Tularam and Ilahee, 2007; RPS, 2009). Impacts on water quality and marine ecosystems are primarily related to the discharge. No details about the Betano RO plant are currently available.

Brine discharged by RO plants typically has a salt concentration twice that of seawater. The discharge may also have a slightly elevated temperature (<2°C above ambient) and contain traces of anti-scalants, flocculants, biocides and cleaning chemicals used in the plant. The brine is denser than seawater and generally sinks from the point of discharge. Consequently, any impact on water quality and marine life is more likely to occur in bottom waters and on the seabed. The long term effects of the discharge of trace chemicals are largely unknown, however elevated salinity is generally considered the primary environmental stressor. High salinity may be acutely toxic, causing dieback of



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marine biota at the outlet. Exposure to slightly elevated salinity in the area adjacent to the outlet may have chronic effects on marine biota, leading to a gradual shift in community structure.

The intensity and extent of impact from the discharge are highly dependent on the volume and concentration the discharge, and the rate of dilution. The rate of dilution is in turn dependent on the situation and design of the outlet, and turbulence in receiving water caused by currents, waves and tides. Rapid dilution reduces the risk of intense impact, but increases the area of low risk.

When discharges are released to a well-flushed environment, the impacts of even large desalination plant discharges tend to be minor (Roberts *et al*, In Press). The planned small RO plant, with low volume discharge, is unlikely to have any acute salt toxicity or chronic exposure effects, provided there is adequate dilution and dispersal of the discharge.

### *Wastewater Treatment Plant Discharge*

Water quality may be impacted by the long-term discharge of pathogens, nutrients and toxicants in treated wastewater.

Effluent from wastewater treatment plants typically contains viruses, bacteria and other microorganisms and its discharge may lead to unsanitary water quality. The magnitude of contamination depends on the level of treatment employed. Primary treated effluent can have a bacterial load of up to 10 million colony forming units (cfu) per millilitre. Secondary treated sewage typically contains 1000 to 10 000 cfu per millilitre. With an active disinfection process, this can be reduced further to less than 100 cfu per 100 millilitres. This level of treatment is suitable for subsurface irrigation (EPA VIC, 2002) but in the marine environment may pose a threat of disease transmission through primary contact recreation and the contamination of shellfish fisheries.

The primary impact of the discharge on marine biodiversity is likely to be through increased nutrient loading. Treated wastewater contains nitrogen and phosphorus. Increased nutrient concentrations can cause increases in phytoplankton biomass, changes in species composition and impact other marine biota.

If chlorination is used as a means of effluent disinfection, residual chlorine may be acutely toxic to marine life at concentrations as low as 0.01 milligrams per litre (DEH, 1991). The use of chlorine can also lead to the formation of toxic chlorinated organic compounds which will potentially bioaccumulate in the environment.

The treated wastewater is likely to contain low concentrations of toxicants such as heavy metals, organochlorines and hydrocarbons. The long-term discharge may lead to reduced water quality, contamination of fisheries resources and the accumulation of toxicants in sediments.

The wastewater discharge may also contain heated effluent where cooling water is required as part of the refining process. Temperature can be an important determinant of species abundance and distribution within the marine environment. Major adverse effects of waste heat occur close to the point source, although subtle effects may be evident further away where only a 1 or 2°C difference in ambient temperatures can elicit behavioural or physiological responses in some organisms (Kennish 1990). Impacts are most likely to develop in shallow, enclosed and poorly mixed bodies of water. In most cases, motile organisms are able to avoid the unfavorable discharges by swimming away, whereas sessile species are vulnerable to exposure.



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### *Sediment Transport and Quality*

#### *Changed Hydrodynamics and Sedimentation Regime*

Construction of a jetty structure is proposed at Betano to facilitate the import and export of feedstock product (i.e raw materials) for the refinery.

No design details for the proposed structure have been provided, however a typical jetty would be a trestle structure constructed using steel piles. The structure will be a suitable length to accommodate ships of a particular design size. By constructing the jetty into a suitable depth of water, requirements for dredging may also be minimised or avoided altogether. Geotechnical conditions on the seabed will determine the method of piling required. Underwater blasting to assist piling is not currently proposed but may be required if sub-surface material is very hard.

The major impacts from jetty construction are likely to be noise and disturbance from pile driving and associated activity e.g., anchoring of floating plant. There would also be localised short term turbidity from pile driving and boat movements (including anchoring).

Impacts on coastal processes are likely to be minimal if the jetty is an open trestle structure.

#### *Impacts from Turbidity and Sedimentation*

Jetty construction has the potential to generate increased turbidity and sedimentation, but these increases will be extremely localised and transitory in nature. The main source of turbidity generation will be from the pile driving. Water movement in the coastal environment from currents and wind are significant and any plume generated is unlikely to persist.

#### *Impacts from Noise*

The noise associated with jetty construction is usually dominated by intermittent high levels of impulsive sound generated by piling which is caused by ramming of a hammer onto the pile (CoA 1996). This level of noise is readily transmitted underwater and will most likely deter mobile species such as fish from approaching the construction area. Other sessile forms including corals are unlikely to be affected by noise.

#### *Discharges, Spills and Runoff*

As discussed previously, spills, discharges and contaminated runoff may occur during construction and operation of the jetty. These may reduce sediment quality as well as water quality. Major spills, repeated small spills and ongoing discharges can lead to the accumulation of contaminants such as petroleum hydrocarbons, metals, organochlorines and organic materials in sediments. These substances can contaminate fisheries resources and have toxic effects on marine biota, including slowed growth and poor reproductive success of individuals (e.g., Dicks et al, 1982; Guzmánand Holst, 1993). Infaunal assemblages in contaminated sediments typically have lower species richness and diversity (Johnston and Roberts, 2009).

#### *Antifoulant Contamination of Sediments*

Antifouling coatings are used to prevent biofouling on vessels and some marine structures. These coatings are usually toxic to marine biota in very low concentrations and also have implications for



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human health. Vessel cleaning and the application or removal of antifouling coatings either in maintenance facilities or in-water can lead to the contamination of sediments and fisheries resources, and have lasting effects on marine ecosystems.

A widely used antifoulant, organotintributyltin (TBT) was recently banned, and the use of some other toxic antifoulants restricted, in countries that adopted the *International Convention on the Control of Harmful Anti-fouling Systems on Ships* (IMO, 2001). However, these chemicals may still persist on older vessels and those originating from non-signatory countries. TBT causes deformation and imposex in marine gastropods and has been linked to mortality in higher order predators (Daffronet *al*, 2011).

### ***Benthic Habitat***

The construction of the jetty and marine facilities will disturb areas of seabed through the following activities:

- Construction of a shipping berth and jetty.
- Land reclamation for construction of material offloading facility (MOF).

At this stage, it is unclear whether dredging will be required.

There will be a permanent loss of marine habitat associated with infilling and reclamation works. Construction of the jetty and other maritime structures will also result in the loss of soft bottom habitat, however the presence of the jetty, berth and pilings will provide new hard substrate for the settlement and colonization of marine organisms.

Most of the construction activities, including dredging (if required), will cause localised direct impacts to a combination of soft bottom benthic communities and rock pavement habitat both of which presently occur in the intertidal and shallow subtidal zones of the project area. Disturbed areas will be recolonised by locally occurring marine species, that occur in adjacent intertidal and subtidal habitats.

Some land reclamation along the shore may be required to construct the MOF which will remove further habitat from the marine environment.

### ***Infauna***

Only relatively small areas of infauna and associated sandy benthic habitat are likely to be directly impacted by construction activity.

Depth, water quality, sediment quality and sedimentation rates are important determinants of infaunal community structure. Changes in these parameters may result in altered community composition, as different groups of taxa are more suited to different environmental conditions. For example, bivalves are generally less abundant in high sediment-suspension/deposition environments, while some crustacea and polychaete worms are more prevalent (Anderson *et al.*, 2004).

Within the study area, waters are naturally turbid due to the discharge of nearby rivers. Seasonal storms, cyclones and monsoonal flooding are common. The communities inhabiting the area will be suited to this environment and are likely to be relatively tolerant of elevated turbidity. Benthic infauna communities subject to frequent natural disturbances are likely to recover relatively quickly from a





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disturbance event (Dernie *et al*, 2003). Provided impacts on water and sediment quality are comparable to natural disturbance events, community responses will follow natural recovery processes and ecological impacts will be minimal. If impacts on water and sediment quality are long-term or exceed natural levels (frequency, intensity or duration), there may be a shift in community composition or even loss of the community and subsequent colonisation by a different suite of species (Miller *et al*, 2002).

### **Fisheries**

The commercial fishing industry in Timor Leste has recently undergone major redevelopment and expansion, however the industry is predominantly concentrated on the north coast and we are unaware of any commercial operations in the study area. Artisan subsistence fishing occurs in the vicinity of the study area.

It is unclear whether exclusion areas will be applied around the proposed marine facilities. Fishing will most likely be permanently excluded from around the facilities as ships will be loading and unloading hydrocarbons from the jetty to and from the refinery. The loss of fishing area is relatively minor and is unlikely to have a noticeable effect on regional fish catches, but may displace some local fishers. Affected fishers are likely to relocate to adjacent fishing grounds, and this may increase fishing pressure in these areas.

There is potential for impacts on sediment and water quality to adversely affect fisheries resources, but any effects are unlikely to extend much beyond the project footprint. Increase suspended sediments or eutrophication could reduce local productivity, cause population dieback or displace fisheries resources. Heavy metals, petrochemicals, chlorinated hydrocarbons and wastewater pathogens bioaccumulate in fish and shellfish, and may exceed levels safe for human consumption. Sediments and water in the study area are presently uncontaminated. Provided water and sediment quality impacts are managed appropriately, contamination of fisheries resources by project activities is unlikely.

### **Colonisation by Invasive Marine Species**

As previously discussed, construction activities will disturb and in places remove existing biota within the project area. Disturbed and stressed communities are particularly susceptible to invasive marine species for a number of reasons (Hutchings *et al*. 2002). Disturbed areas and new structures provide vacant space for colonization by opportunistic species. Disturbance can reduce biodiversity within a community and low biodiversity may reduce the community's resilience to invasion. The disturbance may also create environmental conditions in which the invasive species has a competitive advantage over indigenous species (e.g., low light climate, low water movement, or high concentration of suspended solids).

The construction of the Betano development, including the proposed jetty and marine offloading facility, will likely include the use of floating plant, such as barges and dredgers, from other domestic or international ports. These vessels have spaces and structures where marine species can attach and they are often slow moving, so antifouling is less critical to vessel performance and may not be well maintained (GISP 2008). These vessels typically have long residency times in ports and work sites. This increases their chance both of becoming infected by a potentially invasive marine species and of infecting the site if they are carrying one. Consequently, dredges and barges are considered to



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be a particularly high-risk vector for the translocation of invasive marine species (e.g., GISP 2008; Wells et al. 2009).

During operation, the jetty and marine facility will receive regular visitation by commercial vessels. These vessels are a vector for the translocation and introduction of invasive marine species. Petroleum industry vessels are usually well maintained and antifouled, and spend minimal time in port, so they are considered lower risk than dredgers and barges. However, due to the high traffic volume and their frequent transits between ports where invasive marine species are present, these vessels still pose a moderate risk (e.g., GISP 2008; Wells *et al.* 2009; API 2010). The risk is higher where vessels are moving between ports with similar environmental characteristics.

### 6.9.4 Avoidance, Management and Mitigation Measures

#### ***Resuspension of Sediments***

Construction and operational activities will unavoidably disturb and resuspend some sediment. The impact of this was reduced by avoiding sensitive and high conservation value habitats when selecting the development location. The MOF will most likely be constructed first followed by the jetty and associated marine facilities.

#### ***Discharges, Spills and Runoff***

Policies and procedures will be developed for construction works, bunkering, cargo transfer and waste management that eliminate intentional discharges to water and minimise the risk of accidental discharge or spillage. These procedures will be incorporated into an environmental management system for the Betano Refinery.

Adequate reception facilities will be provided to receive ship wastes.

A spill detection, reporting and response system will be developed to ensure prompt control and clean-up of any spills.

Spill containment equipment will be maintained on site.

Site runoff from the tank farm will be controlled with a containment bund.

#### ***Desalination Plant Operation***

The location of the plant outlet is critical for the minimisation of impacts from the discharge. The outlet will be situated in an area of high turbulence and water movement to optimise dilution and dispersal of the discharge. The outlet design will include a diffuser to further accelerate dilution. With adequate dilution of the discharge, impacts on water quality and marine biota are expected to be minimal.

#### ***Wastewater Treatment Plant Discharge***

To reduce the environmental impact of wastewater discharge on the marine environment, treated wastewater will be retained on land for re-use or recycling wherever practicable and environmentally beneficial.

As there is a low risk to human health for the discharge of pathogens, primary contact recreation will be excluded within 100 m of the outlet and shellfish collection excluded within 500 m.



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The design of the wastewater treatment plant is not defined. Secondary treatment of wastewater and subsequent disinfection by microfiltration, UV irradiation or ozone treatment would have the lowest impacts on the marine environment but may not be practicable. If a chlorination disinfection process is used, de-chlorination and toxicity monitoring of the discharge is recommended.

### ***Changed Hydrodynamics and Sedimentation Regime***

The alteration of hydrodynamics and sedimentation in the project area is a likely and unavoidable consequence of the construction process. The impact of these alterations can be minimised by avoiding sensitive and high conservation value habitats when selecting the development location.

### ***Antifouling Contamination of Sediments***

The contamination of port sediments by antifoulants will be minimized by controlling the application, maintenance, removal and disposal of antifouling coatings within the project area. The Australian government has developed *Antifouling and In-water Cleaning Guidelines* (DAFF, 2011) that provide a practical approach for management of antifouling. Recommendations in these guidelines include:

- The prohibition or control of certain antifoulant coatings.
- The containment and controlled disposal of all antifoulant residues and waste.
- The removal of vessels and movable structures from the water for cleaning and maintenance wherever practicable.

### ***Benthic Habitat***

Construction and operational activities will unavoidably alter benthic habitats within the project area. The impact of this was reduced by avoiding sensitive and high conservation value habitats when selecting the development location.

The piles will provide substantial artificial reef habitat. When mature, artificial reefs can have fish and benthic communities that are comparable to natural reefs in terms of abundance and diversity (Lincoln-Smith et al, 1994). Development of the marine facilities at Betano, including construction of the jetty, is not expected to impact reef habitats significantly and further mitigation is not required.

### ***Infauna***

Construction will unavoidably remove some areas of benthic soft-sediment habitat and the infaunal communities they contain. Further impacts on infauna will be limited through the control of impacts on sediment and water quality.

### ***Fisheries***

Construction and operational of the marine facilities will unavoidably displace some fishers from the project area. Any exclusion of fishing, to some extent, may protect the fisheries resources contained within, and in the long-term these may act as breeding stocks that contribute to fisheries in nearby waters. Although this may have some positive effect, it is likely to be relatively minor.

While not implemented specifically to mitigate for the loss of fishing grounds, construction of the jetty will provide reef habitat in an area where there is limited natural reef. Where fisheries populations are



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habitat limited, artificial reefs have been shown to increase productivity and augment local fisheries resources (Pickering and Whitmarsh, 1997; Pondella et al, 2002).

### ***Colonisation by Invasive Marine Species***

The primary vectors for invasive marine species are vessel ballast water and biofouling.

The *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (IMO 2004) provides technical standards and requirements for the control of marine pest translocation in ships' ballast.

At present there are no international conventions for the management of biofouling, however the Australian government has developed a *National System for the Prevention and Management of Marine Pest Incursions*, including:

- National biofouling management guidelines for commercial vessels (NSPMMPI, 2009a).
- National biofouling management guidelines for non-trading vessels (NSPMMPI, 2009b).
- National biofouling management guidelines for the petroleum production and exploration industry (NSPMMPI, 2009c).

### **6.9.5 Residual Impacts**

Construction will unavoidably disturb and alter habitats in some areas of the site. The consequence of these changes are likely to be confined to the jetty footprint and were minimised by locating the development site in an area where habitats are likely to have a relatively high tolerance to turbidity and disturbance, and are generally of low conservation value.

Operation of the desalination plant is not expected to have any noticeable impacts, provided discharge of brine occurs in deeper waters away from shore. Similarly, suitable treatment of wastewater generated by the refinery should be undertaken prior to its discharge into the marine environment.

The risks of spills, antifoulant contamination and marine pest incursions will be greatly reduced through the implementation of specific management plans as part an environmental management system.

### **6.9.6 Monitoring and Reporting**

Water quality monitoring adjacent to any point source discharges is recommended to determine compliance with environmental guidelines. Measurements should include a standard suite of physico-chemical parameters and contaminants.

### **6.9.7 Further Work**

At present, the assessment of marine biodiversity impacts is generalised, as the extent and intensity of effects from project activities are uncertain.

The development of a hydrodynamic model for the Betano project area would allow:



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- Prediction of dispersal and settlement patterns for sediments suspended by construction and operational activities.
- Prediction of sediment accumulation within the harbour, allowing the assessment of maintenance dredging requirements.
- Modeling of residence times inside the harbour to assess the risk of eutrophication.
- The identification of the optimal location for the desalination plant and wastewater treatment plant outlets and the prediction of discharge dilution and dispersal patterns.

At present the design of the wastewater treatment plant has not been defined. The level of treatment and type of disinfection process used (if any) will have significant bearing on the facility's impact on the marine environment. Completion of the design would enable a more comprehensive assessment of impacts.

The development of procedures and management systems for the Betano Refinery Complex would support a systematic and consistent approach to environmental management. These include:

- Procedures for construction works, bunkering, cargo transfer and waste management that eliminate intentional discharges to water and minimize the risk of accidental discharge, spillage and runoff.
- A process for spill detection, reporting and response.
- Protocols for the management of antifouling.
- A marine pest management plan.
- Protocols for dredging operations and dredged material disposal.





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### 6.10 Social and Economic Values

#### 6.10.1 Socio-economic Objectives

The objective of the socio-economic component of the Tasi Mane Project – Betano Petrochemical Refinery (the project) Strategic Environmental Impact Assessment (SEIA) is *‘to identify social and economic impacts that are likely to result from the proposed project’*. The expected output of this component of the SEIA is:

- Population Distribution:
  - To present a demographic profile according to size, age, sex and ethnic group encountered in the baseline investigation.
- Socio-Economic
  - To present a description of the socio-economic profile of the local people.
  - To present general views and opinions of local people on the implementation of the project.
  - To solicit the degree of acceptance and opposition, as well as the condition set by the public on the proposed project.
  - Identify and describe anticipated negative and/or positive socio-economic impacts at local, regional and national level.
  - Providing recommendations for the development of potential mitigation and management measures to mitigate potential negative impacts and enhance positive impacts.

#### 6.10.2 Study Method

##### ***Baseline Data Gathering***

The approach adopted for the socio-economic component used both desktop investigations (secondary research) and participatory techniques (primary research) to gather relevant and the most up- to- date social and economic baseline data.

##### *Secondary Research*

Secondary research (desktop) included a review of previous studies to identify information gaps and areas that require further investigation. Secondary research was predominantly used to inform the national context, except for the government census data that informed the demographic profile at a local level and the Spatial Design Planning documents for Manufahi district (RDTL, 2011b) that provided information on current land use within the study area. GIS analysis of aerial photography was also used.

The National Strategic Development Plan (2011-2030) (SDP, undated) was the key document used to provide an overview of the national context. The SDP outlines the government’s vision for Timor-



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Leste and provides recent (2010) socio-economic baseline information that highlights strengths and weaknesses of Timor-Leste with respect to development. This document provided critical input in developing appropriate recommendations for socio-economic mitigation and management measures.

### *Primary Research*

Primary research activities (fieldwork) focused on the villages located closest to the project development sites that are expected to be the most directly affected. This village is defined as the study area for the Betano development (as shown in Figure 6-25).

During this SEIA, baseline information was gathered during a site visit, through interviews and focus group meetings, and cultural mapping. The approach for each primary research activity can be summarised as follows.

#### Key informant interviews

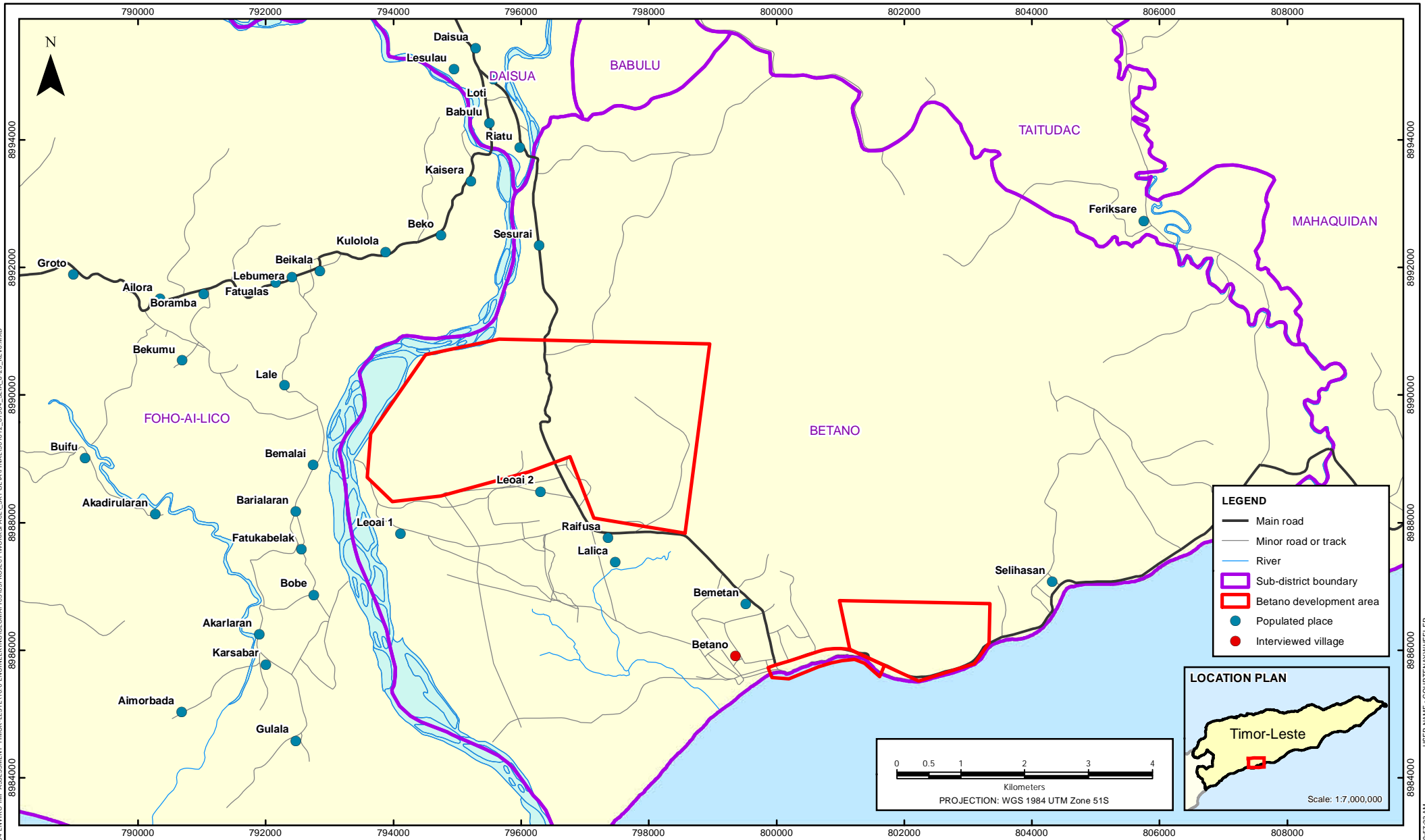
- Interviews were held with the chiefs and the traditional village council to discuss the fieldwork objectives and to notify them about the forthcoming focus group. This was done using a semi-structured questionnaire specifically designed for these interviews (refer to Appendix I).
- During these interviews, baseline information about the social organisation in the respective villages was gathered as well as perceptions about the project.

#### Focus group meetings

- Baseline information about a wide range of socio-economic aspects in the Betano study area was gathered as well as perceptions about the project. This was done using a more detailed semi-structured questionnaire. This questionnaire included the same questions asked in the key-informant interviews as well as additional questions about socio-economic aspects in the village that could best be answered by the respective focus group attendees (refer to Appendix J).
- Chiefs were requested to invite individuals who fulfil specific roles within the village to ensure questions that were posed could be answered by the most suitable informed individuals e.g., village elders were in the best position to answer questions about sacred sites, and teachers to answer questions about the education conditions in the village.

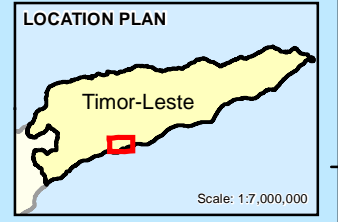
#### Cultural mapping

- Following the semi-structured interviewing, the focus group attendees were requested to participate in the cultural mapping exercise.
- Large maps of the applicable site were printed, with key landmarks indicated to orientate the participants.
- Villagers were then asked to indicate sites of cultural value on these maps. These sites included sacred sites, water points, agricultural fields and scattered dwellings.



**LEGEND**

- Main road
- Minor road or track
- River
- Sub-district boundary
- ▭ Betano development area
- Populated place
- Interviewed village



**NOTES:**  
 This map consists of:  
 1. Rivers: Geographic Information Group TimorLeste (2010)  
 2. Roads: DivaGIS (2010)  
 3. Villages: Geographic Information Group TimorLeste (2010)

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**TASI MANE PROJECT - BETANO AND BEACO  
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**Figure 6-25**  
 Betano development social and economic study area

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The first team, comprising of a Worley Parsons social consultant accompanied by a Timorese interpreter and a SERN representative undertook the key informant interviews on 10 December 2011 for the Betano development.

The second team undertook the focus group meeting and cultural mapping were undertaken on 11 December 2011 with the Betano village.

Details of the key informant and focus group meetings are provided in Chapter 5.

### ***Impact Assessment***

Using the baseline information gathered, findings of the stakeholder engagement process, as well as an analysis of the project plan and GIS data, potential impacts on the socio-economic environment were identified for the construction and operational phases of the project. This assessment includes positive, and negative, direct and indirect, residual and cumulative impacts, taking into account concerns identified through the stakeholder consultation (Chapter 5).

As part of the assessment of socio-economic significance, consideration is given to the ability of affected parties to adapt to changes and thus maintain livelihoods over the long term. Cumulative socio-economic impacts of the project are also analysed as part of the impact assessment.

The study method adopted for the socio-economic assessment did not include application of a Social Impact Assessment impact rating system (i.e., allocating a rating for severity, spatial scale, duration and probability) since detailed project information that would enable impact rating system was unavailable at the time of the study.

### ***Data Assumptions and Limitations***

Assumptions and limitations associated with the socio-economic component of the SEIA include:

- Census (RDTL, 2010) statistics are predominantly presented in diagrams and figures and in some cases do not show exact percentages. Furthermore, the statistics are not accompanied by detailed descriptions or analysis, e.g., indicating how 'employed' (formal employment or also informal trading) or 'economic inactive' (only people between 16 and 65 or also people with disabilities) are defined. In other cases, census findings contradict some responses received during field interviews. This lack of interpretation and discrepancy between census findings and interviews necessitated a number of assumptions to be made. These assumptions have been highlighted pointed out in the baseline section where applicable.
- Due to the early phase of development planning, a detailed project description for Betano has not yet been developed. The lack of project information has limited the findings of the impact assessment and development of mitigation measures. On this basis, the socio-economic sections should therefore be viewed as a strategic (preliminary) socio-economic assessment.
- Uncertainty regarding projected construction expenditure, number and type of jobs associated with the project and royalties and tax payment details made it difficult to accurately assess economic impacts. As a result, the impact section provides a high level description of economic



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impacts that are likely to occur based on project information available and based on actual impacts of similar projects in South East Asia and other developing countries. Once project information becomes available, it is suggested that a detailed economic impact assessment with associated management plans be completed.

- Some construction expenditure and workforce estimates for Betano were obtained from a report that was compiled by KBC (2011). These figures have been used at face value; hence the assessment of associated impacts is based on the assumption that these figures and estimates are accurate and achievable.

The socio-economic assessment did not include an SIA impact rating system due to the absence of detailed project information required to make such an impact rating system feasible.

Rather than providing detailed management/action plans, the report provides recommendations to consider in subsequent phases of project planning due to the preliminary nature of the assessment.

Other information gaps which have limited the findings include:

- Meeting details and issues and concerns raised during previous stakeholder engagement by SERN have not been provided (A number of other stakeholder engagement limitations are discussed separately under Chapter 5).
- Details of the resettlement approach being adopted by SERN.
- Specific project plans for water, electricity, roads to be upgraded, marine areas that will be off limits to local boats.
- Due to the lack of field surveys being undertaken, the full extent of physical and economic displacement could not be accurately assessed. Therefore, a rough estimation of land use within the footprint areas has been provided.
- Impacts associated with physical and economic displacement are described in this SEIA and recommendations are provided for mitigation of these impacts in line with International Finance Corporation Performance Standard 5. However, WorleyParsons has not been requested to develop a Resettlement Action Plan (RAP) since resettlement negotiations are being undertaken by SERN as a separate process. No information about the resettlement principles and the overall process being followed by government has been obtained. The description of these impacts therefore does not take into consideration existing agreements that have been reached between affected parties and government.
- The impacts associated with the construction of other government infrastructure projects, including the highway between Suai and Beaco (~170 km), and the National Electricity Grid project, including the construction of the power plant at Betano, are excluded from this EIA scope. They are; however, considered from a cumulative impact perspective
- Stakeholder consultation for the purposes of the Socio-economic section of this EIA indicates that there have been limitations with respect to the nature and timing of the disclosure of project information. The perceptions recorded in the SEIA therefore reflect the varying levels of stakeholder and community understanding of the project.





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### 6.10.3 Existing Social Environment

#### *District Overview*

Manufahi district is located on the south coast of Timor-Leste. It borders the district of Manatuto to the east, Aileu to the north, Ainaro to the west and the Timor Sea to the south. It has a population of 48,628 inhabitants (RDTL, 2010) and an area of 1,325 km<sup>2</sup>. The capital of the district is Same. In 1945, during the Portuguese rule in Timor, this district was also called Same. It now comprises of the sub-districts of Alas, Fatuberliu, Same and Turiscai. The latter, Turiscai, previously in Ainaro, was moved to Manufahi during the Indonesian administration, while Hatudo was split off from Manufahi and joined to Ainaro. In addition to the official languages of the country (Tetun and Portuguese), the majority of the population speaks Mambai.

In order to provide support infrastructure for the Betano development, the government is also planning to build several roads to connect Welaluhu to Fatuberliu, Dotic to Fatuberliu and Waudebereg to Alas. A new airport will be built in the next 10 years for civil aviation and an administration city for the oil industry will be built. A new electricity generation plant will be established in Betano to ensure electricity and social and economic development in the region and the territory in general. In the area of health, government is planning to build health posts in each village and to provide health services to between 1,000 and 5,000 people (RDTL, 2010).

#### *Village Level*

This section of the report outlines the socio-economic situation in the Betano study area, which constitutes Betano village. Figure 6-25 shows the location of Betano village in relation to Betano development areas. Betano is the only village within a 500 m radius of the development areas and likely to be the most directly affected by the construction and operation of the Betano development.

#### *Population and Demographics Profile*

The total population of Betano village is 5,151, which is relatively evenly split between males and females (2,655 and 2,496 respectively). There were 869 households present in Betano in 2010 and the average household size was 5.9 persons (RDTL, 2010). According to interview respondents, the population of Betano has grown 'naturally' over the last two years i.e., birth rating being slightly higher than the mortality rate. During WorleyParsons fieldwork, interviewees advised that immigration was not thought to be a contributor to population growth.

The population of Betano is relatively young with a large proportion (41%) aged between 0 and 14. Nearly half (51%) of the Betano population was aged between 15 and 59, and 8% were aged 60 or over (RDTL, 2010). From the field work program, WorleyParsons can report that many local young people migrate to Dili in order to find employment. Typically, once they gain employment they would then send some of the earnings home to their family. This high proportion of children in the 0 to 14 age cohort shows the significant demands on schooling in the study area. It highlights the villages' vulnerability to change in that there is a large number of children who would lose food security should the adult population no longer be able to farm.



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There are four major languages spoken in Betano village. Mambai is the preferred language for the majority of people (35%); Tetum Prasa is the preferred language for 32%, Tetum Terik for 21% and Bunak for 11%.

In Betano, land ownership and transition is based around the family unit. Families own the land with the head of the household taking charge. It was reported in the field interviews (2011), that land can be acquired; however compensation will need to be provided for crops, trees and other resources which are grown on the land.

### ***Village Organisation and Vulnerable Groups***

According to Worley Parsons' interview respondents, community based organisations (CBOs) present in Betano include a women's group, youth group, aquaculture group, fishermen's group, martial arts group, exercise group and a livestock group. The local NGOs who are active in the community include KSI (Kdadalak Sulimutuk Institute) who provide microfinance and environmental education.

Vulnerable people in Betano include disabled people who are typically cared for by their parents, and orphans who are cared for by their extended family.

### ***Communication and Travel***

Mobile phone reception is available for most people in the Betano area; however, some sub-villages do not have reception. Some people also have radios. Interviewees reported that community meetings are held using a megaphone and the village chief meets monthly with sub-village chiefs who then pass on information to the remainder of the village, if necessary through village meetings.

Public transport is available on the back of trucks. Motorbikes are owned privately and reportedly are available for hire. Some people use horses for travel and transportation of goods.

### ***Economic activities***

Betano fieldwork respondents indicated that the four main livelihoods present in Betano are:

1. Farming.
2. Livestock and fishing.
3. Government jobs (e.g., teachers, nurses, police, military).
4. Small business.

Census (RDTL, 2010) found that 38% of residents in Betano village were employed, 6% were unemployed and 56% were considered 'inactive'. WorleyParsons found that companies employing locals included a heavy oil company (Chinese), as well as a local construction company. The 2010 census reports received by WorleyParsons did not specify how 'employed' or economically 'inactive' were defined; however, based on WorleyParsons interview responses, it is reasonable to assume that informal trading (e.g., selling of crops and livestock) was included as a form of employment.

From the fieldwork (2011) program, WorleyParsons can report that the main sources of cash income are vegetables, livestock and maize being sold at the local market and small businesses also generated their own income.



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### ***Amenities***

The most common amenity owned by households in Betano village was a mobile telephone (60%). Radios were owned by 38% of Betano households and televisions were owned by 14% of households.

In terms of modes of transport, bicycles were relatively common in Betano with approximately one-third of households (34%) owning bicycles. By comparison, motorcycles were less common (owned by 15% of households) and only a small number of households (2%) owned a car or van. One in every 20 households (5%) owned a freezer (RDTL, 2010).

### ***Agricultural Activities***

Fieldwork participants confirmed that farming is the main source of food in Betano and all families were involved in farming. Farming plots were generally located close to the village. However, if the fields are some distance from the village, farmers often have a small house situated close to the plot. Livestock were allowed to graze freely inside gardens which are fenced off.

The 2010 Census shows that the large majority (91%) of Betano households rear livestock. Chickens were the most common livestock in Betano (6,468 in total), while pigs (2,453), cattle (1,510), goats (1,343) and water buffalo (1,280) were also common. It was reported that 76% of households were involved in crop production. The most common crops were maize, vegetables, temporary fruits and cassava which were each cultivated by more than 60% of households.

### ***Natural Resources***

Water is attained throughout the year from approximately 100 wells in the Betano area. WorleyParsons' interviewees advised that there is a pipe which supplies spring water to the village. The water is reportedly safe to drink with no cases of locals becoming sick from use of the wells or spring water. In the 2010 Census it was reported that between 60% and 80% of households have access to an 'improved source of drinking water'.

Wood is the main energy source of cooking for the large majority (94%) of households in Betano. A small number of households use kerosene (4%), electricity (1%) and cooking or bio gas (less than 1%).

Betano villagers reported that both traditional and modern medicine (from the hospital) was used (WorleyParsons, 2011). Some medicinal plants are cultivated and others grow naturally and are collected when necessary.

Most other natural resources are reportedly available in excess, including arable land, land for grazing, medicinal plants, firewood and thatching grass. Palm leaves for thatching were said to be scarcer.

Fish were also considered an important natural resource and local people went fishing along the coastline. Specific fishing areas were not identified by interview respondents.



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#### Services and Infrastructure

Community infrastructure available in Betano is summarised below in Table 6-32.

**Table 6-32 Community infrastructure in Betano**

Community Infrastructure	Betano
Kindergarten	1
Secondary schools	-
Primary schools	5
Junior High school	1
Hospital	-
Clinic /Health Centre	1
Police station	-
Houses of worship	3 chapels, 1 muslim temple, 2 protestant
Shops (approx.)	100+
Recreation	8
Market	1
Village hall	1 (in each sub-village)
Waste dump	-

Source: WorleyParsons fieldwork, 2011.

According to fieldwork participants, waste disposal is largely effected through burning. No designated waste dump is available in the village. Sanitation systems in Betano are basic. Individuals use the bush as a latrine, or pit toilets. Piggeries are also used in the disposal of waste. The 2010 Census showed that the majority of the households are still living under poor sanitary conditions i.e., the lowest category of 20% to 40%.

Government services received by the community include education (up to secondary school) and government health services. Respondents indicated that they do not have to pay for these services. Household expenses include; food, senior high school, university, funerals, mobile phone charges, fuel, house building, building materials (e.g., bricks, sand, steel, zinc), transport and small household goods from the local shops (e.g., soap, cooking oil).

Housing largely consists of traditional structures built by the locals, and a smaller number of modern housing structures in the Indonesian style. Modern housing was built by specialists available in the village (WorleyParsons, 2011).

The 2010 Census reported that external wall conditions of houses in Betano village fell in the category 0 to 19.9% (lowest category). The condition of house roofs and the floors fell in the second lowest category (20% to 39.9%).



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### ***Education***

Nearly one-third (32%) of the population of Betano were attending school at the time of the 2010 Census. A further 32% of the population had attended school, although not in 2010, and 36% had never attended school.

Overall, the level of education in Betano is relatively low, as nearly half of the population (47%) aged five years or older did not have any formal education. Of those who had a formal education, 1% attained pre-primary school as a highest level of education, 35% attained primary school, 13% attained pre-secondary and 12% attained secondary school. Less than 1% of the population of Betano had a tertiary education. In addition, the statistics show that school attendance is ranging between 60 to 80% (RDTL, 2010).

Youth literacy (the literacy rate of people aged 15 to 24 years old) for people in Betano is 83%, with males and females holding a similar level of literacy. The adult literacy rate (people aged 15 years and over) in Betano is between 40% and 60% (RDTL, 2010).

### ***Health***

According to interview participants, the general level of health has remained the same in Betano in recent years. Both traditional and modern forms of medicine are used. The main challenge in terms of health services was reported as being the lack of medicine, equipment and health professionals (e.g., nurses). Malaria was described as the most common disease in the area, while tuberculosis (TB) was also present. Fieldwork participants reported that malnutrition has become less of a health issue in recent years in Betano. This was mainly ascribed to the newly established health centre in the district.

The 2010 Census shows that 28% of Betano births were assisted by a skilled health provider in the last five years.

### ***Cultural Heritage Practices and Sites***

According to interview participants, cemeteries are situated in Betano village. There are also some historic grave sites located outside the village.

Other areas of ancestral value include numerous sacred sites including rocks, trees and streams. Sacred sites may be 'relocated' if the appropriate rituals are performed; however, if the rituals are not performed, relocation will not be sanctioned. Sacred sites are reported to be signed or marked. Interviewees reported that sacred sites had not been identified by SERN as yet.

As throughout Timor-Leste, sacred houses are an important part of the culture. Everyone in Betano is from the same cultural group and there are estimated to be 100 sacred houses in the area (WorleyParsons, 2011).

As WorleyParsons was not commissioned to undertake an archaeology or grave survey, it should be noted that there is likely to be a number of unidentified scattered ancestral graves or sacred sites within the Betano development areas.





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### ***Social Problems and Crime***

Theft of livestock and household belongings is reportedly the main form of crime in Betano. Some violence (related to martial arts) had occurred in 2010 when local groups clashed. It was reported that crime is usually managed through referral to the court or government; however, sometimes crime is dealt with by the chief (WorleyParsons, 2011).

During cultural festivities, large amounts of alcohol are consumed; however, this is generally not perceived as a social problem. Drug abuse does not appear to be a major problem in Betano.

It should be noted that, due to the sensitive nature of some crime related issues (e.g., prostitution, domestic violence), questions in relation to crime levels were restricted to general statements only. Furthermore, there was no opportunity to interview women (individually) or other minority groups.

### ***Key Perceptions about the Project***

Due to limited project information being disclosed to Betano village, many respondents had not yet formed specific perceptions about the project. The following perceptions were raised by some respondents:

- There will be a large scale development at Suai; however not much information has been disclosed about the project at Betano.
- Request for government to indicate where infrastructure will be placed so that people can see if they will be affected or not.
- The project will have a positive impact on the community. Perceived project benefits listed as electricity provision, water and housing.

### **6.10.4 Socio-economic Impacts**

This section of the report considers the potential socio-economic impacts associated with the Betano development. Impacts were identified via the stakeholder engagement that took place during the fieldwork period, from the documentation available, as well as an analysis of the project plan and GIS data.

#### ***Impact 1: Employment Creation***

This impact relates to the creation of both direct and indirect employment opportunities that will be created by the construction and operation of the Betano Refinery and Petrochemical Complex development, including the accommodation village proposed at Nova Betano.

Many people expressed their concern as to whether the project would create jobs for people living in the area. Villagers, particularly youths, are keen to find a job with the project. The baseline investigation has revealed however, that education and skill levels are low and predominantly relate to subsistence farming.

The construction period (phase 1) for the Betano development refinery is expected to last three years (KBC, 2011). The plan is to employ approximately 1,400 people during the peak construction period. The jobs for the construction of the refinery can be grouped into skilled (e.g., engineers, economists,



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accountants, etc.), medium skilled (e.g., technical specialists, supervisors, etc.), low skilled (e.g., motorists, etc.) and unskilled (e.g., security, cleaners, etc.). It is anticipated that the majority of the construction workforce for the refinery would be skilled workers and imported labour, whilst between 10% and 30% are likely to comprise unskilled (local) labour. The workforce profile associated with the construction of Nova Betano has not yet been received by WorleyParsons.

According to KBC (2011), all unskilled positions will be filled by local people. It is envisaged that a training program will be developed at an early stage of the project so that local people will be able to fill medium skilled positions shortly after the refinery has been constructed. However, it is predicted that skilled positions will take many years to fill with local people as they will require intensive training.

The number of jobs associated with the operation of the Betano development was not known at the time of report compilation. It is safe to assume that less local jobs would be available during the operational phase as jobs associated with the operational phase typically require a higher level of skills. On the other hand, there will be time to implement mitigation measures in order to train some local people for jobs during the operational phase. A significant challenge facing the project will be to decide on a fair mechanism for allocating jobs to local people in order to reduce the potential for conflict over unemployment.

### *Impact Statement:*

*The construction activities will increase job opportunity at a local level as well as district and national levels in the short term. However, if left unmitigated, the majority of jobs will fall within the skilled and medium skilled category and would therefore be taken up by imported labour in the short and medium term.*

### **Impact 2: Skills Development**

Detailed plans relating to training and development for the Betano development have not yet been drafted.

However, it can be assumed that the local population who receive training and employment will be acquiring new experience and skills. These experiences and skillsets will improve their marketability for future roles.

### *Impact Statement:*

*The development of skills in association with development at Betano will improve individual's marketability for future roles.*

### **Impact 3: Creation of Economic Opportunities**

This impact relates to economic opportunities from capital expenditure, indirect jobs, business opportunities, and payment of royalties and taxes.

Estimates of construction expenditure are not yet available; however, it is assumed that only a small percentage, per annum, will be spent on Timorese contractors due to the fact that the majority of services and materials will have to be sourced internationally. It is expected that there will be sufficient time before the construction of the Betano development to fully implement mitigation measures such as building capacity of local businesses.



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The refinery would most likely stimulate the development of local businesses and entrepreneurs. These opportunities relate to an increased market being created by jobseekers and employees moving into the area, and the latter having higher disposable incomes to purchase local produce and services.

Details regarding tax and royalty payments associated with the supply base are not currently available; however, it is reasonable to assume that taxes paid during construction and operation will increase revenue to the Timor-Leste government.

### *Impact Statement:*

*The royalties and other taxes will increase revenue for the Timorese government. This revenue, if managed transparently, will flow to the district levels and promote socio-economic growth and infrastructure development in these areas. The Betano development will increase the opportunities for national businesses during construction and the operational phase; however, local businesses will require assistance to make use of these opportunities. Some local procurement opportunities will be initiated for local businesses and may result in entrepreneurs and other small businesses developing in the area.*

### **Impact 4: Physical Displacement**

This impact involves the loss of scattered buildings and associated community infrastructures such as sheds in the Betano development footprint.

An analysis of aerial imagery provided the following estimates for the potential loss of structures (physical displacement). There are approximately 162 structures within the site boundary and 1,048 structures in a nominal buffer of 500 m allowed for minor modifications to the development footprint. The majority of structures (116) fall within the Nova Betano boundary (or 825 if the buffer zone is implemented). There are 25 structures, and a further 132 structures potentially impacted (with buffer) by the proposed jetty area. The Betano Refinery has the least structures within the boundary (21 within, and a further 91 structures, if the buffer is implemented (refer to Figure 6-26). These structures do not have official village status, though they do fall under the administration of Betano village. These households stand to lose their physical, social and/or economic assets as a result of the Betano development construction.

Further analysis of health and safety risk is also critical as the buffer zone required will substantially influence the scope of resettlement. Furthermore, it should be noted that the structure count is merely an estimate which needs to be verified by undertaking detailed asset surveys and also thorough consultation with local residents to avoid breaking up families, in other words, project boundaries could cut through close knit settlements and therefore cannot be the only measure to determine the scope of resettlement.

Table 6-33 shows the current land use in the respective footprint areas for the Betano development; however, whilst the analysis is based on 2010 aerial imagery and should therefore be verified by undertaking detailed asset and field surveys (refer to mitigation measures).



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**Table 6-33 Current land use in Betano development areas**

Infrastructure	Current land use
Refinery and Petrochemical Complex	Mostly natural vegetation with some crops and a few scattered dwellings along the coast line.
Nova Betano	Mostly natural vegetation, plantations along the existing road cutting through the site. Few scattered dwellings on the southern boundary that may or may not have to be resettled.

Source: 2010 imagery

*Impact Statement:*

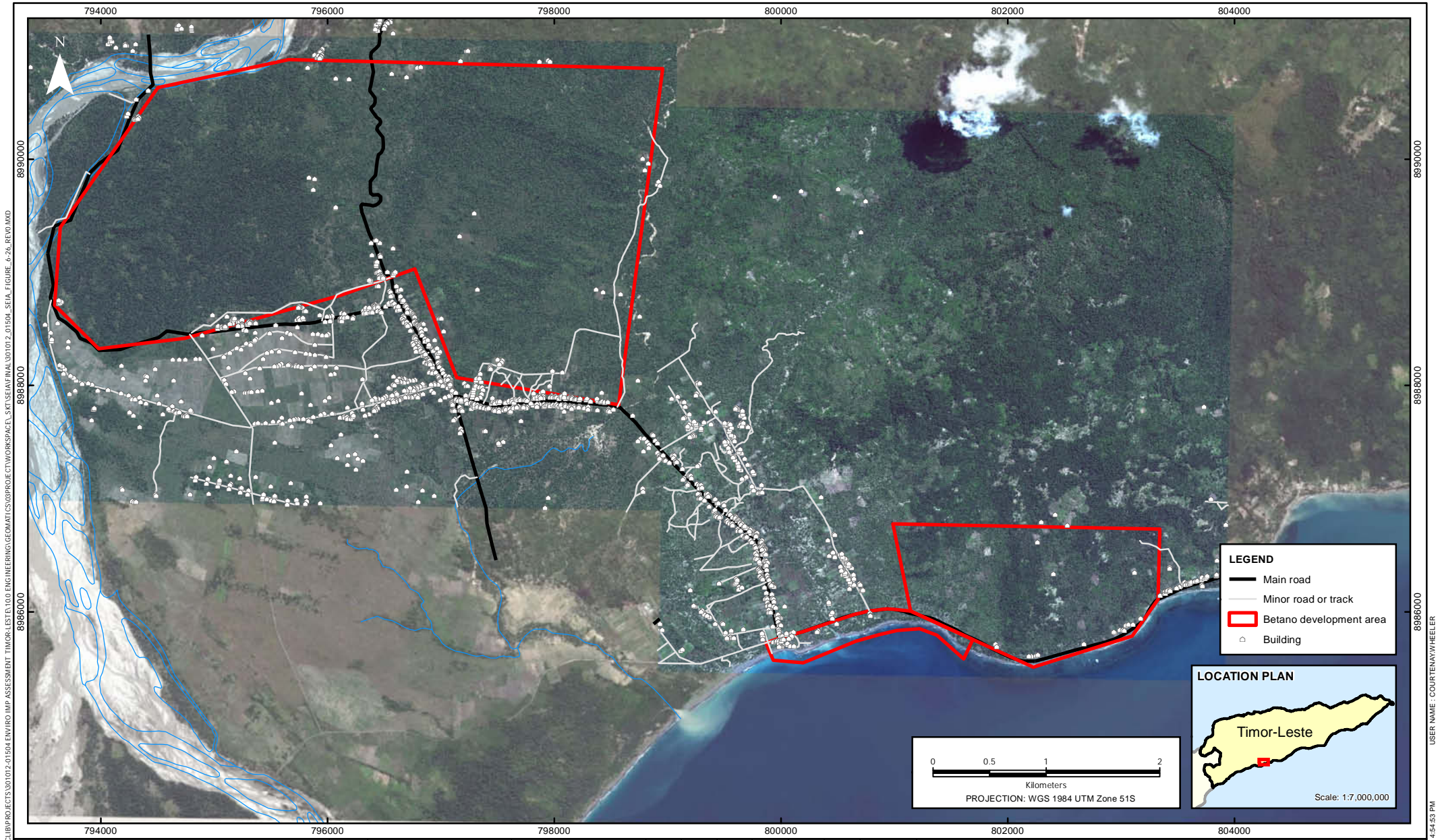
There are 162 scattered structures within the Betano development footprint. However, within a few hundred metres, the numbers potentially requiring resettlement increases to approximately 1,048 structures. Impacts associated with economic displacement (impacts 5 and 6) will have higher significance for the Betano development than physical displacement. Nonetheless, the relocation of dwellings within the Betano development area will be an involuntary resettlement process and as such needs to be treated carefully and transparently to reduce the risk of conflict. If not properly managed it has the potential to result in homelessness for individuals and families, and heighten the risk of civil unrest. Unlike the refinery and petrochemical plant that is subject to technical engineering specifications, the Nova Betano site can be carefully planned to reduce the impact on physical displacement (refer to mitigation measures). The timing of the Betano development should allow adequate time for the mitigation measures to be implemented before construction commences.

**Impact 5: Loss of Land, Crops and Natural Resources including Fishing and Potable Water**

This impact relates to a loss of land affecting landowners, and resources such as crops and natural resources (including fishing and potable water) on the land. The latter affects land users, who may or may not be the same persons as the landowners.

The area occupied by the Betano development is approximately 230 ha, plus an additional 36 ha set aside for the proposed jetty area. An area of approximately 1,200 ha has been identified for Nova Betano. Officially, all land belongs to the government although; there are reports of disputes relating to such issues. At a local level, land is controlled by families in the villages in the study area. In other countries, the desire to participate in compensation related to the development of a large project can result in a build-up of tension between individuals or villages where there is unclear land ownership boundaries either between or within villages. However, since landownership is not always documented or registered, it is difficult to determine the rightful landowners.





NOTES:  
 This map consists of:  
 1. Imagery: Digital Globe (2008-2011)  
 2. Rivers: Geographic Information Group/TimorLeste (2010)  
 3. Roads: DivaGIS (2010)  
 4. Buildings: WorleyParsons (2012)

0	6/06/2012	FINAL FOR ISSUE	CS	MW	-	-	GH	-	A4 SHEET	SCALE 1:45,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
resources & energy		TIMOR GAS & PETROLEO		REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				Copyright © WorleyParsons Services Pty Ltd		

TASI MANE PROJECT - BETANO AND BEACO  
 STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

**Figure 6-26**  
 Buildings and roads affected by the  
 Betano development

LOCATION: \\PFWORLE\IT\INFESTRUC\LIB\PROJECTS\301012-01504\ENVIRO\IMP\_ASSESSMENT\_TIMORLESTE\00\_ENGINEERING\GEM\TAS\TASI\SE\INF\A\301012\_01504\_SE\A\_FIGURE\_6-26\_REV01.MXD

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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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It was reported during the WorleyParsons fieldwork that there is no proper land registry, no recording or verification of land transactions, and no framework to determine competing claims to land. It is therefore very important that thorough checks are made during the planning stage to ensure that potential claims are settled amicably, through use of social surveys with affected landowners and liaison with government officials. Landownership is also a complex issue in Timor-Leste due to internal displacement during the Indonesian occupation which resulted in many layers of landownership e.g., the landowner is not necessarily the same person as the land user. Thus, identifying the rightful person eligible for compensation will have to be carefully investigated to avoid conflict.

As far as land use is concerned, the land currently comprises primarily scrubland and forest (60% to 70%) in which natural resources are utilised and the remaining 30% to 40% is arable land (KBC, 2011). As a consequence, there will be a loss of land and associated resources for the scattered dwellings currently residing on the land, and for the Betano villagers making use of the resources found on it (refer to Figure 6-27).

The loss of this area of land will place greater demand and pressure on other agricultural land and resources. Interviewees reported that arable and grazing land is available freely in the wider area and so are medicinal plants, firewood and thatching grass. Farmers' vulnerability to loss of arable land should be understood in terms of the existing challenges faced by them. These relate to inadequate irrigation systems, climate change, rodent infestation, inadequate selling prices, a lack of machinery or technical knowledge, and minimal response by government to the priorities identified by farmers (La'o Hamutuk, 2011).

As far as the impact on fishing is concerned, the construction of the Betano Refinery and Petrochemical Complex will result in approximately 2.5 km coastline that may be inaccessible to the villagers. This will affect onshore fishermen (fishing from the coast). In contrast, the impact on offshore fishermen will depend on the marine areas that will be dredged or used for spoil dumping, whether there will be public access from the newly constructed jetty and the potential exclusion zones established for local boats.

The construction and operation of the Betano development will require large quantities of water. There will also be an increase in water users (jobseekers and outside employees) as well as the possibility that some water points may be situated on the footprint areas, and therefore may no longer be accessible. This could increase pressure on water resources in the area; however, water is available freely, with interviewees reporting that there are more than 100 wells in Betano village. The proposed water sources for construction and operation were not known at the time of writing, thus the full extent of the impact on community water resources cannot be assessed at this stage.

### *Impact Statement:*

*Local villages in and around the Betano development are reliant on arable land and natural resources (wood for fuel, building materials, medicinal plants, fruits, fishing, water, etc.). The loss of land to the Betano development would certainly result in the loss of agricultural land and natural resources found in the land. Access to water points will also be affected and new residents and workers, and water requirements of the project, will increase water usage in the area. SERN should further assess the need for alternative water points to replace those potentially lost by the project.*



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### **Impact 6: Loss of Commercial Trees**

The exact number of trees within the Betano development area had not been recorded at the time of writing. However, based on an analysis of aerial imagery and observations during the site visit, there are some plantations next to the road cutting through the Nova Betano site, the most important being tic and coconut trees.

#### *Impact Statement:*

*The loss of trees is potentially a severe impact due to the difficulty of mitigating this impact i.e., it is not possible to provide mature replacement trees (replacement seedlings/saplings will take some years to reach maturity) which results in the community being without a guaranteed food source (and in some cases source of income) for a number of years.*

### **Impact 7: Disturbance and/or Loss of Access to Sacred Sites and Scattered Graves**

Based on feedback from interviewees all cemeteries are located in the villages and would not be affected by the Betano development. There may; however, be some scattered graves located within the footprint of the Betano area. Only graves located in the areas to be disturbed by construction activities would need to be relocated. The relocation of the affected graves would require the exhumation of these human remains and reintering them in a new area. Based on current information, it is foreseen that only a few, if any, graves would need to be relocated.

Interviewees indicated that there are numerous sacred trees, rocks and streams in the area; however, the number and location of these sites were not provided by respondents. Despite interviewees reporting that some of the sacred sites could be 'relocated' if the appropriate rituals are performed, the issue remains very sensitive.

#### *Impact Statement:*

*Due to the nature of the impact and the potential sensitivity related to the disturbance of culturally significant sites such as sacred sites and scattered graves, it is expected that the impact will be highly significant.*

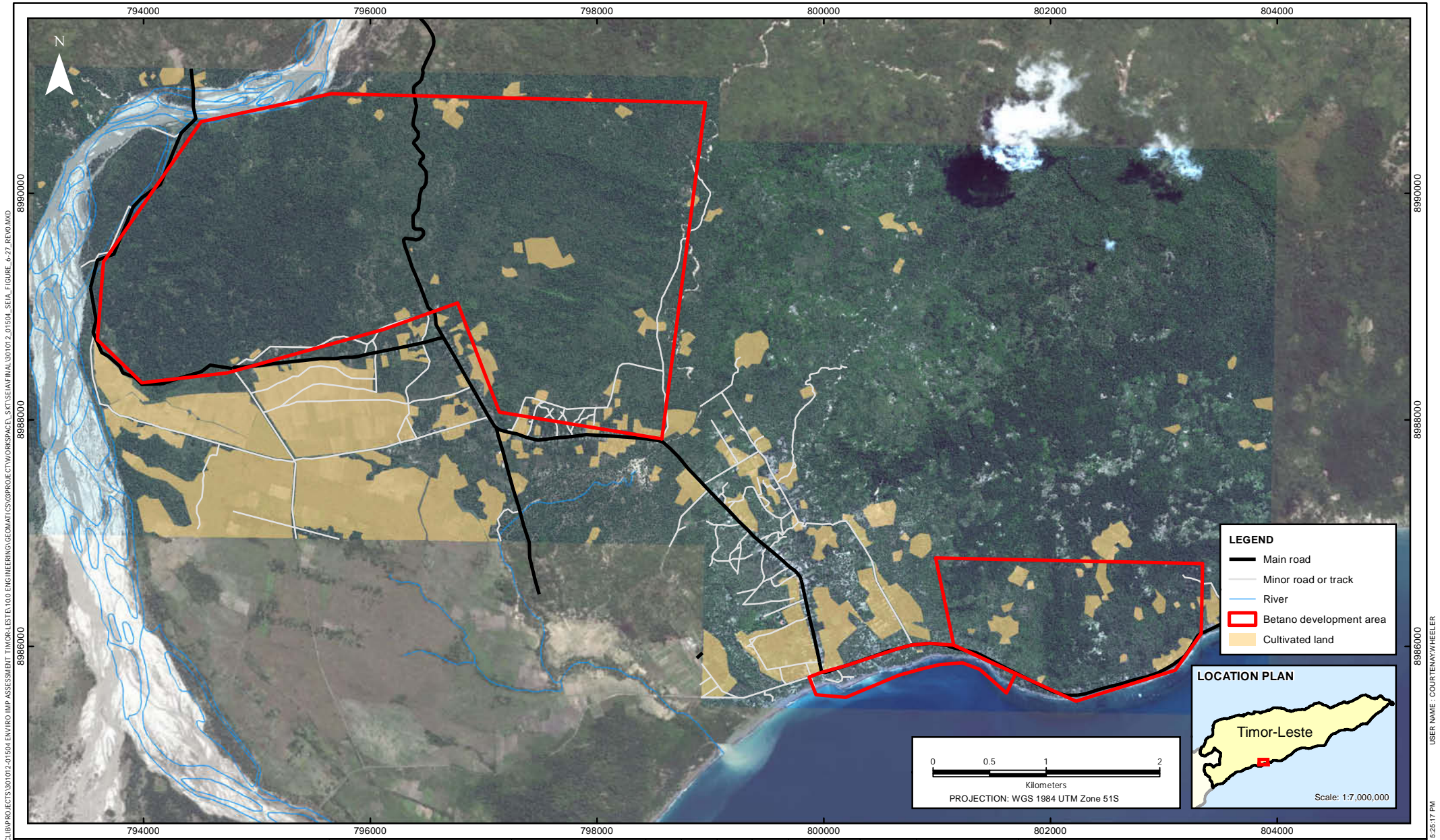
### **Impact 8: Reduced Mobility due to Loss of Road Network Inter-linking Grazing Areas, Water Points**

Due to safety and security reasons, the refinery and petrochemical complex will be fenced off. Fencing of these areas has the potential to disturb people's travel patterns. The fencing of the development areas may result in villagers having to travel substantially longer distances to reach their fields, water points or business centres in the area (refer to Figure 6-27).

#### *Impact Statement:*

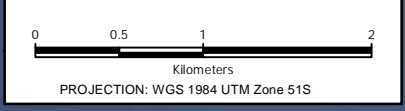
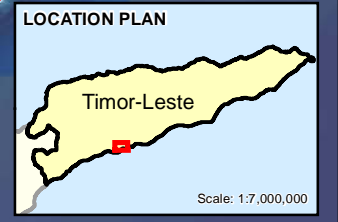
*This impact will be marginal in comparison to the Suai development, due to the smaller footprint areas to be fenced off. The north and south road from the town of Same towards the southern beach would dissect Nova Betano into two separate areas, creating an access route through Nova Betano for surrounding villagers to use.*





**LEGEND**

- Main road
- Minor road or track
- River
- Betano development area
- Cultivated land



**NOTES:**  
 This map consists of:  
 1. Imagery: Digital Globe (2008-2011)  
 2. Rivers: Geographic Information Group TimorLeste (2010)  
 3. Roads: DivaGIS (2010)  
 4. Cultivated land: WorleyParsons (2012)

0	6/06/2012	FINAL FOR ISSUE	CS	MW	-	-	GH	-	A4 SHEET	SCALE 1:45,000
REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	PROJECT No: 301012-001504	
resources & energy		TIMOR GAS & PETROLEO		REPUBLICA DEMOCRATICA DE TIMOR-LESTE SECRETARIA DE ESTADO DOS RECURSOS NATURAIS				Copyright © WorleyParsons Services Pty Ltd		

**TASI MANE PROJECT - BETANO AND BEACO  
 STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT**

**Figure 6-27**  
 Cultivated areas affected by the Betano development

LOCATION: \\PFWORP\IT\INFRASTRUCTURE\PROJECTS\301012-01504\ENVIRO\IMP\_ASSESSMENT\TIMORLESTE\00\_ENGINEERING\GEMWAT\CS\303\PROJECT\WORKSPACE\SP\SET\FINAL\301012\_01504\_SEIA\_FIGURE\_6-27\_REV01.MXD

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## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### ***Impact 9: Population Influx***

As with many large-scale projects in developing countries, it can be expected that there will be an influx of people into the area seeking employment or to take advantage of the economic growth during construction and operations. Currently, people living the Betano study area live in close-knit homogenous communities belonging to the same cultural group.

During the construction phase, the number of people living in and around the Betano study area might increase and due to the lack of cross-cultural interaction experienced by the villages, they will be vulnerable to some of the changes/impacts. These might include:

- Conflicts over jobs.
- Conflicts over access to resources – social infrastructure, housing, etc.
- Increased pressure on housing and social facilities.
- Overcrowding and associated health impacts (see health impact).
- Increased prices for goods and services.
- Increase in community health risks.
- Increase in social pathologies such as crime, prostitution, drug abuse and alcoholism due to increased amounts of cash circulating in the study area.
- Lost sense of place, due to industrialisation.
- Increased business opportunities

From a positive perspective, the Betano study area will be redefined as a hub of activity and economic opportunity. This may inject a new level of energy into local communities who may be inspired to find ways to adapt to and benefit from the host of activities and opportunities associated with the Betano development. Already, the baseline study identified the desire amongst many respondents, in particular the youth, to move away from current subsistence and lifestyles to a more economically engaged and active lifestyle. For these individuals, the change in the sense of place and identity will be welcomed.

#### ***Impact Statement:***

*The project is likely to result in an influx of people in to the Betano study area. An influx of people into the development area would place increased pressure on the socio-economic infrastructure and may erode some community values.*

### ***Impact 10: Increased Pressure on Government to Deliver on Infrastructure, Service and Administrative Demands set by the Project***

The Timor-Leste Government is in the process of implementing the National Strategic Development Plan (SDP). The SDP highlights several challenges faced by government in terms of social capital and infrastructure development (refer to Chapter 4). The Betano development will require significant supporting infrastructure e.g., roads, electricity, and health and education facilities to accommodate





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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newcomers. The provision of this infrastructure will be required in the medium term and will therefore place a lot of pressure on government services.

Nova Betano is likely to have unique management issues, particularly in relation to the management and maintenance of the public infrastructure and facilities. Any special institutional and management arrangements within Nova Betano may result in an undesirable structure of double bureaucracy which in future may divide the community and place government under increasing pressure.

Currently there is little administrative capacity at the district level of Government. The challenge is going to be for the local administration to manage the project impacts and additional demand on services and facilities such as health, education, sanitation, roads, housing, etc. due to general population growth in the villages and not Nova Betano *per se*. Compared to the Suai Supply Base, there will be more time prior to construction to build capacity among government officials and to put supporting infrastructure in place. On the other hand, there is likely to be less current capacity and infrastructure in place in the Betano study area compared to the Suai study area, since the latter is generally a more developed area.

### *Impact Statement:*

*The construction of the Betano development would place significant pressure on the current national and district administration, increasing demand for the provision of additional government services.*

### **Impact 11: Community Health and Safety**

The following are potential community health impacts that may result from the Betano development:

- Increase the level of respiratory ailments such as tuberculosis as a result of influx of people into the area, overcrowding in settlements and poorly ventilated houses.
- Increase in the level of respiratory ailments due to increased dust caused by construction activities and gaseous air emissions during operational activities posing serious potentially human health risks to nearby settlements that have been earmarked for further investigation (refer to the air quality assessment, Section 6.4, Air Quality for more detail).
- Increase in vector-related ailments such as malaria.
- Increase in sexually transmitted infections such as HIV due to population influx.
- Increase in soil and water-borne diseases such as diarrhoea, typhoid and cholera.
- Increase in lifestyle risks such as hypertension and diabetes.
- Increase in lifestyle risks such as alcoholism, drugs, gender and domestic violence.
- Increase in ambient noise.
- Increased pressure on health services infrastructure.

During construction, the key safety issues will be related to increased traffic volumes (mostly trucks and four wheel drives) on access roads, on many occasions 24 hours a day. The local community is not used to such heavy traffic. Vehicular traffic will also increase on the main access roads during operation. As many of these are in proximity to local villages, there is an increased risk of accidents





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and noise pollution. The transport assessment, Section 6.11, Land Transport of the SEIA provides more detail in this regard.

### *Impact Statement:*

*It is likely that the construction and operation of the Betano development would impact on the health and safety of the villages in the area, in particular Betano village and scattered farm dwellings. Health related issues like pollution (water and air), vector related diseases and sexually transmitted infections, would increase especially among the communities in and around the Betano development and also those along the transport routes.*

### **Impact 12: Improvement of Basic Services and Infrastructure**

The Betano development will consist of an industrial park where refinery and petrochemical industries will be located, along with the new residential area, Nova Betano. It is intended that Nova Betano would provide housing and social services, and form a new base of employment on the south coast. As a result of the Betano development, social infrastructure in the local area will be upgraded. The following infrastructure which is planned as part of the Betano development will benefit the local population in the area:

**Road infrastructure:** As described in the Suai Supply Base EIA, the construction of the Suai-Beaco highway will increase overall accessibility of the wider project area. Specifically for the Betano development, several existing roads are proposed to be upgraded and new roads constructed.

**Energy infrastructure:** With regards to energy infrastructure, the National Electricity Project is currently underway. The Southern Power Station (adjacent to the Betano development area) will be constructed, with 8 x 17 MW generation with a total capacity of about 136.6 MW. The plant will include storage facilities for fuel. The station will include a substation that raises the voltage to 150 kV for the purposes of connection with the transmission network. The engines will initially run on light or heavy fuel oil and will be capable of being converted to natural gas. The plant is expected to be operational in late 2012. However, the impacts associated with the power plant e.g., physical and economic displacement, employment creation etc. do not fall within this SEIA's scope. For this SEIA, it should only be noted that people's access to electricity will be improved as a result of another government initiative and not the Tasi Mane project *per se*.

**Nova Betano infrastructure:** As the 'petroleum administration city', Nova Betano, will be the largest oil and gas community within the four 'Nova' towns to be developed for the Tasi Mane project. Nova Betano will include several different types of facilities and services including offices, commercial areas, hospitality, bars, residential single and multi-family units, club house, sports club and recreational area, 18 hole golf course, driving range, national elementary and secondary school, international elementary and secondary school and hospital. Other services that will support Nova Betano land uses include fire station, security station and maintenance facilities. All of these services and functions will be aimed to house around 14,000 residents and visitors to Nova Betano. Based on current planning, Nova Betano will also be the resettlement area for houses that need to be relocated from the refinery areas (RDTL, 2011b). The extent to which local villagers will be able, due to spending power, or allowed to make use of the new facilities and services in Nova Betano is not currently known. Nonetheless, based on the information available, it appears as if it will primarily be for use by the residents and their visitors.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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Some community infrastructure development could form part of community investment programs to be implemented by the project during the operational phase. This could include the improvement or provision of new health centres, education facilities, waste management infrastructure, sports facilities, churches and roads.

### *Impact Statement:*

*Based on information provided to date, it is predicted that the project would have a long term beneficial impact on the communities around the Betano development in terms of social infrastructure development. Infrastructure such as roads, water and electricity will enhance socio-economic development in the area, through job creation, increase in commercial activities and potentially improved education levels.*

### ***Impact 13: The Construction and Operation of the Betano Development Triggering Resentment and Local Conflict***

Timor-Leste has faced many conflicts in the past, from the Portuguese colonial period to the more recent decades-long independence struggle against Indonesia. Furthermore, on 31 August 2011, the Betano villagers demonstrated to protest against the government taking 12 more ha's (in addition to the four the community had already given) for the heavy oil power station proposed to be located adjacent to the proposed Betano development area. Betano villagers continue to seek information to understand the potential impacts the project may have on them. There is potential for this to evolve into community unrest.

Additional trigger points for resentment and conflicts around the project site are the following:

- Loss of land and livelihood resources.
- Resettlement and compensation.
- Removal of graves.
- Access to jobs and other economic opportunities.
- Weak government and inability of local authorities to maintain control.
- Lack of royalty flowing to the local administration.
- Inflation and food security.
- Influx of people.
- Lack of community development.
- Safety and health hazards.
- Poor treatment of community by security personnel.

### *Impact Statement:*

*The construction and operation of the Betano development could trigger resentment (and potential conflict) in a fragile environment such as Timor-Leste. These conflicts may arise due to a variety of*



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*reasons e.g., lack of stakeholder engagement, inadequate compensation, unrealistic expectations, tribal and ethnic tensions, among others.*

### **Impact 14: The Betano Development Exacerbating Gender Equality Issues in the Study Area**

The Constitution of Timor-Leste supports freedom from sex-based discrimination. Timor-Leste has been a signatory to the Committee on the Elimination of Discrimination against Women (CEDAW) since 2003 and while the 2009 CEDAW report demonstrated progress, there remain significant issues that require government intervention to ameliorate discrimination against women. The 2009 NGO Report to CEDAW (titled Alternative Working Group) states that while the Constitution guarantees women's rights and equality there are nine crucial areas requiring government action in terms of legislation, practices and service delivery if discrimination is to be eliminated.

Although Timor-Leste has made significant progress in relation to women's rights since Independence (2002), a USAID study indicates that several factors are negatively affecting further advances – including a conservative backlash that seeks to return women to their former domestic roles. The gender division of labour at the community level is relatively rigid, and women's low level of literacy and education are often cited as reasons for excluding them from community processes. East Timor has no legal restrictions on women's rights; it is rather traditions and customary laws constraining the ability of women to attain economic independence. The 2010 Census has revealed that there is no significant difference in literacy levels for girls and boys which may reflect a change in attitude in recent times.

Government regulation (gender quotas) will require a minimum of 30% female employment at the project and at managerial level, with the requirements of the proponent potentially higher. However, this requirement can result in tension at both a workforce level and at a community/village level. At a workforce level, local men may find it difficult to work alongside female employees or to receive instructions from a female supervisor/manager due to the traditional and customary background. At a village level, men may resent women who find employment with the project, in particular if the head of household is unemployed or perform tasks that could be perceived as 'primitive' and possessing lower status e.g., subsistence farming.

#### *Impact Statement:*

*Economic opportunities brought about by the Betano development may exacerbate gender equality issues. These issues may be experienced at a workforce level and also at a community/village level.*

### **6.10.5 Avoidance, Management and Mitigation Measures**

Given that this is a strategic assessment, the mitigation measures and residual impacts listed for the Suai Supply Base are also likely to apply to the Betano development. They have again been detailed in this section, where applicable.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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### ***Mitigation 1: Employment:***

The following mitigation measures are designed to optimise the positive impact of the Betano development with regards to job creation at a local level during the construction and operational phases of the project. These measures are:

- Determine how to increase the number of people that can be employed at a local level, whilst maintaining the productivity standard required. This will require the proponent to develop a workforce profile and undertake a skills audit to identify local capacity against the workforce profile. This will lead to the identification of the relevant training programs to optimise local employment.
- Based on the training programs identified via the skills audit, implement a Skills Development Plan for the Betano development and ensure a training centre at Betano is constructed in a timeframe which delivers substantial numbers of relevantly trained people.
- Provide guidelines for contractors that enhance local jobs.
- Design an appropriate recruitment strategy that focuses on local villages whilst avoiding any patronage with selected groups that could result in conflict.
- Design a social investment initiative that provides technical bursaries for local children and education programs for school children developing an awareness of the local employment opportunities at the Betano development and enhances future potential for local employment through appropriate skills development.
- Seek to integrate the demobilization of construction personnel with the mobilisation of the operations team to minimize impact on ancillary services provided by the local community (e.g., accommodation, supplies, etc)
- Implement the measures outlined in the SDP, which include improving access to education, ensure sufficient number of classrooms in project areas, refurbishing existing schools and implement quality teacher training programs. The implementation of these measures will not have an immediate effect on local employment; however, considering the timeframes for the Tasi Mane project (estimated at 50+ years), implementing these measures now would result in a brighter future for the youth.

### *Mitigation measures for conflict over jobs.*

Measures should be designed to reduce the potential for conflict over accessibility of jobs at the local level such as

- Develop a localisation policy which will ensure local residents are prioritised with regards to employment opportunities.
- Develop training mechanisms that will focus on increasing and improving local capacity.
- Develop systems to ensure that local residents are able to access certain categories of jobs.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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- Establish a system for local procurement that has a suitable definition of 'local' that all stakeholders agree to. The system must be transparent and not open to abuse. The manner in which people are selected must be fair and trusted.
- Develop a dispute resolution mechanism that caters for disputes regarding employment (see grievance mechanism).
- Develop a mechanism that aligns human resource policies to community development needs.
- Ensure that recruitment prevents, rather than promotes an influx of job seekers by having clear policies, guidelines and communication strategies which prevent confusion and reduces expectations. It should be noted that this type of mitigation may be difficult to achieve given Timor-Leste's current unemployment levels.
- Recognise and understand how political dynamics might create conflict over a scarce resource such as skilled labour.
- Avoid creating long-term patronage with one group at the expense of other groups.
- Training of local people to be able to secure a job at the Betano development.

### ***Mitigation 2: Skills Development***

The following mitigation measures are suggested to further enhance this positive impact:

- Prioritise the development and implementation of a skills development plan.
- Use a rigorous selection process for trainee candidates to ensure the right individuals are identified, with a strong work ethic and high level of commitment.
- Properly communicate to the candidates the selection process and make provision for candidates who struggle during the training to downgrade and still find a suitable position at a lower level.
- Local vocational institutes would need to develop additional curriculum (or work with an external party to do so) to train students in the areas required at the Betano development (e.g., riggers, welders, heavy equipment operators and mechanics).

### ***Mitigation 3: Economic Opportunities***

Mitigation measures should be designed to enhance the opportunities for development as a result of the royalties and taxes that would need to be paid to the Timor-Leste government, including:

- Capacity building of the district authority to utilise the royalties efficiently.
- Increased transparency of the royalty payments made to the Timor-Leste Government and how these are distributed to the district governments.

Mitigation measures designed to enhance opportunities for local businesses could include:

- Developing systems to enhance the potential of Timorese businesses to supply quality goods and services to the Betano development, in so doing improve the positive impacts of the Betano development. This could be done through the identification of potential local contracting





## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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enterprise opportunities and communicating these opportunities to existing local businesses. Existing businesses that have the required capacity should be identified, along with existing businesses that may require further assistance.

- Establishing programs that can strengthen business networks and relationships between the private sector, government, education institutions and firms of suppliers (as noted in the SDP, SEFOPE and ADB partnership).

### ***Mitigation 4: Physical Displacement***

To mitigate the potential impact of resettlement, the project should ensure proper systems for replacement and compensation for land are put in place. Mitigation measures should include:

- A Resettlement Action Plan (RAP)<sup>5</sup> should be developed to address the involuntary relocation of all affected households and associated assets (impacts 4, 5, 6 and 7). This RAP should outline the principles governing how the proponent would undertake to replace and compensate households that require relocation through the project's resettlement and compensation process. The RAP should include the following components:
- Identification of project impacts and affected population (includes mapping, census, inventory of affected assets including dwellings, fields and trees, graves, sacred sites), consultation with affected people concerning assistance benefits and development opportunities. Develop a legal framework in accordance with Timorese legislation and IFC performance standards. .
- Develop a compensation and entitlement framework (including compensation packages, eligibility for assistance, responsibilities and schedule for compensation payments), which also reflects legal requirements.
- Resettlement assistance and livelihood restoration (influx management, relocation schedule and assistance, replacement of services and enterprises, livelihood restoration, treatment of cultural property, special assistance to vulnerable groups as identified in the baseline section)
- Selection process and preparation of the resettlement host site. Identify the most appropriate host site in consultation with the community and bear the following aspects in mind:
  - Proximity to existing residence.
  - Access to natural resources.
  - Maintaining village organization and cohesion.
  - Maintain access to existing economic activities or proximity to replacement agricultural land, and land ownership and tenure rights.
  - Budget and implementation schedule.
  - Organizational responsibilities.

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<sup>5</sup> Compared to the Suai development, the ability to develop and implement a full RAP is higher due to more time being available before construction activities will commence. As was suggested for Suai, households residing within Betano footprint areas who will have to be resettled should have a choice in terms of the relocation site to avoid breaking community cohesion and integration.



## STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT BETANO PETROLEUM REFINERY AND BEACO LNG PLANT

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- Consultation and participation throughout the resettlement process to ensure all directly affected parties clearly understand the compensation procedure to be followed.
- Grievance redress.
- Monitoring and evaluation.
- Reduce physical and economic displacement by carefully planning and designing the Nova Betano town infrastructure around existing community assets. This should be achievable based on the town planning approach currently being considered e.g., having open spaces, vegetation and natural landscapes within the western wing of Nova Betano (RDTL, 2011b).

### ***Mitigation 5: Loss of Land, Crops and Natural Resources including Fishing and Potable Water***

To mitigate these impacts, the proponent should consider the following:

- Undertake thorough checks during the planning stage to ensure that potential land claims are settled amicably, through the use of social surveys with affected landowners and liaison with government officials.
- Develop a RAP to address the loss of crops and natural resources for all affected households (refer to mitigation for impact 4).
- The proponent would be required to replace or compensate affected households for the loss of natural resources in line with the outcomes of a RAP.
- For the loss of agricultural fields, provide land based compensation, i.e., replacement fields where possible and undertake soil, water and agricultural investigations and intervene via agricultural extension programs where necessary to ensure good agricultural yields similar to or better than before the resettlement.
- Implement the SDP strategy of offering subsidies, training and expert advice to farmers, and encouraging them to use appropriate fertilisers, high yielding varieties and pesticides to ensure that the expansion of the cash crops sector over the next 20 years contributes to Timor-Leste's goal of food security and creates jobs in rural areas. This strategy should target the farmers whose fields will be affected by the Betano development construction as this will assist them in restoring their livelihoods at replacement fields. However, this initiative should also be targeted at all farmers in the study area, as this will increase indirect economic opportunities by selling crops to newcomers.
- Ensure the replacement of fields is done in a timely manner, to ensure affected people have a prepared field available once they can no longer make use of their existing field.
- Once more detail is provided on the areas that will be dredged and no longer accessible to fishermen, identify ways to manage impacts on fishing e.g., by providing controlled access to certain fishing sites (if feasible).
- Consult with local fishermen in the planning of the fishery terminal to minimise impacts on their existing fishing activities and to optimise local opportunities generated by these facilities.



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### ***Mitigation 6: Loss of Commercial Trees***

Compensation for trees should be both financial (cash or equivalent based on market value) and in-kind (the provision of saplings). The calculation of the replacement value for fruit and nut bearing and tic trees could be based on the following:

For lost productivity, use the following formula:

- Compensation =  $V \times D + CP$
- Where:
  - V: Average market value of the produce of one tree for one year.
  - D: Average period of time required to re-establish the tree to an adult production level in years.
  - CP: Cost of planting (soil preparation, initial fertilisation).

For replacement saplings:

- Saplings of the same species as the trees that will be lost where possible. Whether these saplings will be planted at a location of the owner's choice or whether a nursery will be developed needs to be discussed with tree owners.
- Transport for the saplings to the respective village.
  - An additional 20% of saplings to compensate for trees that may not reach maturity.

### ***Mitigation 7: Disturbance and/or Loss of Access to Sacred Sites, Graves***

Mitigation measures designed to manage the impact on sacred sites and graves are as follows:

- Disturbance to sacred sites will be avoided where possible and enclosed or fenced off and controlled access allowed. If disturbance to sacred sites is unavoidable, the project will consult with the affected parties to find culturally appropriate solutions e.g., compensation for village elders to perform the required traditional ceremonies for site 'relocation'.
- Attempt to reduce impacts on sacred sites and graves through careful project planning.
- Graves located inside the Betano development boundary and not in areas to be disturbed by surface infrastructure placement, will be enclosed or fenced off and controlled access will be allowed.

In order to manage this sensitive process, a grave relocation procedure should be developed in close consultation with relevant stakeholders. This could include the following aspects:

- Registering of all affected individual graves.
- Making use of culturally significant and appropriate methods of exhumation and reintering of remains.
- Provision of resources to assist people in the relocation process (such as a hearse).



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- Conduct the process in accordance with accepted local traditions and practices and international best practice for the relocation of isolated graves (including international health standards).

An archaeological (including grave) and heritage survey and impact assessment should be prepared which outlines cultural and heritage impacts related to the project.

### ***Mitigation 8: Reduced Mobility Due to Loss of Road Network inter-linking Grazing Areas, Water Points***

The following mitigation measures apply:

- Through consultation with the community, allow access points to reduce impacts caused by fencing of footprint areas.
- Before entire footprint areas are fenced off, alternative roads and paths should be established to minimise the distance people need to travel around the fenced off areas.

### ***Mitigation 9: Population Influx***

Mitigation measures designed to reduce the number of people into the area and the impact of population influx include:

- Develop a local procurement program which gives opportunities to the local population and thereby discouraging jobseekers from other areas to move into the area.
- Development of an influx management plan together with relevant authorities and traditional authorities. This could include the following:
  - A recruitment strategy that reduces the number of jobseekers into the area.
  - A settlement management plan for existing housing and market place.
  - Sponsor community crime prevention programs.
  - A health management plan.
  - A grievance mechanism for people who might have complaints about not having access to jobs and other economic benefits.
  - An audit of available social infrastructure and the need to increase capacity based on influx.

### ***Mitigation 10: Increased Pressure on Government to Deliver on Infrastructure, Service and Administrative Demands Set by the Project***

Mitigation measures designed to increase the capacity of the national and local administration include:

- Assess opportunities for building capacity of the district administration.
- Develop training programs which are aimed at reducing the knowledge gaps in district administration.



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- Implementation of measures outlined in the SDP and prioritising the respective study areas, which include among others:
  - From 2011 to 2015 undertake an intensive road rehabilitation program
  - Implement bridge construction program
  - Scoping sewerage solutions as part of the district centres' master plan, e.g., increasing the number of houses with proper toilet facilities and building community managed toilet facilities for groups of households
  - Timely completion of the National Electricity Grid that is currently under construction.
  - Align the 'Millennium Development Goals Village Program' with the predicted demands that will be set by the project

### ***Mitigation 11: Community Health and Safety***

Mitigation measures are designed to reduce the impact on community health and safety, and potentially improve the health standard of the communities. These measures may include:

- Development of an influx management plan (as discussed under mitigation 9).
- Implement the measures outlined in the SDP, which include among others, building health clinics, hospital upgrades and expansion, expanded and improved training capacity, improved health communications and improved ambulance/transport in the health sector.
- Facilitate education and awareness programs throughout the lifespan of the Betano development.
- Establish a secure buffer zone from activities posing health and safety risks to villages or scattered dwellings.
- Develop driver training programs and strict protocols to address road safety.

### ***Mitigation 12: Basic Services and Infrastructure***

Enhancement of this positive impact can be achieved by maximising the employment opportunities derived from the infrastructure development. This will require a concerted effort to encourage local contracting and embed supporting procurement practices as well as the mitigation measures listed to reduce pressure on government services and infrastructure.

The development of a multi-stakeholder model for strategic planning and management of project related infrastructure requirements will further enhance the infrastructure development benefits. This is particularly relevant for Nova Betano where significant new infrastructure is required. Adopting a multi-stakeholder model where government and other suitable partners deliver and maintain new infrastructure to enable government to fulfil its obligations with respect to provision of municipal services in a timely manner.





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### ***Mitigation 13: The Construction and Operation of the Betano Development Triggering Localised Conflict***

To reduce the overall risks associated with this impact, government could review and implement, where feasible, six steps that have been developed by the Boston Consulting Group (2012) to help developing countries avoid the 'resource curse'. The six steps could be summarised as follows:

1. Progressive capacity building and knowledge sharing among all stakeholders.
2. A shared understanding of the benefits, costs, risks, and responsibilities related to mineral development.
3. Collaborative processes for stakeholder engagement throughout the life cycle of mining projects. This includes implementing the stakeholder consultation recommendations outlined in Chapter 5 and the Grievance Mechanism to ensure full and on-going disclosure of project information, to manage community expectations about the project and to enable stakeholders to voice their concerns.
4. Transparent processes and arrangements, especially with respect to compensation measures for any physical and economic displacement.
5. Commonly agreed upon compliance, monitoring, and enforcement of commitments.
6. Effective dispute-resolution mechanisms (BCG, 2012).

In addition to these six steps, government should ensure the focus for infrastructure development is not restricted only to Nova Betano. That is, ensuring that basic infrastructure for the broader Betano region is developed in order to improve quality of life of local people living in the area around the proposed Nova Betano.

### ***Mitigation 14: The Betano Development Exacerbating Gender Equality Issues in the Study Area***

The following mitigation measures would apply:

- Identify gender issues among the local population by facilitating discussions with men and women separately to ensure participants feel free to voice their opinions and concerns.
- Provide resources for gender sensitization training for government staff, contractors and communities to gain support and acceptance of inclusion of women in all aspects of the Tasi Mane project. There are existing training modules available as well as local NGOs (Rede Feto, Fokupers) with the capacity to deliver such training. Emphasis in the training should be on the benefits to be gained from inclusiveness.
- Put in place enabling laws, such as antidiscrimination and domestic violence legislation, in order to consolidate and strengthen the gains made in the area of governance. (e.g., gender equality is guaranteed under the Constitution and the Timorese government is a signatory to the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) and has adopted the Millennium Development Goals targets and indicators in national planning (PRD, 2005).



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### 6.10.6 Residual Impacts

The residual impacts described under the Suai Supply Base are likely to be similar for the Betano development. However, there is expected to be more time available to fully implement mitigation measures for Betano and as a result it is likely that the severity of negative impacts will be further reduced, and positive impacts enhanced after mitigation.

For example, as far as employment is concerned, the construction of the Betano development is planned as part of the 2nd stage (2013 – 2016) of the Tasi Mane project (RDTL 2011b). Thus, compared to the Suai Supply Base, more time will be available to implement training programs before construction activities commence and as a result it is possible that more local people could be employed in semi-skilled and skilled positions during the construction and operation of the Betano development.

#### ***Residual Impact 1: Job Creation***

The implementation of mitigation measures for job creation could substantially change the impact rating significance during the construction phase based on the increased time available (compared to the Suai development) for the local community and economy to adapt to the change and therefore take advantage of the available opportunities.

Local employment during the operations phase will be limited due to the technical nature of jobs; however, the number of local employees may gradually increase if intensive training programs are successfully implemented.

#### ***Residual Impact 2: Skills Development***

On-going implementation of the mitigation measures for skills development will further enhance local capacity and in turn, lift the overall capability of the Timor-Leste people.

#### ***Residual Impact 3: Economic Opportunities***

The mitigation measures for economic opportunities will result in more effective and sustainable expenditure of royalties and tax payments. It will further increase business opportunities at a local level. However, similar to job creation, limited time will be available before construction activities are scheduled to commence, thus the consequence of implementing mitigation measures such as enterprise development initiatives will only be felt towards the latter phases of construction and operation.

#### ***Residual Impact 4: Involuntary Resettlement***

The successful implementation of the mitigation measures for involuntary resettlement may result in the households being affected by physical displacement to be the same or better off after the resettlement e.g., improved housing conditions and access to services and facilities. However, this may be difficult to achieve bearing in mind the limited time available to implement mitigation measures before construction activities are scheduled to commence. Therefore, a sustained effort in this area will be required in order to ensure fair and equitable outcomes.



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### ***Residual Impact 5: Loss of Land, Crops and Natural Resources including Fishing and Potable Water***

The mitigation measures are expected to reduce the impact of the loss of crops and natural resources for those who secure continued access to these resources. For those who do not receive alternative farming and grazing land, the impact may be hard felt due to the vulnerability of cash-based livelihood strategies.

### ***Residual Impact 6: Loss of Commercial Trees***

Despite the implementation of the mitigation measures, the severity of the impact is likely to remain high due to the difficulty of mitigating this impact i.e., it is not possible to provide mature replacement trees and replacement seedlings/saplings take time to reach maturity, which results in the community being without a guaranteed food source in the medium term.

### ***Residual Impact 7: Disturbance and/or Loss of Access to Sacred Sites and Scattered Graves***

Graves and sacred sites that do not have to be relocated can be mitigated rather easily e.g., by being fenced off and allowing controlled access to these sites. However, due to the sensitivity associated with relocating sacred sites and graves, the impact will be very high for any graves or sacred sites that are disturbed.

### ***Residual Impact 8: Reduced Mobility due to Loss of Road Network Inter-linking Grazing Areas, Water Points***

The implementation of the mitigation measures would reduce the severity of this impact. However, it is not possible to mitigate in full as some farmers or villagers will end up having to travel longer distances to reach their fields, grazing areas or water points despite mitigation measures being implemented.

### ***Residual Impact 9: Population Influx***

Social problems often accompany a massive influx of foreigners and rapid urbanisation. Responses to this change can vary dramatically from person to person and can change over time, as someone either adapts, or does not, to this change. Controlling the behaviour of jobseekers moving into the area is also not easy. However, with the implementation of the mitigation measures, combined with people's tendency to adapt and accommodate change, the impacts of this change may be reduced.

### ***Residual Impact 10: Increased Pressure on Government to Deliver on Infrastructure, Service and Administrative Demands set by the Project***

If government is able to partner effectively with the district and local government and other stakeholders in implementing mitigation measures, the significance of the impact may be reduced. However, in terms of the difficulties inherent in managing the impact on local services and infrastructure, this impact may remain one of major to moderate negative significance, particularly if government is unable to partner effectively with local and district authorities to manage the operation of Nova Betano and other service and infrastructure demands.



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### ***Residual Impact 11: Community Health and Safety***

Whilst the implementation of the mitigation measures will reduce the severity of this impact, this impact cannot be mitigated entirely. The influx of people will result in an increase in social problems affecting the health of the community. The type of behaviour that leads to these risks such as excessive drinking or prostitution is difficult to fully control (see Impact 8). Similarly the increase in traffic will bring with it a number of key risks to the local community which can only be mitigated to a certain extent.

### ***Residual Impact 12: Improvement of Basic Services and Infrastructure***

The mitigation measures provided will increase the longevity of this positive impact by ensuring government can independently govern Nova Betano and any other new infrastructure to be developed.

### ***Residual Impact 13: The Construction and Operation of the Betano Development Triggering Localised Conflict***

The successful mitigation of these measures would substantially reduce the risk of conflict emerging. Unlike the Supply Base, there should be adequate time to implement some mitigation measures in full, which should reduce the risks associated with community resentment of the project.

### ***Residual impact 14: The Betano Development Exacerbating Gender Equality Issues in the Study Area***

This impact would be difficult to mitigate and will require a long-term mitigation strategy, especially to change attitudes and views among the adult population that have been formed over many years.

## **6.10.7 Monitoring and Reporting**

Monitoring is usually an internal and on-going management responsibility. It is carried out to scrutinize progress that has been made in the implementation of proposed mitigation measures, to take remedial action and to review and update plans where necessary. It also highlights key successes and failures that need to be addressed.

In order to assess whether the mitigation measures are effective in managing the socio-economic impacts associated with the Betano development, a monitoring plan will be required. Such a plan would include monitoring criteria, milestones and the resources needed to carry out the monitoring. Monitoring and responding to issues that are highlighted through monitoring, is a way in which to adapt to arising and existing social issues in the Betano study area.

The project should therefore provide for the following:

- Review existing social monitoring policies/program (if applicable) to include the monitoring of mitigation/management measures as proposed in the Strategic EIA;
- Undertake internal and external monitoring of the social management plans at a frequency determined by operations management;
- Progress reports (quarterly or bi-annual) should be written by the internal and external



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- evaluators to monitor progress made toward mitigating adverse social impacts;
- Funds for external monitoring should be provided under the project’s budget and should be factored in from the onset of the project.

### 6.10.8 Further Work

Limited project and site information was available to inform the SEIA of the proposed Betano development. Hence, the full extent of certain impacts could not be determined. Table 6-34 outlines the impacts and associated mitigation measures that require further work and the information required to complete the assessment.

**Table 6-34 Impacts and mitigation requiring further work**

Impact	Outstanding information	Task
Impact 1: Employment Impact 2: Skills development	Betano development workforce projections, in particular for operation phase and for Nova Betano (construction and operation).  Detailed workforce estimates per skills category, i.e., unskilled, semi-skilled, skilled.	Reassess impacts of direct employment on the local population.  Develop skills development/ workforce strategy.
Impact 3: Economic opportunities	Royalties and tax payments associated with the Betano development.  Breakdown of contracting opportunities and establish minimum requirements for local contractors to successfully bid for contracts.	Reassess economic impacts.
Impact 4: Involuntary resettlement Impact 5: Loss of land, crops natural resources (including fishing and potable water) Impact 6: Loss of commercial trees	Detailed baseline data as to the number of households in scattered dwellings, fields and trees in the project footprint area, linked to owners’ details and the socio-economic dynamics of owners and their families.  Roads that will be constructed or upgraded.  Water source for Betano construction and operation.  Areas that will be off limits to fishermen.	Reassess impacts associated with physical and economic displacement.  <b>Note:</b> It is very important that the resettlement and compensation principles and procedures for the three respective developments are consistent, which stresses the importance for government to undertake the resettlement gap analysis and to take corrective action, if necessary, before the compensation payments have been finalised. If this is not done, it is going to be difficult to adhere to Performance Standard 5 of the IFC at Betano and Beaco without protests from the affected households at Suai.





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**Table 6-34 Impacts and mitigation requiring further work (cont'd)**

<b>Impact</b>	<b>Outstanding information</b>	<b>Task</b>
Impact 7: Disturbance and/or loss of access to sacred sites and graves	Exact location of scattered graves and sacred sites within footprint areas.	Reassess impact once heritage and archaeology assessment studies have been completed.
Impact 8: Reduced mobility due to loss of road network inter-linking grazing areas, water points	Areas to be fenced off and approach to be adopted by government e.g., will alternative access routes be developed before fencing commences.	Reassess impact once more project information has been obtained.
Impact 9: Influx of people	Type and location of construction workforce accommodation.	Reassess impact once more project information has been obtained.
Impact 10: Increased pressure on government to deliver on infrastructure, service and administrative demands set by the project	Detailed infrastructure construction schedule to determine whether proposed timeframes are realistic.	Reassess impact once more project information has been obtained.
Impact 11: Community health and safety	Seek health specialist advice whether a health impact assessment should be undertaken or not.	Reassess health impacts based on specialist report (if necessary).
Impact 12: Improvement of basic services and infrastructure	Roads that will be upgraded or newly constructed. Energy supply for Betano development construction and operation. Confirmation about accessibility of Nova Betano to local villagers.	Verify and potentially reassess impact once more project information has been obtained.
Impact 13: Construction and operation of the Betano development triggering resentment (and potentially conflict)	Updated project information for the three sites Obtain details of previous consultations undertaken by SERN	Identify additional community perceptions about the project to accurately assess how views and concerns about the project may inform this impact, among other impacts.



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### 6.11 Land Transport

The Betano Refinery and Petrochemical development is expected to result in the increased use of land transport links between the site, other Tasi Mane project sites such as Suai and Beaco and, other parts of Timor-Leste.

The purpose of this section is to:

- Describe the methods used to assess the potential land transport related impacts of the Betano refinery.
- Report the results of the impact assessment.
- Outline measures for mitigating and monitoring predicted impacts.

It should be noted that the proposed highway from Suai to Viqueque is not part of this study.

#### 6.11.1 Study Method

There is currently no established guidance or methods for undertaking traffic and transport impact assessments within Timor-Leste.

The methods used to assess potential land transport impacts associated with the project are based on the UK Institute of Highway Engineers (IHT) Guidelines for Traffic Impact Assessment (1994). The sections of the IHT guidelines adopted for this traffic impact assessment are presented as Appendix K. Use of the standard assessment methods set out in these guidelines conforms to international practice as requirements for assessing impacts in the UK are subject to stringent European and UK legislation.

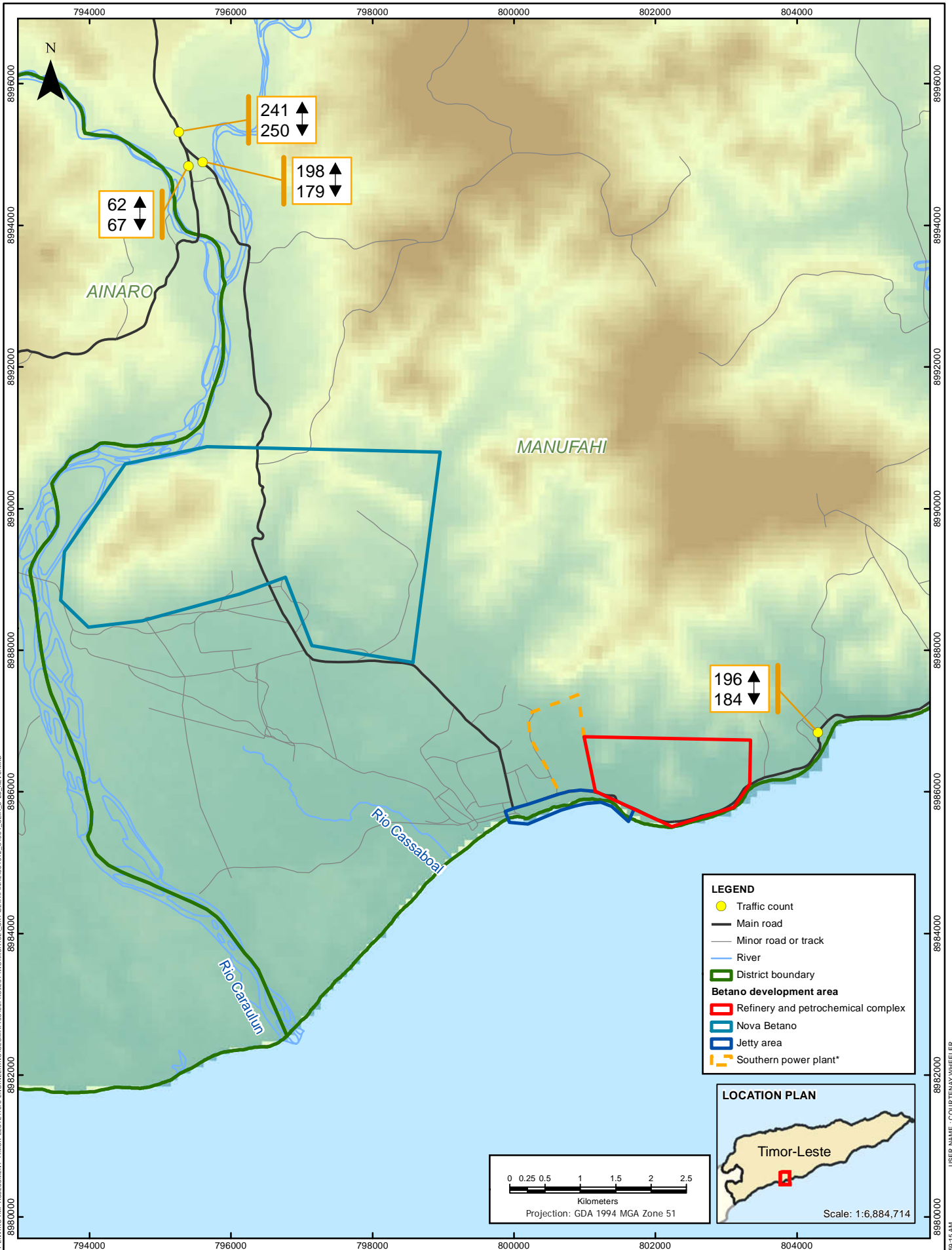
In addition to the use of these guidelines, three other guidelines were reviewed and used where appropriate. These are:

- *Guidelines for Preparation of Traffic Impact Assessment Reports Revision (2011)* Land Transport Authority (LTA), Singapore.
- *Guide to Traffic Generating Developments Version 2.2 October 2002* Road and Traffic Authority, New South Wales, Australia.
- *Transport Assessment Guidelines for Developments Version for Trial and Evaluation*, August 2006, Department of Planning and Infrastructure, Western Australia, Australia.

It should be noted that these guidelines, and many of the methods set out within them, are based on more defined, dense urban locations where significant baseline monitoring data is available. Not all of the formulae or impact measurements set out in these guidelines have been applied to the project given the nature of the existing land transport network and the limited availability of baseline data.

#### Study Area

The study area comprises existing and proposed land transport infrastructure associated with the Betano development as described in Section 4. The study area is shown in Figure 6-28 with the primary road network highlighted.



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 PROJECT: 301012-01504\_ENVIROMENT IMP ASSESSMENT TIMOR-LESTE\10.0\_ENGINEERING\GEMAT\CS\30\PROJECT\WORKSPACE\SKT\SE\AF\NAL\301012\_01504\_STA\_6\_29\_REV0.MXD  
 USER NAME: COURTNEY WHEELER  
 PLOT DATE & TIME: 30 MAY 2012, 8:58:15 AM

NOTES:

This map consists of:

- DEM: SRTM (2011)
- Rivers: Geographic Information Group TimorLeste (2010)
- Roads: DivaGIS (2010)
- District boundaries: Geographic Information Group TimorLeste (2010)
- Traffic counts: WorleyParsons (2012)

\*Not part of this scope

0	30/05/2012	FINAL FOR ISSUE	MW	CS	-	-	GH	A4 SHEET	SCALE 1:70,000
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								Copyright © WorleyParsons Services Pty Ltd	

**TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT**

**Figure 6-28**  
 Betano traffic count locations and volumes



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### Scope

This traffic impact assessment is predominantly a desktop-based assessment of the existing road network and the land transport infrastructure proposed as part of the Betano development.

The desktop assessment has been supplemented by onsite traffic observations from the study area to establish existing conditions. The impacts of the proposed development have taken into account these baseline conditions although, it is recognised that these observations only represent a “snapshot” of existing traffic patterns.

As with projects of this scale and nature, the project will be subject to more detailed planning and development which could alter the baseline assumptions and assessment outcomes. The lack of baseline data and information regarding the proposed works, has limited the accuracy of the traffic and transport assessment.

### Method

As previously stated, the method used to assess traffic impacts is based on the UK Institute of Highway Engineers (IHT) *Guidelines for Traffic Impact Assessment (1994)* and three other internationally recognised traffic impact assessment guidelines.

The purpose of an impact assessment is to establish the difference between baseline conditions (as the land transport network currently exists in both infrastructure and patterns of use) and how it will look during the construction and operational stages of the project. It is also important to understand the manner in which anticipated traffic from the project will distribute and impact the study area.

From this assessment, potential mitigation measures can be reviewed and assessed which will help to reduce impacts on the existing network and sensitive receptors, such as residences, community facilities and commercial districts, in the study area.

Broadly, there were five key stages used in the study method to assess the land transport impacts of the project. They are:

- Desktop assessment.
- Onsite traffic observations and assessment of existing conditions through development of a spreadsheet model.

Traffic observations were carried out on site at both major turning locations and at link locations. The chosen sites were monitored and movements recorded.

The methods used in the traffic counts were taken from previous studies undertaken in both the UK and Australia using methods set out within guidelines previously referred to in this section.

The duration for link count observations at each site was 12 hours for two consecutive days. Turning movement observations were conducted during the morning and evening peak hours.

All the data collected from the site observations has been used to develop an overview spreadsheet model of the local land transport network. This model has assisted the identification of both existing trip generators and existing trip distribution.



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The spreadsheet model was created to display the collected traffic count data and establish the volumes on transport links throughout the study area. With the base year conditions identified, the traffic volumes associated with the project are able to be assigned to specific transport links.

- Review of the trip generation associated with the proposed development.
- Assessment of traffic distribution in the study area by reviewing the existing traffic volumes and possible travel routes through the study area network. Impact on land transport network.

Although specific waterway crossings were not assessed as part of this study, it is envisaged that any crossing along a primary route between Suai, Betano and Beaco will need to accommodate a greater number of vehicle movements and also provide a reliable, permanent crossing.

- Mitigation, monitoring and further work required.

### *Impact Assessment - Study Method*

Impacts on the land transport network from development can be measured in both qualitative and quantitative means. This includes the following:

- Changes in volumes of vehicles.
- Changes in vehicle types using land transport links.
- Fluctuations in number of people accessing the study area.
- Increase or decrease in the length of the road network.
- Increase or decrease in the number of intersections.
- Changes in the number of pedestrian or cycle movements.
- Change in distance that vehicles travel.

The qualitative impact assessment is set out in Section 6.11.3.

Both the construction and operational phases of the project have been tested as separate traffic scenarios. Construction of the first phase of the refinery is to commence between 2013 and 2016 (30,000 BPD) and is predicted to be completed between 2017 and 2023. This will result in some overlap of the construction and operational project phases, and have associated traffic impacts. To accurately model and assess this staged impact a detailed traffic model is recommended.

For desktop assessment purposes, it has been assumed that the construction traffic trips occur at the same time. To reflect that there will be some level of operation during the construction phase, a nominal amount of daily light and heavy vehicles have been assigned between Suai, Betano and Beaco. Spreadsheet modelling is not accurate enough to suggest a growth rate attributed to the construction traffic rather, the percentage change in volume on individual links is presented. An average growth across all links through the Betano study area indicates an increase of approximately 50% over the current volumes. It should be noted that the existing traffic volumes on the network are very low, hence, the high percentage increase.





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The operational scenario tested assumes 14,000 residents at Novo Betano, and to account for the ongoing construction phases of Suai and Beaco, daily light and heavy vehicle trips have been assigned between Betano and the other development areas. The average growth across all links through the Betano study area, are likely to result in an increase in the order of approximately 120% over current volumes.

### ***Data Assumptions and Limitations***

Limited data availability has increased the reliance on a series of 'high-level' assumptions relating to both current and future use, and condition of the road network. Specific limitations and assumptions are described below and are discussed in relation to the assessment in Section 6.11.3.

There is limited availability of traffic count information in Timor-Leste. Historical data is set out within two separate reports which provide limited information on traffic counts around the study area. These two reports are:

- *Road Sector Investment Planning in Timor-Leste*, The Louis Berger Group, Inc. Technical Working Paper October 2006 (LBG, 2006).
- *Road Sector Investment Planning in the Pacific. An Example of Good Practice*, Timor-Leste, Asian Development Bank, July 2007 (ADB, 2007).

Historical traffic count data and trends in land transport modes are important in establishing patterns in traffic use on specific roads over time. These trends provide an indication of the level of underlying growth in traffic that isn't attributed to the project's construction and operational phases.

### **6.11.2 Existing Environment**

The existing land transport network in the study area is limited. As set out in ADB (2007), the core road network of Timor-Leste in 2007 comprised 1,400 km of national roads and 800 km of district roads which is a small national network when compared to those of many countries in the region. Since 2007, there has been little expansion in the core network, which is comprised of the following (road designation number is in brackets):

- National road between Betano and Same heading north from the study area (A05).
- National road between Betano and Alas Jct (Natarbora) heading east from the study area (A14).
- National road between Daisna and Hato Udo road heading west (A05).

Other roads in the study area are primarily urban roads within townships and rural roads leading from either urban roads or the core network to individual properties or locations. There are no known cycle paths and limited pedestrian facilities. The majority of roads in the area are not surfaced, in poor condition and affected by seasonal weather patterns.

### ***Desktop Assessment***

There is limited existing information available on the land transport network in the study area. No strategic or statutory land transport plans are available. The primary source of information for the land transport network is ADB (2007). This report sets out information and data on the existing land



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transport network in Timor-Leste as well as recommendations for forward planning and strategic development of the road network.

The status of recommendations from this report is unknown. However, a number of core network roads were considered for immediate, medium and longer term investment to improve linkages between Betano and other locations in Timor-Leste. There are various levels of road investment being; heavy, medium and light, as defined in ADB's Road Sector Investment Planning Report (2007). The level of investment differs depending on whether the road is sealed or unsealed; however, investment levels range from light investment which comprises periodic maintenance operations, such as re-gravelling, up to heavy investment that would be considered major roadworks.

The core network links highlighted for investment comprised of the following:

- Heavy investment in the A12 link between Maliana and the A02 at Zumalai.
- Heavy investment in the A13 link between Same and Betano.
- Medium investment in the A13 between Betalula and Same.
- Light investment in the A13 between Hatuto and Aissa.
- Light investment in the C23 between Alnaro and the A13 at Hatuto.
- Light investment in the A14 between Betano and Viqueque.

Some traffic observations and network condition reporting is provided within LBG's Road Sector Investment Planning report (2006). Available data for roads within the study area, which informed the recommendations set out in ADB (2007) are set out in Table 6-35.

**Table 6-35 Core Road Network Characteristics**

From	To	Surface	Length	Width	Last Surfaced	Quality	Annual Average Daily Traffic (AADT) (year data recorded)
Alas Jct	Betano	Paved	9.1 km	3.5 m	2002	Good	245 (2005)
Same	Betano	Paved	24.4 km	4.4 m	1997	Fair	397 (2005)
Aissa	Hato Udo	Paved	16.9 km	3.5 m	1996	Poor	151 (2005)

### **Onsite Traffic Observations – Existing Conditions**

Onsite road conditions were assessed for the study area during site observations completed for the project.

Traffic observations were undertaken in the study area in late 2011 at two main locations, namely:

- Betano intersection with link counts for roads to Seli and Belana.
- Betano Simpang Tiga intersection, with link counts for Betano, Hato Udo and Same.



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The locations of the traffic count observations through the Betano area are shown in Figure 6-28 (page 6-266) and actual site photographs are set out in Plate 6-46 and Plate 6-47.

Observations were taken in Betano to understand the movements around the urbanized part of the study area. It should be noted that the data was collected in late 2011 during the start of the wet season and travel behaviour often changes during seasons, and as such, there is significant uncertainty associated with the data collected. The traffic counts are provided in Table 6-36 and reflect average daily link volumes at the locations shown in Figure 6-28 (page 6-266).

**Table 6-36 Study Area Traffic Observations 2011**

Link Name	Between		Road Number	Direction		Two-way Combined
	Same	Daisna		1	2	
Same	Same	Daisna	A05-2	241	250	491
Betano	Same	Betano	A05-3	198	179	377
Seli	Betano	Seli	A14-2	184	196	379
Hatudo Link	Same	Junction A13	Local	67	62	129

The volume of vehicles observed at each location was consistent across the two recording days. The location to record the highest daily counts, Same, reflects the activity around the district capital’s urban area.

It was apparent that no noticeable investment or significant improvement in road conditions for the core road network has occurred since the completion of the assessment by the ADB between 2005 and 2007. Core roads linking villages and towns within the study area are in poor condition with the urban and rural roads poor and subject to significant impacts from weather events.

Traffic management throughout the land transport network is limited. For example, there are no controls at intersections. Pedestrian facilities are minimal in towns and villages and are generally restricted to untreated and informal paths which have formed over years of use.

***Existing Trip Generation and Trip Distribution***

The trip generators through the local study area are primarily focused around the Betano village and Same.

The distribution of trips through the Betano area local road network appears relatively consistent throughout the day, with a lack of a specific tidal movement from one area to another at any particular time of day. The 2011 surveys suggest a reasonably strong movement of trips between Same and Seli where traffic travels through Betano.

Source: Gaspar Da Costa, 2011



Plate 6-46 Betano Simpang Tiga intersection

Source: Gaspar Da Costa, 2011



Plate 6-47 Betano Town intersection





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### 6.11.3 Environmental Impacts

This section describes the potential impacts of the project on the land transport network in the study area for both construction and operational phases. Where possible, reference is made to existing conditions set out in previous sections to provide a clear link between the impact of movement as a result of the project, as opposed to the existing and expected impacts without the project.

For the purposes of the impact assessment it has been assumed that:

- Outside of the influence of the project, there are very few other land uses which would generate traffic levels that could affect the land transport network. No other significant developments are known for the study area.
- Travel patterns of the local population would not be altered as the majority of trips made on the land transport network are localised and relate to key daily activities, commerce, school trips, work trips and movement between villages and key urban areas.
- There are no significant influences of inter-regional trips along the core road network. There are no significant trip generators or new links known outside the study area which could heavily influence traffic patterns on the local transport network.
- There are no known GoTL strategies or plans in place to change investment levels in the road network or make improvements to the land transport network conditions outside of those that may be required for the project. Transport network proposals set out in ADB (2007) do not appear to have progressed within the project area and represent very little investment in improving existing roads.

#### ***Construction Impacts***

The baseline 2011 traffic volumes are shown in Section 6.11.2 Existing Environment in Figure 6-28. Not all links will have impacts during the construction stage as there will be no significant known generation of traffic along those links. However, all of the links with additional traffic resulting from the project would see an increase in the volume of heavy vehicles. Although the 2011 count information did not record the proportion of heavy vehicles on the road network, anecdotal information, knowledge of the road network conditions and details provided in LBG (2006) indicate that there is currently very little movement of heavy vehicles in the study area.

Given the low existing traffic volumes and the deteriorated road surfaces, there would be measurable impacts on other users, adjoining land uses and on the core road network conditions. These impacts, and potential changes to trip generation and distribution across the road network, are set out below.

- Movements in the study area are expected to be primarily heavier vehicles associated with the construction of the project.
- Heavy supply and construction material may be transported to Betano from the Suai Supply Base by road. The majority of the heavy vehicle trips associated with the construction phase from the Suai quarry sites would affect on the local traffic network as these vehicles would have to pass through Betano to access the refinery and MOF sites.





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- Increase in the volume of traffic along roads in the study area, primarily heavy vehicles, would result in impacts on air and noise quality along key links at Betano.
- The nature of existing road network conditions will also likely require slow speeds and constant deceleration and acceleration of trucks and buses increasing more localised air quality and noise impacts.
- The ability of many roads to handle a significant increase in daily movements of heavy vehicles is questionable given the current poor pavement conditions.
- Use of heavy vehicles on the core road network will result in a further deterioration of road network conditions as described in Section 6.11.2. Impacts will be pronounced during the wet season where sideways movement of trucks and buses along roads in poor conditions will exacerbate the existing poor condition of the majority of roads.
- Increase in the volume of traffic passing through Betano in particular will result in a decreased level of safety for other road users around the Betano village turn location. At present, the majority of vehicle movements at this location are by motorcycles or small vehicles. Increasing heavy vehicles in this location could affect the more vulnerable road users such as pedestrians and cyclists.
- Movement of heavy vehicles along all roads in the study area during heavy weather events or dusk will result in reduced safety for other road users.
- It is predicted that approximately one-third (30%) of the construction workforce is likely to be local labour from Betano, and 10% is assumed to arrive by light vehicle. The remaining personnel are predicted to arrive from Nova Betano on buses.

### ***Operational Impacts***

Following commissioning of the Betano Refinery and Petrochemical Complex, it is expected that vehicle movements on the road network in the study area for the operational stage will see a greater number of light vehicle trips than heavy vehicle trips.

The majority of vehicle trips associated with the operational stage of the project would be from Nova Betano to the refinery and the MOF, a smaller number from Nova Suai to the Betano development area, and vehicles passing through the area from Suai to the Beaco development area. Heavy vehicle impacts would be largely dependent on the method of distribution of the refinery product. The land-based distribution of this product has not yet been assessed. The only heavy vehicles passing through Betano would be buses ferrying workers from the refinery to Nova Betano.

Operational impacts, and potential changes to trip generation and distribution across the road network, are set out below.

- Of the approximate 14,000 residents located at Nova Betano, approximately 20% are likely to be workers at the refinery. The majority of workers (>90%) from Nova Betano would be expected to travel by bus.
- Movement of workers from Nova Betano to the refinery by private vehicle is predicted to be a relatively low (5%) proportion of total private vehicle trips from Nova Betano.



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- Significant increase in the movement of light vehicles to Nova Suai and Nova Viqueque from the refinery.
- Due to phased construction, light and heavy construction vehicles would continue to travel between Suai, Betano and Beaco.
- Movement of heavy supply and construction material vehicles to Suai and Viqueque from the refinery in each direction is estimated to occur on a daily basis.

### Impacts summary

Impacts on the land transport network associated with the project have been measured through qualitative criteria set out within the UK Institute of Highway Engineers (IHT) *Guidelines for Traffic Impact Assessment (1994)* and the supporting *Guidelines for the Environmental Assessment of Road Traffic* (Institute of Environmental Assessment, 1991). The criteria attributed to impacts are set out in Table 6-37.

**Table 6-37 Significance criteria**

Significance	Criteria
Major	These effects are likely to be important considerations at a regional or district scale but, if adverse, are potential concerns to the project, depending on the relative importance attached to the issue during the decision making process. Mitigation measures and detailed design work are unlikely to remove all of the effects upon the affected communities or interests.
Moderate	These effects, if adverse, while important at the local scale, are not likely to be key decision making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource. They represent issues where effects will be experienced but mitigation measures and detailed design work may ameliorate/enhance some of the consequences upon affected communities or interests. Some residual effects will still arise.
Minor	These effects may be raised as local issues but, are unlikely to be of importance in the decision making process. Nevertheless, they are of relevance in the detailed design of the project and consideration of mitigation or compensation measures.
Negligible	No effects or those which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

A summary of the impact categories and the predicted level of impact on the land transport network are set out in Table 6-38.



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**Table 6-38 Impacts summary - land transport network**

Impact	Stage	Criteria Measurement
Air and noise quality impacts.	Construction	Moderate
Deterioration of road condition due to significant increase in daily movements of heavy vehicles.	Construction	Moderate
Deterioration of roads from significant increase in daily movements of light vehicles.	Construction	Moderate
Reduction in safety for other road users around the Betano village intersection	Construction	Moderate
Change in road safety for pedestrians in the study area.	Construction	Moderate
Impact on existing intersections.	Construction	Moderate
Air and noise quality impacts.	Operation	Moderate
Deterioration of roads from significant increase in daily movements of light vehicles.	Operation	Moderate
Change in road safety for pedestrians in the study area.	Operation	Moderate
Change in road safety for other road users (increased volumes of at least 130%)	Operation	Major
Introduction of new intersections.	Operation	Minor
Impact on existing intersections.	Operation	Minor
Impact on local road network requiring improved traffic management - Nova Betano.	Operation	Negligible

### 6.11.4 Avoidance, Management and Mitigation Measures

The impacts of the construction and operational phases of the project set out within Table 6-38 have been addressed individually in the following sections; however, they are also subject to the almost certain change arising from the detailed engineering design and related amendment to the mitigation measures. These measures would be designed to reduce the environmental impacts on the local transport network.

#### **Construction**

##### *Air and noise quality impacts*

- Detailed assessment of air quality issues, impacts and mitigation measures are set out in Section 6.4.



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- Detailed assessment of noise issues, impacts and mitigation measures are set out in Section 6.5.

### ***Road condition –heavy vehicles***

The existing core road network in the study area is in poor condition. The impact of additional heavy vehicle use, in particular, during and after rainfall, will cause further deterioration in the state of national and district roads.

- Key roads used for access to the construction sites should be upgraded in accordance with accepted design standards to be able to handle both the anticipated volumes and nature of the various heavy vehicles employed on the project. The surfaces should be adequate (gravel or pavement) to withstand the multiple construction phases and should reflect accepted design standards.
- Drainage is a key issue for the maintenance of pavement conditions during the construction stage and beyond. Roads should be designed to include the requisite level of drainage that does not otherwise impact negatively on existing drainage features or properties.
- Heavy vehicles moving between the Suai, Betano and Beaco development areas should be restricted to key routes only and should not travel on local roads where possible. Any local roads impacted should also be upgraded or constructed to accepted design standards.
- Traffic management controls should be upgraded to provide priority for through movements which will reduce deceleration and acceleration of heavy vehicles, where appropriate. Each intersection along the key routes from the supply base to the refinery and LNG plant should be examined for improvements in traffic management.
- Regular maintenance and review of pavement and drainage features should be undertaken during the construction period and repaired as required.

### *Road condition – light vehicles*

The mitigation and management measures in the previous section will also provide mitigation for the impacts of additional light vehicle movements.

### *Decreased level of safety for road users around Betano - construction*

Road network improvements proposed to cater for construction vehicles will provide some mitigation for the potential impacts around Betano.

- Dedicated areas for motorcycle parking should be provided away from the proposed heavy vehicle routes through Betano.

### *Change in road safety for pedestrians*

Increase in heavy traffic volumes and the proposed improvements to the road network will result in a changed environment for pedestrians.



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- Temporary manned and controlled pedestrian crossing points should be provided at key locations where there is significant heavy vehicle traffic. These locations include in front of schools, commercial locations and community facilities.
- A Traffic Management Plan should be developed at each construction stage of the Betano development which clearly sets out which routes vehicles can use, when these routes will be used and the volume of vehicles anticipated.

### *Impact on existing intersections*

The road improvements proposed as part of the project will result in both positive (improved road condition), and negative (increased traffic volumes/congestion) impacts at existing intersections.

- A detailed review of the existing road network function and impacts at intersections should be undertaken as part of the design process.

### **Operation**

#### *Air and noise quality impacts*

- Detailed assessment of air quality issues, impacts and mitigation measures are set out in Section 6.4.
- Detailed assessment of noise issues, impacts and mitigation measures are set out in Section 6.5.

#### *Road condition light vehicles*

- Key roads used for access to the project should be upgraded using accepted design standards to be able to accommodate the anticipated level of traffic and provide year-round access.
- Drainage is a key issue for the maintenance of pavement conditions during the operational phase. Roads should be designed to include the requisite level of drainage that does not otherwise impact negatively on existing drainage features or properties.
- Appropriate lighting should be provided on key links where there is likely to be significant traffic flow at night.

#### *Change in road safety for pedestrians*

- An assessment of the existing pedestrian routes along the A05-3 and A14-2 should be undertaken to understand the impacts of the new access point into the refinery and petrochemical complex and how people will access the area.
- Formalised pedestrian crossings should be provided along the A05-3 and A14-2 where there is anticipated to be movement of pedestrians across the section of road anticipated to be more heavily trafficked.

#### *Introduction of new intersections*

- Clear signage and lighting should be provided within the design of new intersections for the access to the refinery along the A14-2.





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- Traffic management controls should be provided at new intersections providing priority along the A14-2.
- Pedestrian crossing points should be incorporated into intersection design.

### *Impact on existing intersections*

- A detailed review of the existing road network function and impacts at intersections should be undertaken as part of the design process of the road network and intersection improvements proposed for the operation stage.

### *Impact on local road network requiring improved traffic management - Nova Betano.*

- The road network design for Nova Betano should be completed to a recognised standard and include pedestrian facilities where possible.

### **6.11.5 Residual Impacts**

Mitigation and management measures set out in Section 6.11.4 have been designed to address the key impacts on the land transport network. Not all impacts can be mitigated entirely, as the introduction of additional traffic on the road network in the study area will result in ongoing impacts and issues related to road safety and interaction of pedestrians, cyclists and motorcyclists and light and heavy vehicles associated with the project.

The most critical mitigation measure will be significantly improving the condition of the existing road network which is poor to very poor. This mitigation measure will; however, likely see more informal use of the road surface by pedestrians and motorcyclists as they will be attracted to all weather routes rather than some of the existing fair weather-only urban or rural roads. This in turn will highlight the importance of road safety issues and management of the road network to reduce potential road trauma. These issues can be assessed and managed at a local level.

### **6.11.6 Monitoring and Reporting**

The monitoring and reporting measures for the land transport network during the construction and operational phases are set out below.

- It was noted in Section 6.11.1 that there is a lack of historical traffic data for the study area and this has resulted in there being limited understanding of traffic growth or distribution patterns. In order to understand the impact of both project related construction and operation traffic on the land transport network, annual traffic observations should be undertaken on key links as identified in Table 6-36. These observations should be recorded and made available to the GoTL along with 2011 baseline information included in this SEIA to monitor the traffic volumes in the study area.
- Annual pavement condition reports should be undertaken for all key links in the core road network to allow for programming of maintenance. These condition reports may be used to prioritise upgrades required for the project.
- Annual review of all traffic management measures, including signage and lighting, should be undertaken to maintain all traffic management controls in place. Ongoing maintenance of



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traffic management measures should be undertaken on an as-needed basis e.g., replacement of signage, remarking lines and markers and replacement of road safety items such as reflective raised pavement markers.

- All incidents or near miss vehicle incidents for all traffic generated by the project should be recorded, including traffic moving between the Suai, Betano and Beaco development areas during construction and all vehicles moving to and from Nova Betano to the refinery and other sites during the operational stage. A management plan for dealing with the health and safety implications for all vehicle incidents and recommending improvements should be developed and updated annually.

### 6.11.7 Further Work

It is recommended that a full Transport Impact Assessment be undertaken for the Betano Refinery and Petrochemical Complex, and the new town of Nova Betano. To enable this assessment to be prepared, it is important to gain a full and robust understanding of the current local conditions of the study area. This baseline data collection program should include:

- Current traffic movements through all useable roads in the local area. This data should be gathered at various times during the year to form a representative baseline of traffic count data.
- Accurate population, employment and travel to work data should be gathered for the Same and Betano areas which will inform the distribution and assignment of traffic through the road network.
- Accurate vehicle fleet composition to enable the capacity on existing infrastructure should be calculated.
- All development proposals (land and road network) in the area that would impact on people's movements and travel behaviours.
- Full detailed plans for the operational phase of the Suai, Betano and Beaco developments should be compiled. These details should include the proposed number of trips between all sites and the proposals for routes and delivery of materials and products from each location. This will enable the impact for the wider area along the south coast to be assessed as well as the Betano area itself.
- Staged development of the transport network, including costings, should be updated to reflect revised plans for land uses along the south coast.
- Development of a Traffic Management Plan to enable the safe planning and design of the road network through both the construction and operational phases of the project.

It is also recommended that GoTL should develop a transport master plan, complete with local infrastructure plans, strategies and policies to address potential growth in the area as a result of infrastructure and industrial improvements.



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## 6.12 Waste Management

The focus of this section is to describe typical waste management strategies that could be employed at the Betano Petroleum Refinery. Waste management at the Betano development area will rely on the development of new facilities and waste management areas as, in general, there are no suitable industrial-scale waste management facilities available there currently.

This section does not address the potential impacts of waste on air, land, water, biodiversity, land use and visual amenity, as these impacts have been described in earlier sections of Chapter 6.

Section 6.12.1 describes the existing waste management facilities in Timor-Leste.

Section 6.12.2 details the waste types that will typically be generated during construction and operations and Section 6.12.3 provides estimates of likely waste quantities.

Sections 6.12.4 and 6.12.5 describe typical waste management strategies and processes that could be employed, including reduction, reuse and recycle, treatment and disposal, storage and transportation and monitoring.

Section 6.12.6 details the waste management facilities required at the Betano development area to deal with the wastes described and estimated in Sections 6.12.2 and 6.12.3.

### 6.12.1 Existing Waste Environment

Minimal solid and liquid waste management facilities currently exist in Timor-Leste. As a result, waste is often left untreated resulting in contamination of land and waterways. This is particularly prevalent in highly populated towns and coastal villages.

#### **Solid Waste**

Solid waste in Timor-Leste's capital, Dili, is collected by commercial operators and transported to the Tibar landfill for disposal. The Tibar landfill, approximately 70 km north northwest of Nova Betano and 110 km north west of Nova Beaco, is the only landfill site available to dispose of solid waste from Dili. The landfill accepts medical (hospital) waste, including non-hazardous and hazardous waste (Carlos Lopes Ximenes, 2011).

Despite solid waste collection in Dili, the service is incomplete and a lot of waste remains on the streets and eventually enters streams flowing into the sea (GoTL (2008b) in World Bank, 2009). Occasionally, piles of garbage are burned (Sandlund *et al.*, 2001).

Illegal dumping of waste is also common. Large piles of waste are dumped on the side of streets and at abandoned lots without treatment or compaction. Mangroves are also used as dumping grounds for solid waste, particularly in areas adjacent to the coastal highways (Stockwell (2002) in World Bank, 2009).

There is another landfill near Baucau, approximately 110 km northeast of Nova Betano and 50 km north of Nova Beaco; however, like the Tibar landfill near Dili, is too far away from the development areas to be considered as a viable alternative to deal with the wastes produced (Sandlund *et al.*, 2001).



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Litter is a substantial problem in Timor-Leste, particularly in urban areas. During heavy rainfall, plastic and other materials are washed into the ocean from rivers and open drains (IMF, 2005). Drainage channels are also becoming blocked with solid waste, kangkung and sediment, resulting in flooding and dangerous levels of pollution (RDTL, 2011b).

The GoTL does not have a formal system for the collection, transportation and disposal of solid waste outside of Dili (GoTL (2008b) in World Bank, 2009) and existing systems for solid waste disposal are described as inadequate (IMF, 2005). In the Covalima, Manufahi and Viqueque districts, a single individual produces between 1 and 3 litres of waste per day (RDTL, 2011a). As the population of these districts continue to grow, it is imperative that effective solid waste management systems are implemented.

### ***Liquid Waste***

Liquid waste is a major issue in Timor-Leste as it can cause soil and water contamination, as well as impact the health of terrestrial and aquatic species (Carlos Lopes Ximenes, 2011). Existing systems for liquid waste disposal are currently inadequate (IMF, 2005).

#### *Waste Oils*

Hundreds of small workshops produce waste oil which often leaks into the city drainage and has been known to contaminate the soil (Plate 6-48) (World Bank, 2009). The Secretary of State of Environment has constructed a facility to store used oil at the Tibar landfill. The facility contains seven tanks, each with a capacity of 120,000 litres (Plate 6-49). Two collection trucks have also been made available to transport the waste oil to the facility.

Waste oils and other dangerous wastes are also dumped at the Tibar landfill near Dili (Sandlund *et al.*, 2001).

#### *Sewerage System*

No sewerage system currently exists in Timor-Leste. Despite 36 per cent of the population having access to toilet facilities and sanitation, the waste is generally left untreated to flow into open drains and out to the beaches (GoTL (2008b) in World Bank, 2009). Those households without proper sewage facilities use drains, rivers, fields or gardens for disposal. This results in the contamination of waterways, groundwater and shallow wells, which is particularly important in population centres such as Dili, that rely on the shallow wells for their water supply (World Bank, 2009). Contact with the contaminated water by kangkung farmers, children playing in the drainage channels and the general community also poses a serious health risk (RDTL, 2011b).

Septic tanks are currently used in some homes in Nova Betano and Nova Beaco. The septic tanks are rectangular in shape, with 1 m length, 1 m width and 1.5 m depth, or round shape with a diameter of 0.8 m and 1 m depth (RDTL, 2011a).



Source: Carlos Lopes Ximenes, 2011



Plate 6-48 Typical leaking oil drum

Source: Carlos Lopes Ximenes, 2011



Plate 6-49 Oil storage tanks at Tibar





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### 6.12.2 Waste Types

#### **Construction**

The waste types that will typically be generated at the Betano development area during construction will largely comprise of greenwaste and industrial waste. These wastes are listed below.

#### Solid Waste

- Greenwaste (i.e., leaves, flowers, grass clippings and weeds), timber, topsoil and ASS from early works to prepare the site.
- Construction debris (i.e., wood, scrap metal, glass, insulation and plastic) and general industrial waste (i.e., concrete, steel, metal).
- General (domestic) waste, paper and cardboard.
- Waste clothes and fabric.
- Tyres.
- Redundant electrical goods.
- Empty drums and containers.
- Empty gas cylinders.
- Batteries.
- Medical and first-aid station waste.
- Dredging material (i.e., spoil from the shipping channels and establishment of the docks).
- Waste rock and soils.
- Ash from the incinerator.

#### Liquid Waste

- Domestic sewage and greywater.
- Waste oils, grease and fuels.
- Waste chemicals, paints, adhesives and solvents.
- Engine coolant and cleaning agents.
- Stormwater runoff.

#### Gaseous Waste

- Gaseous and particulate emissions from earthworks and vehicle movements.



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**Operation**

The waste types that will typically be generated at the Betano development area during operations will comprise waste from maintaining the refinery, petrochemical complex and Nova Betano (Table 6-39).

It is anticipated that mercury will be generated by the refined product streams although the exact quantity cannot be determined with the information currently available. The mercury will be removed using a mercury adsorbent material. The adsorbent material will be transferred periodically to the Waste Management Area where it will be analysed to determine an acceptable disposal location.

**Table 6-39 Waste types generated during operations**

Waste Type	Source Location		
	Refinery	Petrochemical Complex	Nova Betano
<b>Solid Waste</b>			
General (domestic) waste	√	√	√√√
Batteries	√	√	-
Oily rags and filters	√√√	√√√	-
Ash from high-temperature incinerator <sup>1</sup>	√	√	-
Contaminated soil from accidental spillages	√√	√√	-
Mercury adsorbent	√	-	-
<b>Liquid Waste</b>			
Domestic sewage and greywater	√	√	√√√
Waste oils, grease and fuels	√√	√√	-
Waste chemicals and solvents	√√	√√	-
Stormwater runoff	√	√	√
Process water	√	√	-
Saline plume from the reverse osmosis plant	√√	-	-
Ballast water from ships	√	√	-
<b>Gaseous Waste</b>			
Gaseous and particulate emissions from vehicle movements (i.e., NO <sub>x</sub> , CO <sub>2</sub> , PM <sub>10</sub> and PM <sub>2.5</sub> ).	√	√	√

<sup>1</sup> Ash from a high-temperature incinerator that would potentially be generated at the Waste Management Area (see Section 6.12.6).

√ Refers to the likelihood and relative volume of the waste type being generated at the source location.

**6.12.3 Waste Quantities**

An estimate of the typical waste quantities that will be generated at the Betano development area during construction and operations is not known at this stage and will be determined during the detailed design stage. Management strategies and disposal methods are discussed in more detail in Section 17.5 and are summarised in Section 6.12.5.



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### 6.12.4 Waste Management Hierarchy

Waste management for the Betano development area will comply with relevant and applicable parts of the Democratic Republic of Timor-Leste's (RDTL) Government Decree Law 5/2011 on environmental licensing.

The reuse, reduce and recycle hierarchy (RDTL, 2011a) will be adopted for the management of waste generated during construction, operations and maintenance activities at the Betano development area. This hierarchy includes the following:

- **Reduce.** Avoid, eliminate or reduce practices that result in waste generation.
- **Reuse.** Reuse waste materials where practicable.
- **Recycle.** Convert waste into other useable materials.

#### **Reduce**

Processes will be designed and implemented to avoid, eliminate and reduce the generation of waste. This may include:

- Considering alternative products, i.e., substituting raw materials with less hazardous or toxic materials, and substituting materials for more environmentally friendly options.
- Using good housekeeping and operating practices, including inventory control.
- Using strict segregation processes to prevent the co-mingling of water and waste streams.
- Using low-sulfur diesel-powered equipment, where practicable.
- Ensuring equipment is maintained in accordance with the manufacturer's specifications.
- Reusing treated sewage effluent, greywater and stormwater as potential onsite irrigation.
- Reusing cleared site vegetation as a mulch to aid site landscaping following site earthworks.
- Clearing the smallest construction footprint possible, therefore reducing the generation of greenwaste, topsoil, dredge spoil, overburden, ASS and greenhouse gases.

#### **Reuse and Recycle**

The total amount of waste will be reduced through the implementation of recycling and reuse strategies. These strategies may include:

- Identifying reuse opportunities and assessing which materials could potentially be recycled.
- Identifying market demands for waste streams in the vicinity of Nova Betano (i.e., reuse of concrete to build roads).
- Installing dedicated skip bins for designated wastes around the construction site.
- Establishing a waste management area where waste can be sorted.



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Potential recycling or reuse of wastes, as given in Table 6-40 may include scrap metal, glass, some industrial waste (i.e., concrete), some general (domestic) waste, drums, containers and some waste oils.

### 6.12.5 Waste Management Strategies

Additional waste management strategies will be adopted following implementation of the waste management hierarchy (see Section 6.12.4), and will include:

- **Treatment and disposal.** Use treatment methods to render wastes safe and dispose of products that can no longer be reused or recycled to an appropriate location.
- **Storage and transportation.** Appropriately store and transport wastes to minimise accidental releases to air, soil or water resources.
- **Monitoring.** Regularly monitor activities to ensure waste management strategies are effective.

Waste management strategies have been provided below and will be further developed as part of the project’s environmental management plan (EMP).

#### *Treatment and disposal*

Waste materials generated after implementing reduce, reuse and recycling measures will be treated before disposal.

Sewage, greywater, stormwater, process water and hydrotest water will be the only wastes treated. They should all be treated by the wastewater treatment plant, before being irrigated to land and reused onsite. Treated water could be irrigated or discharged to the sea.

Waste disposal will be in accordance with the methods given in Table 6-40 and in a manner that, as far as practicable, avoids potential impacts to human health and the environment. Waste disposal will only occur at permitted facilities within the waste management area.

Due to the limited number of waste management facilities in Timor-Leste, incineration has been proposed as a viable option to reduce disposal volumes. It is expected that ash from the incinerated waste will be disposed of at a landfill.

**Table 6-40 Generated waste types, and management and disposal methods**

Waste type	Management Strategies/Treatment	Disposal Methods
<b>Solid Waste</b>		
Greenwaste	Stored in a bin before being incinerated.	Incinerator ash to landfill.
Construction debris – wood material	Stored in a skip before being incinerated.	Incinerator ash to landfill.
Construction debris – scrap metal	Sorted, segregated and stored in a skip.	Recycled or landfill.
Construction debris – glass	Sorted, segregated and stored in a skip.	Recycled or landfill.



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**Table 6-40 Generated waste types, and management and disposal methods (cont'd)**

Waste type	Management Strategies/Treatment	Disposal Methods
Construction debris – insulation	Stored in a skip before being incinerated.	Incinerator ash to landfill.
Construction debris – plastic	Stored in a skip before being incinerated.	Incinerator ash to landfill.
Industrial waste (i.e., concrete, steel, metal)	Sorted, segregated and stored in a skip or a designated area.	Recycled or landfill.
General (domestic) waste, paper and cardboard	Sorted, segregated and stored in a bin.	Recycled or landfill.
Waste clothes and fabric	Stored in a bin before being removed.	Landfill.
Tyres	Stored in a skip or a designated area. Shredding and debanding by an industrial shredder.	Landfill.
Redundant electrical goods	Stripped of restricted materials then stored in a skip.	Landfill.
Drums and containers	Sorted, segregated and stored in a skip. Cleaned and crushed (using the industrial shredder).	Recycled or landfill.
Empty gas cylinders	Sorted, segregated and stored in a skip.	Recycled or landfill.
Batteries	Sorted, segregated and stored in a skip.	Recycled or returned to the manufacturer.
Oily rags and filters	Sorted, segregated and stored in a skip. The wastes are then taken to the incinerator.	Incinerator ash to landfill.
Medical waste	Incinerated.	Incinerator ash to landfill.
Topsoil	Stockpiled and managed for reuse during rehabilitation.	Reuse onsite.
Overburden and waste rock	Stockpiled and managed for reuse onsite.	Reuse onsite.
Mercury adsorbent	Collected and stored in sealed containers. Adsorbent will be analysed to determine acceptable disposal location (i.e., hazardous or non-hazardous section of the landfill).	Analysis of the adsorbent to determine acceptable disposal location.





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**Table 6-40 Generated waste types, and management and disposal methods (cont'd)**

<i>Liquid Waste</i>		
Domestic sewage and greywater	Collected and pumped to the wastewater treatment plant. Note: The option of dewatering the sewage and incinerating the sewage sludge may be considered in the future.	Wastewater treatment plant. Following treatment it will be reused onsite or discharged to sea.
Waste oils, grease and fuel	Sorted, segregated and stored in individual drums. The waste oil is then taken to an oil storage tank (until it is filled, when it will then be taken to the incinerator). The other wastes are taken straight to the incinerator.	Recycled, oil storage tank or landfill.
Waste chemicals, paints and adhesives	Sorted, segregated and stored in individual drums and skips. The wastes are then taken to the incinerator.	Landfill.
Engine coolant and cleaning agents	Sorted, segregated and stored in individual drums and skips. The wastes are then taken to the incinerator.	Landfill.
Stormwater runoff	Collected (using a drainage and sump system) then pumped to the wastewater treatment plant.	Wastewater treatment plant. Following treatment it will be reused onsite or discharged to sea.
Process water	Collected (using a drainage and sump system) then pumped to the wastewater treatment plant.	Wastewater treatment plant. Following treatment it will be reused onsite or discharged to sea.
Hydrotest water	Stored in pipelines or tanks that are being tested. The water will then be reused for additional hydrotesting, discharged to sea (if clean), or pumped to the wastewater treatment plant.	Reused onsite, discharged to sea (if clean) or treated at the wastewater treatment plant.
Brine from the reverse osmosis plant	Discharged to the marine environment.	Pipeline discharge to sea.



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### ***Storage***

Wastes will be stored appropriately to minimise the risk of accidental releases to air, soil or water resources. Implementation of management measures may include:

- Storage of wastes in a manner that prevents co-mingling or contact between incompatible wastes (e.g., acids and alkalis).
- Storage of wastes that allows for the inspection of containers, i.e., to monitor any potential leaks or spills.
- Labelling containers for clear identification of the contents.
- Storage of chemicals, fuel, paint and adhesives in appropriately sized drums and on hard standing surfaces.
- Conducting periodic inspections of waste storage areas to ensure compliance with safety standards.
- Locating spill kits near liquid waste storage areas.
- Training all employees in spill response.
- Covering domestic waste storage bins.
- Stockpiling excess topsoil for reuse onsite. Stockpiles will be managed to ensure runoff is controlled and erosion is minimised.
- Loading and unloading waste within a bunded area, where practicable.

### ***Transportation***

Onsite and offsite waste transportation should be undertaken in a manner that minimises the possibility of spills and potential impacts to human health and the environment. Preparation of an EMP to document the procedures that apply to all aspects of waste management, including transportation will be beneficial to site management practices.

### ***Monitoring***

- Monitoring activities may include the following:
- Recording and reporting the wastes generated by the project.
- Assessing the actual quantities and types of wastes compared to the predicted estimates. Following this, recommending and implementing improvements to waste management practices.
- Auditing the transportation and disposal of waste.
- Regular visual inspections of the waste management area.

These waste monitoring procedures should be further developed as part of the project's EMP.



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### 6.12.6 Waste Management Area

A designated waste management area will need to be established in close proximity to the Betano development area. The designated waste management area is required for the following management, treatment and disposal techniques (as given in Table 6-40):

- Sorting and segregating wastes.
- High-temperature incineration.
- Engineered landfill.
- Wastewater treatment.
- Tyre shredding (prior to disposal at a landfill).
- Drum cleaning and crushing before disposal at a landfill.

The location of the waste management area should be selected based on the following regional criteria (RDTL, 2011a):

- Free of geotechnical risks (fault area, landslide prone area or earthquake prone area).
- Reduced hydrogeological risk, which is an area with less than 3 metres ground water depth, water absorbance soil, closes proximity with water source. If these terms are not fulfilled a technical consultation is required.
- Reduced topographical risk (more than 20% land slope).
- Not within close proximity of the airport (minimum distance is 1.5 to 3 kilometres away).
- Not a conservation area.

Construction contractors and waste management companies will be responsible for the transport and handling of all the waste they produce. This will be detailed in the project's EMP.

#### ***Sorting and Segregating Wastes***

The waste management area will include a designated area for sorting and segregating wastes.

Sorting and segregation of wastes will not always be undertaken in the waste management area as, in some instances, it may be easier to sort and segregate the wastes at the work site.

#### ***Incineration***

The waste management area will include a high-temperature incinerator, to be designed and installed during early works.

#### ***Engineered Landfill***

A local engineered landfill is required. The landfill will be constructed in the waste management area during early works. The landfill will be properly designed to take all non-hazardous and hazardous waste generated at the Betano development area during construction and operations.



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### ***Wastewater Treatment Plant***

A wastewater treatment plant is required to treat the sewage, greywater and stormwater generated at the Betano development area and will need to be built as part of the proposed works.

### ***Tyre Shredding***

The waste management area will include an industrial shredder to shred and debead tyres before they are sent to the landfill for disposal. This will ensure there is available landfill capacity during construction and operations.

The industrial shredder can also be used to shred other waste such as drums. Tyres and drums can be stockpiled initially until a shredder is installed later in the project development schedule.

### ***Drum Cleaning and Crushing Before Disposal at a Landfill***

Drums will be cleaned and crushed (by the industrial shredder) before they are sent to the landfill for disposal. As above, this will ensure there is available landfill capacity during construction and operations.

### **6.12.7 Further Work**

A detailed assessment of the volumes and types of wastes generated will need to be undertaken in order to appropriately size the required waste management facilities for the project.



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