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Papua New Guinea LNG Project

Environmental Management Plan: Upstream Facilities, Infrastructure and Pipelines

PGGP-EH-OPZZZ-000004-001

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ACRONYMS AND DEFINITIONS

ACRONYM	DESCRIPTION
µg/m^3	micrograms per cubic metre
AGI	Above Ground Installation
AWPAR	Angore Wellpad Access Road
BTEX	Benzene, toluene, ethylbenzene, and xylene
CEPA	Conservation and Environment Protection Authority
CP	Cathodic Protection
CPF	Central Processing Facility
CV	Check Valve
dBA	A-weighted decibels
DN	Nominal Diameter
E&R	Environmental and Regulatory
EMPNG	ExxonMobil PNG Limited
EMP	Environmental Management Plan
FOLER	Fibre Optic Local Equipment Room
GPF	Gobe Production Facility
HGCP	Hides Gas Conditioning Plant
HVWF	Hides Vehicle Wash Facility
HWMF	Hides Waste Management Facility
HWPAR	Hides Wellpad Access Road
IESC	Independent Environmental and Social Consultant
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
KP	Kilometre Point
LNG	Liquefied Natural Gas
MEG	monoethylene glycol
MEGVG	monoethylene glycol (MEG) Vent Gas
mg/m^3	milligrams per standard cubic metre
MLV	Main Line Valve
ng/m^3	nanograms per standard cubic metre
NTU	Nephelometric Turbidity Unit
OIMS	Operations Integrity Management System
OSL	Oil Search Limited
PNG	Papua New Guinea
PNG LNG EIS	PNG LNG Project Environmental Impact Statement
PM	Particulate Matter
ppm	parts per million
PWRW	Produced Water Reinjection Well

ACRONYM	DESCRIPTION
ROW	Right of Way
SHE	Safety, Health and Environment
WHRU	Waste Heat Recovery Unit
WWTP	Wastewater Treatment Plant
WORD	**DEFINITION**
above grade	Above the surrounding ground surface
de minimis	A term used by the United States Environmental Protection Agency to describe emissions levels which are negligible and for which no conformity levels are established
grade	Gradient/slope of the surrounding surface which could be concrete, asphalt, earth etc.
receiving environment	A representative point, zone, or boundary within the natural aquatic (freshwater or marine) environment where naturally occurring physical, chemical and biological conditions should not be influenced by discharges arising from EMPNG activities and or facilities.

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PNG LNG is an integrated development that includes gas production and processing facilities, onshore and offshore pipelines and liquefaction facilities. Participating interests are affiliates of Exxon Mobil Corporation (including ExxonMobil PNG Limited as operator), Oil Search Limited, Kumul Petroleum Holdings Limited, Santos Limited, JX Nippon Oil and Gas Exploration, and Mineral Resources Development Company.

1.0 INTRODUCTION

This Environmental Management Plan: Upstream Facilities, Infrastructure and Pipelines is a component of the Environmental and Social Management Plan for production of the Papua New Guinea Liquefied Natural Gas (PNG LNG) Project.

1.1 Scope

This Environmental Management Plan (EMP) is applicable to the following facilities and infrastructure, collectively referred to as Upstream facilities, infrastructure and pipelines:

- Hides gas field wellpads (Wellpads B, C, D, E, F[1] and G)
- Angore gas field wellpad(s)
- Hides Wellpad Access Road
- Angore Wellpad Access Road
- Produced Water Reinjection Well (PWRW)
- Hides Gas Conditioning Plant (HGCP)
- Hides Waste Management Facility (HWMF)
- Hides Vehicle Wash Facility (HVWF)
- Support camps (for example Moro B camp)
- Komo Airfield
- Hides Gathering System including the Hides Spineline
- Angore Gathering System
- HGCP-Kutubu Condensate Pipeline
- HGCP-Kutubu Condensate Pipeline Above Ground Installations (AGIs)
- PNG LNG Gas Pipeline (onshore/offshore)
- PNG LNG Gas Pipeline AGIs
- PNG LNG Gas Pipeline and AGI Access Tracks.

The location of the Upstream facilities, infrastructure and pipelines is shown in Figure 1-1 and Figure 1-2.

This EMP is not applicable to the LNG Plant and Marine Facilities, which is addressed in the Environmental Management Plan: LNG Plant and Marine Facilities. This EMP is also not applicable to the PNG LNG Port Moresby office, which is addressed in the Environmental Management Plan: Port Moresby office.

This EMP is applicable to normal operating conditions, startup and shutdown activities, and reasonably foreseeable abnormal operating conditions and emergency situations. Where deemed necessary by ExxonMobil PNG Limited (EMPNG), a site-specific or scope-specific Environmental Management Plan may be developed as an addendum to this EMP. For example, well plug and abandonment activities, construction of new facilities. In these instances, additional mitigation measures and commitments outlined in the PNG LNG Project Environmental Impact Statement (PNG LNG EIS; EMPNG as Esso Highlands Limited, 2009) that are not specifically included in this EMP, may be applicable.

This EMP is applicable to the activities of ExxonMobil PNG Limited (EMPNG) including its contractors and subcontractors. Where deemed necessary by EMPNG, contractors and subcontractors may be required to develop and implement a site-specific or scope-specific Environmental Management Plan.

This EMP is supported by and makes reference to a number of procedures and other working documents including protocols and method statements, which are internal EMPNG documents developed on the basis of standard industry methods, where applicable.

[1] Wellpad F refers to the wellpad where the Hides 5 deep producing well was installed. This wellpad was originally called Hides 5 wellpad and is different to the original Wellpad F referred to in the PNG LNG Project Environmental Impact Statement (Esso Highlands Limited, 2009).

1.2 Objectives

This EMP describes the measures in place to manage environmental aspects pertaining to the Upstream facilities, infrastructure and pipelines and implement applicable legal and other requirements. Specific environmental management objectives are outlined in Section 4.0.

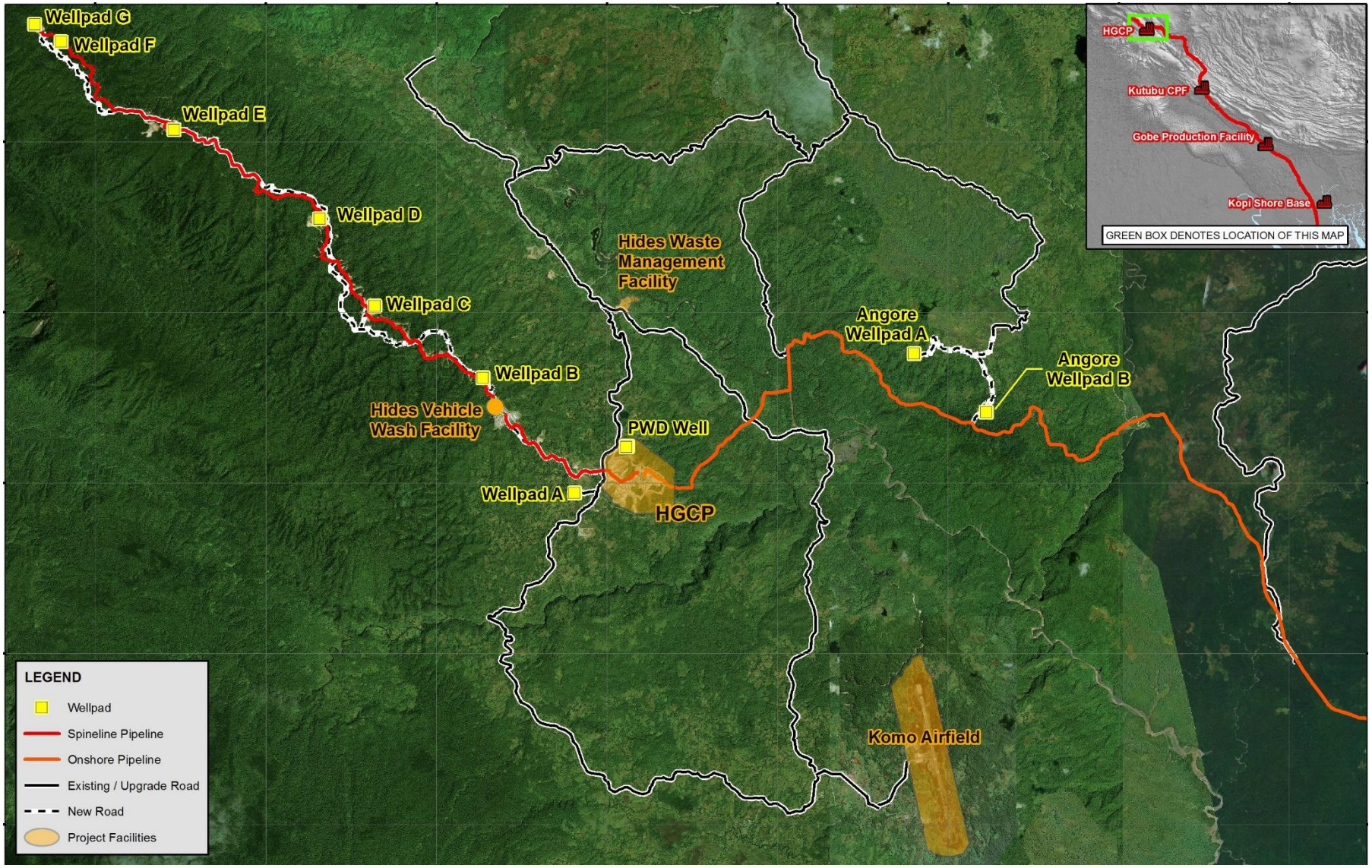

Figure 1-1: Upstream facilities and infrastructure location map

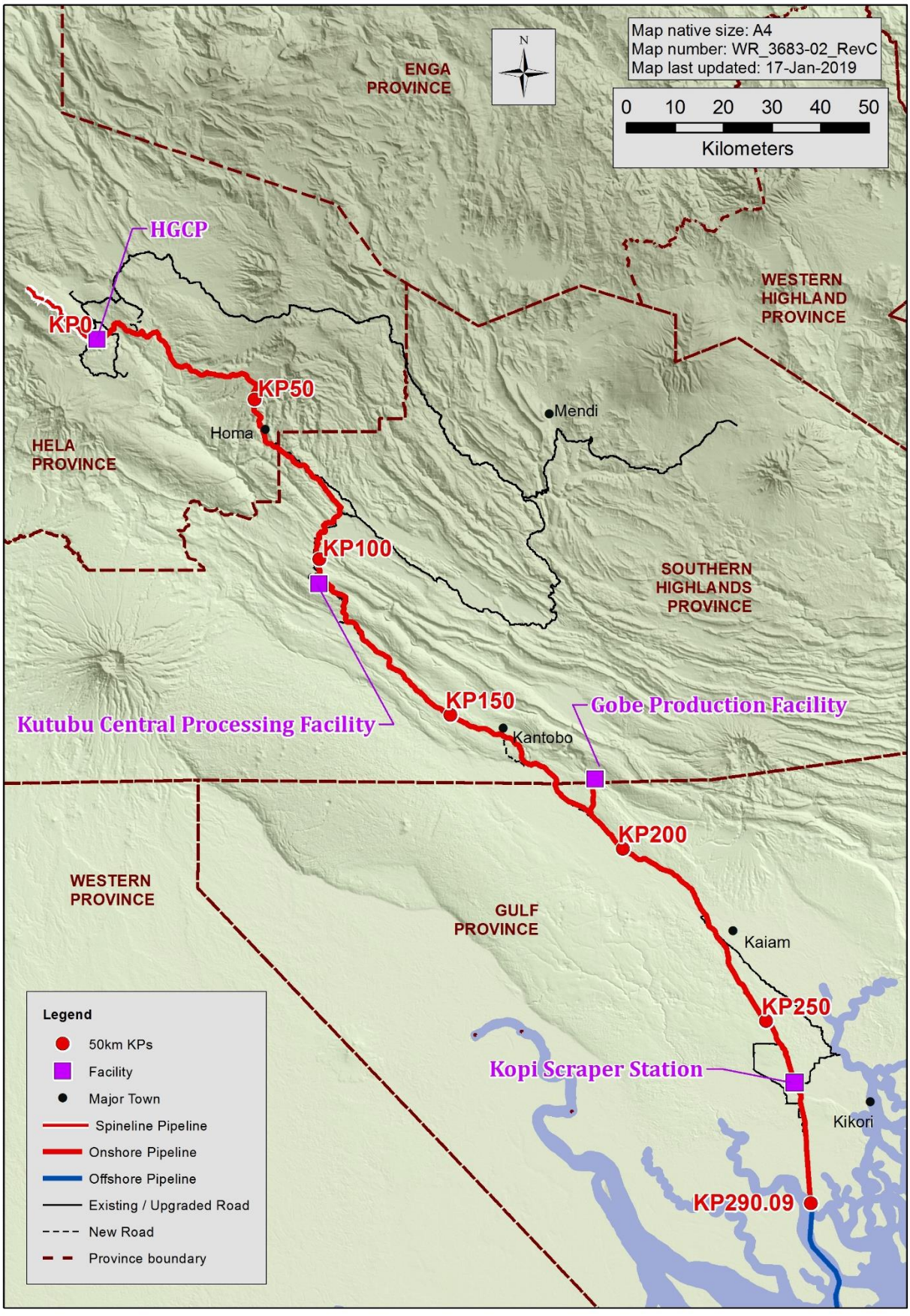

Figure 1-2: Pipelines and Above Ground Installations location map

2.0 LEGAL AND OTHER REQUIREMENTS

Details of applicable legal and other requirements are provided below.

2.1 Laws and regulations of Papua New Guinea

Key laws and regulations relevant to this EMP are as follows including associated amendments:

- *Climate Change (Management) Act 2015*
- *Conservation and Environment Protection Authority (Environment Management Fee) 2015*
- *Conservation Areas Act 1978*
- *Environment Act 2000*
- *Environment (Prescribed Activities) Regulation 2002*
- *Environment (Permits) Regulation 2002*
- *Environment (Water Quality Criteria) Regulation 2002*
- *Fauna (Protection and Control) Act 1966*
- *International Trade (Fauna and Flora) Act 1979* (Chapter 391)
- The Environmental Code of Practice for Sanitary Landfill Sites, Papua New Guinea (The Office of Environment and Conservation, 2001)
- *Customs (Prohibited Imports) Regulation 1973*
- *Explosives Act 1953* and *Explosives Regulation 2002*
- *Inflammable Liquid Act 1953* and *Inflammable Liquid Regulation 1968*
- *Public Health Act 1973*
- *Public Health (Sanitation and General) Regulation 1973*
- *Public Health (Sewerage) Regulation 1973*
- *National Water Supply and Sanitation Act 2016*
- *National Cultural Property (Preservation) Act 1965*

Specific requirements of these laws and regulations are discussed, where relevant, in this EMP.

2.2 Environment Permit

The primary legislation governing environmental matters in Papua New Guinea is the *Environment Act 2000*. The *Environment Act 2000* is supported by the *Environment (Prescribed Activities) Regulation 2002*.

An Environment Permit is required for PNG LNG pursuant to the *Environment (Prescribed Activities) Regulation 2002*. Environment Permit EP-L3 (210) (the Environment Permit) was issued by the Papua New Guinea Conservation and Environment Protection Authority (CEPA), formerly known as the Department of Environment and Conservation, on 9 September 2009. Amendments to the Environment Permit were issued on 29 October 2009, 22 October 2012 and 12 October 2015.

This EMP, together with the Environmental Management Plan: LNG Plant and Marine Facilities, constitutes the Project Environmental Management Plan for production, referred to in the Environment Permit. Specific requirements and conditions of the Environment Permit are discussed where relevant in this EMP.

2.3 Operations Integrity Management System

ExxonMobil and its affiliates meet policy commitments and control operations integrity risks through the Operations Integrity Management System (OIMS).

OIMS establishes common worldwide expectations for addressing inherent risks. It addresses all aspects, including security, which can impact safety, health and environmental performance.

OIMS is certified as equivalent to *ISO 14001:2004 Environmental management systems - Requirements with guidance for use (International Organization for Standardization, 2004)* by Lloyd's Register. Certification is periodically reviewed by Lloyds Register and maintained current.

Several OIMS Systems are relevant to this EMP and specific OIMS requirements are discussed where relevant, throughout this EMP.

2.4 Lender Group requirements

Debt financing was secured for PNG LNG through various Export Credit Agencies and commercial banks. The Export Credit Agencies and commercial banks, collectively referred to in this document as the Lender Group, apply the International Finance Corporation's (IFC's) Performance Standards on Social and Environmental Sustainability (IFC, 2006), referred to as the 'IFC Performance Standards'; and the International Finance Corporation's Guidance Notes: Performance Standards on Social and Environmental Sustainability (IFC, 2007), referred to as the 'Guidance Notes' and relevant guidelines.

IFC Performance Standards, Guidance Notes and guidelines applicable to this EMP are:

- Performance Standard 1: Social and Environmental Assessment and Management Systems
- Performance Standard 3: Pollution Prevention and Abatement
- Performance Standard 4: Community Health, Safety and Security
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management
- Performance Standard 8: Cultural Heritage
- Guidance Note 1: Social and Environmental Assessment and Management Systems
- Guidance Note 3: Pollution Prevention and Abatement
- Guidance Note 4: Community Health, Safety and Security
- Guidance Note 6: Biodiversity Conservation and Sustainable Natural Resource Management
- Guidance Note 8: Cultural Heritage
- Environmental, Health, and Safety General Guidelines (IFC, 2007)
- Environmental, Health, and Safety Guidelines for Waste Management Facilities (IFC, 2007)
- Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities (IFC, 2007)
- Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development (IFC, 2007)
- Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development (IFC, 2007).

Specific requirements of the above listed IFC Performance Standards, Guidance Notes and guidelines are discussed where relevant in this EMP.

3.0 ORGANISATION

OIMS System 1-1 Management Leadership, Commitment and Accountability requires the allocation of sufficient resources for the implementation and continuous improvement of operations integrity, along with the establishment of OIMS-related roles and responsibilities.

An overview of EMPNG's organisation as relevant to environmental management during production is provided in this section.

3.1 OIMS Management Steering Committee

Pursuant to OIMS System 1-1 Management Leadership, Commitment and Accountability, EMPNG managers and supervisors will demonstrate commitment and accountability to operations integrity, including the implementation of this EMP, through active participation.

As such, EMPNG will charter an OIMS Management Steering Committee to provide management perspective, set expectations and allocate resources for the implementation and continuous improvement of operations integrity within the organisation.

The OIMS Management Steering Committee will steward OIMS goals and objectives, including goals and objectives pertaining to environmental management as set out in this EMP.

3.2 Environmental and Regulatory organisation

EMPNG's Environmental and Regulatory (E&R) group is allocated primary responsibility for the implementation and ongoing oversight of this EMP. The E&R group forms part of the Safety, Health and Environment (SHE) department.

An outline of EMPNG's SHE department is shown in Figure 3-1, but it is recognised that the organisation will be adapted as required to meet conditions and operational needs.

In addition to the SHE department, other EMPNG production and maintenance personnel have defined roles and responsibilities with respect to this EMP. Roles and responsibilities of key personnel are described in Section 22.0. Competency and training is discussed in Section 23.0.

EMPNG will retain third party consultants and other specialist organisations and individuals as necessary to support implementation of this EMP.

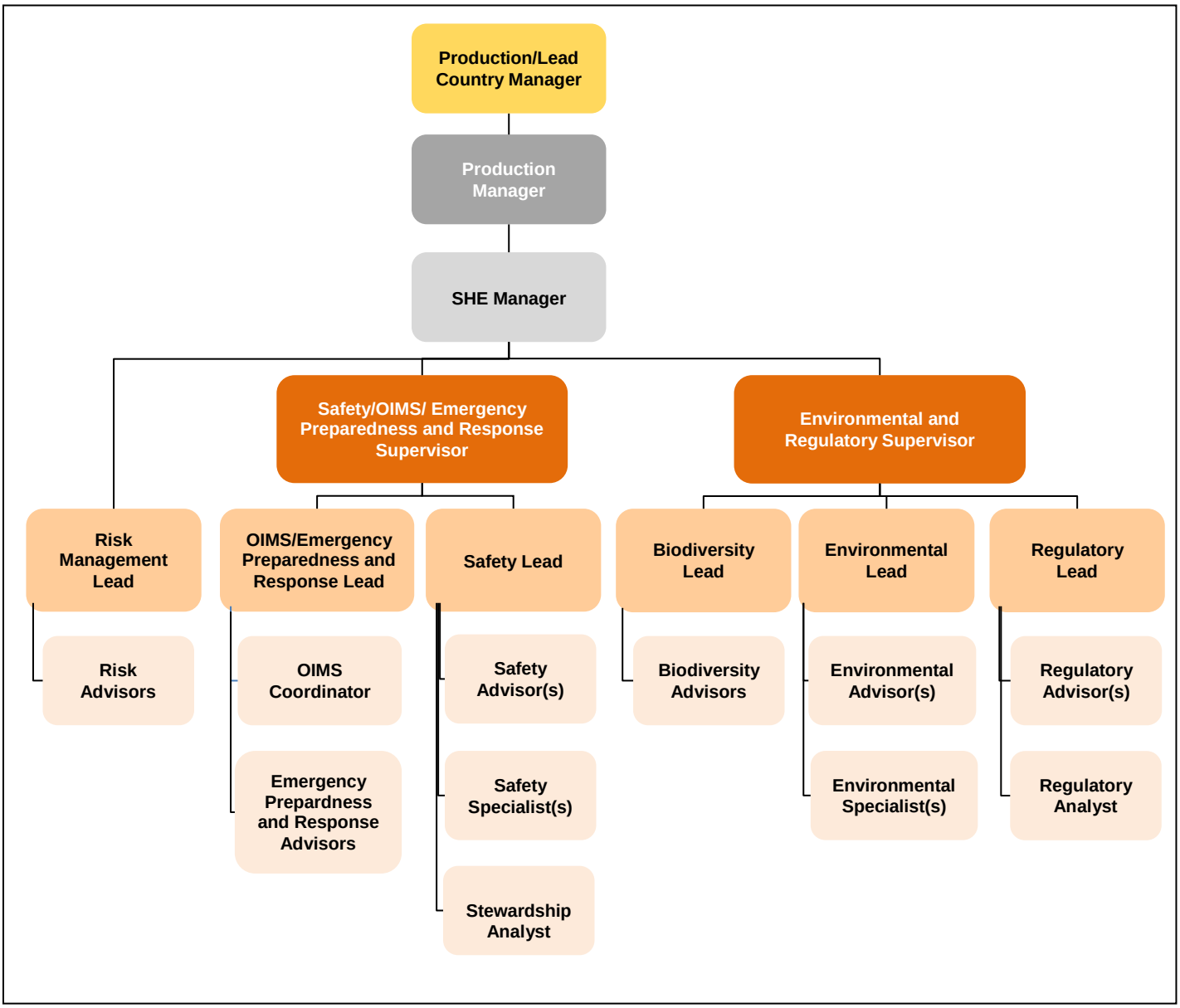

Figure 3-1: Safety, Health and Environment department

4.0 ENVIRONMENTAL ASSESSMENT AND MANAGEMENT

OIMS System 6-5 Environmental Management requires the identification of environmental aspects. It also requires that environmental management is fully integrated into the organisation's business planning and that environmental performance is tracked and stewarded to meet performance goals. The physical, biophysical and socioeconomic setting and context is summarised below, followed by a description of the process of identification and evaluation of environmental aspects relevant to production. A description of the process for environmental management and establishment of mitigation measures set out in this EMP is also provided for in this section.

4.1 Environmental and social overview

An overview of key environmental and social features associated with the Upstream is outlined below. Further details are provided in the PNG LNG EIS.

4.1.1 Physical environment overview

The Upstream Project Area encompasses the drainage of the Kikori River Basin extending north-west into the drainage of the upper Strickland River in PNG's Western Province. Limestone terrain, consisting mostly of rugged polygonal and doline karst, karst plains and plateaus with karst corridors, dominates the Upstream Project Area which ranges from sea level to 3,650 metres in altitude.

There are extensive volcanic areas to the north and north-west of the Upstream Project Area, with Mount Bosavi dominating the landscape to the west of Kutubu. South-west of Hides lies the blown-out crater of Mount Sisa, its lava flows responsible for the basalt soils of the agricultural lands in the area. The Doma Peaks, north-east and outside the Upstream Project Area, is a region of remnant volcanic cones and domes, volcano-alluvial fans and mudflows resulting from an eruption several hundred years ago.

The Upstream Project Area also encompasses large expanses of relatively undisturbed tropical forest across diverse geologies, geomorphologies, soils and habitats and consequently there is a great heterogeneity in biodiversity composition and ecology. A comprehensive description of the biodiversity of the Upstream Project Area is provided in the PNG LNG EIS.

4.1.2 Biophysical environment and social overview

PNG Highlands and Kikori River Basin

The Upstream Project footprint extends through several regions with distinct biodiversity characteristics that have high conservation value. These areas feature extensive tracts of montane, lowland hill and lowland forest environments which support a broad range of plants and animals, notably birds-of-paradise, cassowaries, fruit doves, tree kangaroos, microhylid frogs, fruit bats, vireya rhododendrons, ferns and orchids. Key biological aspects in the Papua New Guinea Highlands and the Kikori River Basin include:

- Kikori River Basin lowlands and the Moro region bioregions, which are important for waterbirds, swamp fauna and over-wintering migratory waders
- Hides Ridge, which supports a high-altitude beech (*Nothofagus spp.*) forest, dominated by epiphytes and ferns, with noteworthy ecological values - this forest is slow to regenerate and susceptible to die-back
- Homa-Benaria Ridge, which has a very high mammal diversity and is weed-free,
- Caves featuring cave-dwelling bats
- Sinkhole swamps, the main breeding habitat in the karst area for tree frogs and other water-dependent frogs

- Swamp forests, including pandanus swamp, that support a range of specialist vertebrates and a range of aquatic fauna
- Streams in the higher-altitude hill and mid-montane forest, which maintain populations of specialist vertebrates
- Lowland rivers, which support crocodiles and freshwater turtles.

Areas of conservation value within the PNG Highlands and the Kikori River Basin include formally gazetted Wildlife Management Areas, consisting of the Lake Kutubu Wildlife Management Area and the Neiru Aird Hills Wildlife Management Area, along with World Wildlife Fund-designated conservation areas.

The Upstream Project footprint crosses through three provincial governments. The Hela and Southern Highlands Provinces occupy approximately 25,700 square kilometres in the central western part of Papua New Guinea. The total population of the two Provinces in 2000 was 546,265. Population densities are highest in the Tari Basin at about 190 persons per square kilometre, while areas around Lake Kutubu support about 40 persons per square kilometre. In the western part of the Komo-Margarima District, the population density is less than 20 persons per square kilometre.

The Gulf Province occupies some 13,500 square kilometres on the south coast of PNG, where the estuaries of six major rivers converge into one large delta of islands, swamps and channels. The total population of the Province in 2000 was 106,898. Population densities range from 25 to 35 persons per square kilometre in the most densely settled areas, to less than ten persons per square kilometre in other areas.

Key social aspects in the PNG Highlands and the Kikori River Basin areas are: customary land ownership and use; predominant livelihood dependency on land and natural resources; high incidences of communicable diseases, including pneumonia, malaria, tuberculosis, diarrheal diseases, meningitis and, increasingly, Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome; maternal and child morbidity and mortality, under-resourced and largely ineffective rural health and education systems; limited health facilities, limited educational opportunities and limited infrastructure and transportation routes; project induced in-migration; and a significant number of archaeological and cultural sites.

Gulf of Papua

The Gulf of Papua provides an important path for the Ornate Rock Lobster's *Panulirus ornatus* annual migration which tracks across the Gulf to the reefs of Yule Island and further east along the PNG coast. This region also provides prawn spawning grounds, as well as habitat for marine turtles, cetaceans and dugongs.

The Gulf of Papua supports a commercial prawn-trawling fishery. Prawn trawling grounds in the Gulf extend from the Fly River delta to the village of Lokea in the east. The area is also characterised by a variety and abundance of fish, such as barramundi, threadfin salmon, jewfish, mud crab and lobster. These form the basis of subsistence fishery, with some produce being sold at local markets.

4.2 Environmental impact assessment

Environmental aspects and impacts associated with production were initially identified and evaluated as part of the impact assessment conducted for the PNG LNG EIS (EMPNG as Esso Highlands Limited, 2009). The PNG LNG EIS was finalised and submitted to CEPA in January 2009 as the statutory basis for environmental and social assessment pursuant to Section 50 of the *Environment Act 2000.*

The impact assessment presented in the PNG LNG EIS is based on an impact significance assessment process. For aspects associated with terrestrial biodiversity, surface water and

groundwater, soils, air quality and noise, the impact significance is expressed in a matrix of the value (or sensitivity) of a receptor and the magnitude of the impact. In the case of cultural heritage, the impact significance is presented using a matrix of valence (positive or negative), nature of impact (direct, indirect or cumulative), duration, extent, magnitude and likelihood. In both cases, the impact significance assessment process accounted for a range of factors, including the nature (positive, negative, direct or indirect) extent, duration and severity.

The PNG LNG EIS includes environmental management and mitigation measures designed to address potential environmental impacts during production. Each mitigation measure has a unique reference code. Mitigation measures applicable to the Upstream facilities, infrastructure and pipelines are within the scope of this EMP and are shown in Appendix 1.

Further details are provided in the PNG LNG EIS available at www.pnglng.com.

4.3 Environmental aspects assessment

An environmental aspect is an activity, product or service that interacts with the environment and may have beneficial, adverse, and/or neutral effects. OIMS System 6-5 Environmental Management requires that environmental aspects are evaluated using an Environmental Aspects Assessment process, consistent with requirements of ISO 14001:2004 Environmental management systems - Requirements with guidance for use (International Organization for Standardization, 2004). In accordance with these requirements, EMPNG undertook an Environmental Aspects Assessment for production operations, and is reviewed and updated on a regular basis. The Environmental Aspects Assessment forms the basis for the management of environmental aspects as set out in this EMP.

A summary of the environmental aspects applicable to Upstream facilities, infrastructure and pipelines, the associated risk scenarios and a reference to the section of this EMP where these aspects and scenarios are addressed is shown in Table 4-1.

4.4 Environmental management and mitigation

This EMP describes management and mitigation measures in place to address the identified environmental aspects and to achieve the environmental management objectives shown in Table 4-2. Mitigation measures include design controls (controls that are inherent to facilities and infrastructure) and operational controls (controls implemented by EMPNG and other personnel).

Table 4-1: Overview of environmental aspects and risk scenarios

IFC PERFORMANCE STANDARD THEME	ENVIRONMENTAL ASPECT CATEGORY	ENVIRONMENTAL ASPECT OVERVIEW	RISK SCENARIO OVERVIEW	EMP SECTION REFERENCE
Performance Standard 3: Pollution Prevention and Abatement Pollution Prevention, Resource Conservation and Energy Efficiency	Emissions and releases to air	HGCP gas turbine compressor emissions	Risk of health and ecological impacts associated with release of pollutants to air	Section 6.0
		HGCP main power generator emissions		
		HGCP monoethylene glycol vent gas incinerator emissions		
		HGCP incinerator emissions		
		HGCP high pressure flare emissions		
		HGCP pressure control valve emissions		
		HGCP pressure safety valve emissions		
		HGCP atmospheric vent emissions		
		HWMF incinerator emissions		
		Pipeline blowdown vent emissions		
		Diesel engine emissions		
		Fugitive emissions		
		Dust		
		Light		
		Ambient air quality	Risk of health and ecological impacts associated with ground level pollutants	Section 7.0
		HGCP noise	Risk of health and ecological impacts associated with exposure to noise and vibration	Section 8.0
		HWMF noise		
		Komo noise		
		Pipeline AGI noise		

IFC PERFORMANCE STANDARD THEME	ENVIRONMENTAL ASPECT CATEGORY	ENVIRONMENTAL ASPECT OVERVIEW	RISK SCENARIO OVERVIEW	EMP SECTION REFERENCE
		Noise from construction equipment and vehicles working on the ROW or other remote locations		
		Blasting activities		
	Discharges and releases to water	HGCP stormwater discharges	Risk of health and ecological impacts associated with the release of pollutants to surface water and groundwater	Section 9.0
		HGCP retention pond discharges		
		HGCP sanitary wastewater discharges		
		HWMF stormwater discharges		
		HWMF sanitary wastewater discharges		
		HWMF leachate system discharges		
		Komo stormwater discharges		
		Komo sanitary wastewater discharges		
		Moro B Camp sanitary wastewater discharges		
		Wellpad cellar discharges		
		Pipeline AGI stormwater discharges		
		Vehicle and equipment wash stations		
		Washdown waters from cement plants		
		Produced water reinjection		
		General – Stormwater-runoff from cleared/disturbed areas		
Performance Standard 3: Pollution Prevention and Abatement Waste	Waste	Waste avoidance and minimisation	Risk of health and ecological impacts associated with release of pollutants in waste	Section 12.0
		Waste collection		
		Waste storage and transfer		
		Waste reuse, recycling and recovery		

IFC PERFORMANCE STANDARD THEME	ENVIRONMENTAL ASPECT CATEGORY	ENVIRONMENTAL ASPECT OVERVIEW	RISK SCENARIO OVERVIEW	EMP SECTION REFERENCE
		Waste treatment and disposal		
		Waste tracking and documentation		
Performance Standard 3: Pollution Prevention and Abatement Hazardous Materials	Hazardous materials	Prohibited substances	Risk of health and ecological impacts associated with the transport, storage, use and disposal of hazardous materials	Section 11.0
		Avoidance of hazardous materials		
		Transportation of hazardous materials		
		Storage and use of hazardous materials		
		Disposal of hazardous materials		
Performance Standard 3: Pollution Prevention and Abatement Emergency Preparedness and Response	Releases to soil and water (spills)	Transport of fuel and chemicals	Risk of health and ecological impacts resulting from a spill or release of pollutants (oil or chemicals) to the environment	Section 10.0
		Fuel storage and transfer		
		Chemical storage and transfer		
		Spill response		
		Site remediation		
Performance Standard 3: Pollution Prevention and Abatement Greenhouse Gas Emissions	Emission and releases to air (greenhouse gases)	Emissions of greenhouse gases from HGCP	Contribution to climate-related effects associated with the release of greenhouse gases	Section 6.0
		Emissions of greenhouse gases from HWMF		
		Emissions of greenhouse gases from Komo		
		Vegetation clearance		
		Emissions of greenhouse gases from construction equipment and vehicles		

IFC PERFORMANCE STANDARD THEME	ENVIRONMENTAL ASPECT CATEGORY	ENVIRONMENTAL ASPECT OVERVIEW	RISK SCENARIO OVERVIEW	EMP SECTION REFERENCE
Performance Standard 3: Pollution Prevention and Abatement Pesticide Use and Management	Chemical usage	Use of pesticides and herbicides	Risk of health and ecological impacts associated with the use of pesticides and herbicides	Section 11.0
Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management	Land and vegetation disturbance	Erosion and sediment	Risk of impacts to biodiversity values and water quality associated with erosion and sedimentation	Section 13.0
		Reinstatement and regeneration	Risk of impacts to biodiversity values associated with failure of reinstatement works and poor vegetation succession	Section 14.0
		Invasive species (priority weeds and pests)	Risk of impacts to biodiversity values and subsistence and commercial agriculture associated with the introduction and/or spread of invasive species	Section 15.0
		Plant pathogens	Risk of impacts to biodiversity values associated with the spread of plant pathogens	Section 15.0
		Ecological sensitivities and focal habitats	Risk of impacts to habitats, specific habitat features and species of ecological importance and other ecological sensitivities	Section 16.0
		Control of access to EMPNG roads and infrastructure	Risk of impacts to biodiversity values associated with the use of EMPNG roads and infrastructure by third party vehicles	Section 17.0
	Water usage	Abstraction of surface water and groundwater	Risk of impacts to community use or ecological flows associated with the abstraction of water	Section 11.0
	Other services	Use of aggregate and quarry material	Risk of impacts to biodiversity values and community safety associated with the procurement of aggregate and quarry material	Section 11.0
		Use of timber and wood products	Risk of impacts to biodiversity values associated with procurement of timber and wood products	Section 11.0
Performance Standard 8: Cultural Heritage)	Cultural heritage	Management of known and unknown archaeological and oral tradition sites	Risk of impacts to cultural heritage	Section 18.0

Table 4-2: Environmental management objectives

ENVIRONMENTAL ASPECT	OBJECTIVE
Emissions to air and ambient air quality	• Avoid significant impacts associated with the release of pollutants to the atmosphere • Meet applicable emissions and air quality criteria
Noise	• Avoid significant noise and vibration impacts to community and fauna • Meet applicable noise criteria
Discharges to water and water quality	• Avoid significant impacts associated with the release of pollutants to surface water and groundwater • Meet applicable discharge criteria
Spill prevention and response	• Prevent spills of hydrocarbons and chemicals • Respond quickly and effectively to spills should they occur
Materials management	• Avoid significant impacts associated with the procurement and use of raw materials • Use materials which are less hazardous or otherwise preferable from an environmental perspective, where practical
Waste	• Apply the waste management hierarchy • Manage and dispose of waste at EMPNG facilities and approved third party facilities only
Erosion and sediment control	• Control significant erosion and prevent significant sedimentation of surface waters
Reinstatement and regeneration	• Establish and maintain stable landforms in areas disturbed as a result of construction type activities • Promote regeneration of vegetation in disturbed areas that are no longer required for production • Achieve established benchmarks for regeneration areas
Invasive species and plant pathogens	• Prevent invasive species (priority weeds and/or pests) and plant pathogens from entering or establishing in areas affected by PNG LNG • Contain invasive species (priority weeds and/or pests) and plant pathogens already established in areas affected by PNG LNG
Ecology	• Avoid impacts to specific features of ecological importance
Induced access	• Establish access controls and procedures to ensure vehicle access to EMPNG roads and infrastructure prevent potential damage by third party activities
Cultural heritage	• Avoid impacts to known cultural heritage sites, including archaeological and oral tradition sites • Manage cultural heritage sites in consultation with landowners

5.0 DESCRIPTION OF FACILITIES

An overview and description of the Upstream facilities, infrastructure and pipelines is provided in this section.

5.1 Hides Wellpads and Hides Wellpad Access Road

There are nine producing wells at Hides located across a total of five wellpads (two producing wells at Wellpads B, C, D and G, and one producing well at Wellpad F). There are currently no producing wells at Wellpad E.

A flowline connects each wellpad with the Hides Spineline.

Facilities at each producing wellpad vary but typically include a wellhead tree; production piping and valves; monoethylene glycol (MEG) injection piping and valves; corrosion inhibitor storage tank and injection pumps; hydraulic power system; closed and open drain systems; vent knockout drums and pots; local equipment room including controls and electrical equipment.

MEG is used for suppression of hydrates (crystals which may form in the presence of water under certain conditions and may cause line plugging) and is delivered to each producing wellpad via a pipeline from the HGCP. Corrosion inhibitor is injected via individual pumps located at each wellpad.

The Hides Wellpad Access Road (HWPAR) is approximately 22 kilometres long, extending north-west from the HGCP to Hides Wellpad G. A diagram of the Hides Wellpads and HWPAR is shown in Figure 5-1.

5.2 Angore Wellpads and Angore Wellpad Access Road

There are two wells located at Angore. No producing wells are installed at Angore Wellpad B. Facilities at Angore wellpad(s) will be similar to that described above for the Hides Wellpads. The Angore Wellpads are accessed via the Angore Wellpad Access Road (AWPAR), which is approximately 18 kilometres long.

The two producing wells at Angore will be connected to the HGCP via flowlines.

5.3 Produced Water Reinjection Well

A reinjection well is required for the disposal of formation wastewater produced at the HGCP when processing the multi-phase wellstream fluids extracted from the Hides and Angore gas fields. The PWRW is located within the perimeter of the HGCP. It has a capacity of 40 cubic metres per hour and provides the required injection pressure of approximately 44,000 kilopascals.

5.4 Hides Gas Conditioning Plant

The HGCP is located in the Hela Province at the southeast base of the Hides Ridge near the village of Laite. The HGCP includes a processing facility, rotator housing community, and an industrial park within shared security and perimeter fences.

The processing facility is designed to process, stabilise and condition multi-phase wellstream fluids from the Hides and Angore gas fields, into two separate phases, a condensate phase and dry gas phase.

Process systems currently comprise inlet facilities including slug handling; gas and liquid inlet separation; dewpoint conditioning; compression; produced water injection; condensate stabilisation and condensate transfer system. A number of utilities support the HGCP including fuel gas system; MEG storage, distribution, and regeneration; chemical injection systems; portable methanol skid; hot oil system; main power generation; essential power generation; diesel storage and distribution system; instrument and utility air system; high pressure and low pressure flare systems; closed and open drain systems; MEG vent gas incineration; slop oil

storage and transfer; firewater system; utility water storage and distribution; potable water system and nitrogen reticulation system.

The rotator housing community includes: accommodation units; canteen and recreation building; indoor sports and fitness centre; administration office building including a training centre; heliport and refuelling facility; medical centre; laundry, convenience store; muster and smoking shelters; sanitary wastewater treatment plant (WWTP) and other associated infrastructure.

The industrial park provides the facilities necessary to support production and maintenance of the HGCP, including: a warehouse; chemical and hazardous materials storage shelter; outdoor storage yard; maintenance workshop; vehicle workshop; laboratory; diesel fuel storage and distribution station; waste management depot; incinerator, and other associated infrastructure. A diagram of the HGCP is shown in Figure 5-2.

5.5 Hides Waste Management Facility

The HWMF receives and treats waste generated throughout the Upstream Project area. The HWMF currently comprises a: weighbridge; process building; drum crusher and cleaner; tyre de-beader; shredder; sewage sludge dewatering system; sanitary WWTP; incinerator; ash stabilisation system; landfill; and leachate treatment system. A diagram of the HWMF is shown in Figure 5-3.

5.6 Hides Vehicle Wash Facility

The HVWF is a permanent vehicle wash facility that operates on the lower section of the HWPAR at Kilometre Point (KP) 3.5. The purpose of the HVWF is to prevent the spread of invasive species and plant pathogens into Hides Ridge. A diagram of the HVWF is shown in Figure 5-4.

5.7 Komo Airfield

Komo Airfield, located 20 kilometres south-east of Hides, was developed to support construction and production of the HGCP. The Airfield facility is currently privately owned and operated by EMPNG. It includes a: 3,200-metre sealed runway; taxiway and aprons; terminal building; hangar; freight storage area; powerhouse; fuel depot; guard house; along with firefighting and rescue services; potable water system; sanitary WWTP; boundary and security fencing; and navigation aids. A diagram of the Komo Airfield is shown in Figure 5-5.

5.8 Hides Gathering System and Hides Spineline

The Hides Gathering System consists of flowlines, a spineline, and a MEG Pipeline.

A series of flowlines connect Hides Wellpads B, C, D, F and G to the Hides Spineline. The flowlines transport wellstream fluids from each well to manually operated isolation valves on the Hides Spineline, which then transports the combined well stream fluids to the HGCP. The MEG Pipeline originates from the HGCP and transports MEG to each of the Hides wellpads. The Hides Spineline and MEG Pipeline are located directly in parallel to each other within the same right of way (ROW), over a length of approximately 25 kilometres.

The Hides Spineline is pigged on a regular basis via a pig launcher at Hides Wellpad G and pig receiver at the HGCP.

5.9 Angore Gathering System and Angore Spineline

The Angore Gathering System will consist of a spineline and a MEG Pipeline.

The Angore Spineline will transport combined wellstream fluids from Angore to the HGCP. The MEG Pipeline will originate from the HGCP and transport MEG to the Angore wellpads. The Angore Spineline and MEG Pipeline will be located directly in parallel to each other within the same ROW over a length of approximately 18 kilometres.

The Angore Spineline will be pigged on a regular basis via a pig launcher located at Angore wellpad(s) and a pig receiver at the HGCP.

5.10 HGCP-Kutubu Condensate Pipeline

A Nominal Diameter (DN) 200 (8-inch) Condensate Pipeline transports the conditioned liquid stream condensate from the HGCP to the Kutubu Central Processing Facility (CPF).

The Condensate Pipeline is generally located within the same ROW as the PNG LNG Gas Pipeline between HGCP and the Kutubu CPF.

The Condensate Pipeline is pigged as required via a pig launcher located at the HGCP and a pig receiver at the Kutubu CPF Metering Station.

The route of the condensate pipeline is shown in Figure 1-2.

5.11 HGCP-Kutubu Condensate Pipeline Above Ground Installations

Several AGIs serve the Condensate Pipeline:

- four Main Line Valves (MLVs)
- two Check Valves (CVs)
- Kutubu CPF Metering Station.

A summary of services located at the AGIs is shown in Table 5-1.

Table 5-1: Services at HGCP-Kutubu Condensate Pipeline Above Ground Installations

SERVICE	FACILITY						
	MLV 1	MLV 2	MLV 3	MLV 4	CV 1	CV 2	KUTUBU CPF METERING STATION
Generator	✓	✓	✓	✓			
Pig receiver							✓
Cathodic protection	✓		✓				
Condensate drain tank							✓
Helipad	✓	✓	✓	✓	✓	✓	
Emergency accommodation	✓	✓	✓	✓			

The MLVs enable isolation of five discrete sections of the Condensate Pipeline in case of repair or emergency. The MLVs are spaced to reduce the volume of release, should it occur.

The MLVs can be operated locally or remotely controlled from the HGCP, and include an actuated shutdown valve with a bypass containing isolation valves. The buildings house an equipment shelter, emergency accommodation and a diesel generator, and a helipad is provided for access by air.

A diagram of MLV1 is shown in Figure 5-6.

The CVs enable further isolation of the Condensate Pipeline in case of a leak and are designed with an internal non-return valve that closes when the line is shut-down for repair or emergency. One CV is located immediately upstream of the Tagari Fault Crossing to limit exposure to the Tagari River and the other is located approximately 10 kilometres downstream of MLV4 to the north of Lake Kutubu to limit exposure of the Lake Kutubu catchment. Environmental aspects associated with the CVs are negligible and they are not discussed further in this EMP.

The Kutubu CPF Metering Station houses two metering skids, one of which measures the volume of condensate delivered to the Kutubu CPF operated by Oil Search Limited (OSL) and the other which measures the volume of associated gas being delivered from the Kutubu CPF to the PNG LNG Gas Pipeline. A condensate drain tank receives any condensate drained from the pig receiver and meter piping. The condensate metering skid's safety valves also relieve into the condensate drain tank. Power, instrument air and water are provided from the adjacent OSL facilities.

5.12 PNG LNG Gas Pipeline onshore

The PNG LNG Gas Pipeline delivers conditioned dry gas from HGCP to the Omati River Landfall. It is a DN 800 (32-inch) carbon steel pipeline from the HGCP to the Kopi Scraper Station and a DN 850 (34-inch) line from there to the Monolithic Isolation Joint, close to the Omati River Landfall. The Monolithic Isolation Joint isolates the onshore section's cathodic protection from the offshore section of the PNG LNG Gas Pipeline. The total length of the onshore section is approximately 290 kilometres. The PNG LNG Gas Pipeline is mostly located within the same ROW as the Condensate Pipeline between HGCP and the Kutubu MLV. From there, the PNG LNG Gas Pipeline generally runs in parallel to the existing oil export line operated by OSL, until a deviation south of the Kaiam River towards Kopi.

The PNG LNG Gas Pipeline is pigged as required via pig launchers at the HGCP and DN 800 (32-inch) pig receiver at Kopi Scraper Station, and a DN 850 (34-inch) pig launcher at Kopi Scraper Station and DN 850 (34-inch) pig receiver at the LNG Plant.

The route of the onshore section of the PNG LNG Gas Pipeline is shown in Figure 1-2.

5.13 PNG LNG Gas Pipeline offshore

The offshore section of the PNG LNG Gas Pipeline is a DN 900 (36-inch) diameter carbon steel pipeline with concrete coating. It delivers gas between the Omati River Landfall and the LNG Plant located near Port Moresby. The offshore section is located initially at the bed of the Omati River for approximately 24 kilometres and then skirts the continental shelf of the Gulf of Papua to the landfall at Caution Bay. The total length of the offshore section is 407 kilometres.

Environmental aspects associated with the operation of the offshore section are negligible and it is not discussed further in this EMP.

The route of the offshore section of the PNG LNG Gas Pipeline is shown in Figure 1-2.

5.14 PNG LNG Gas Pipeline Above Ground Installations

Several AGIs serve the PNG LNG Gas Pipeline:

- Kutubu MLV
- Kutubu CPF Metering Station
- Gobe MLV
- Gobe Production Facility (GPF) Metering Station
- Kopi Scraper Station
- two Cathodic Protection (CP) stations.

A summary of the services located at the AGIs is shown in Table 5-2.

Associated gas from the Kutubu CPF and the GPF ties in with the PNG LNG Gas Pipeline at the Kutubu MLV and Gobe MLV, respectively.

The Kutubu MLV, Gobe MLV and the MLV at the Kopi Scraper Station enable isolation of discrete sections of the PNG LNG Gas Pipeline in case of repair or emergency. The MLVs are spaced to reduce the volume of gas release should it occur. A diagram of the Kutubu MLV is shown in Figure 5-7.

Table 5-2: Services at PNG LNG Gas Pipeline Above Ground Installations

SERVICE	FACILITY						
	KUTUBU MLV	KUTUBU CPF METERING STATION	GOBE MLV	GPF METERING STATION	KOPI SCRAPER STATION	CP1	CP2
Generator	✓		✓		✓	✓	✓
Pig receiver	Future		✓		✓		
Pig launcher		Future		✓	✓		
Blowdown vent	✓		✓		✓		
CP	✓		✓		✓	✓	✓
Equipment Shelter	✓	✓	✓	✓	✓	✓	✓
Helipad	✓		✓		✓	✓	✓
Emergency accommodation	✓		✓		✓	✓	✓

The MLVs can be operated locally or remotely controlled from the HGCP and include an actuated shutdown valve with a bypass containing isolation valves and pipe blowdown vents. The buildings house an equipment shelter, emergency accommodation shelter and a diesel generator. A helipad is provided to facilitate access by air.

The Kutubu CPF Metering Station houses one metering skid which measures the volumes of associated gas being delivered from the Kutubu CPF to the PNG LNG Gas Pipeline.

The GPF Metering Station also houses one metering skid which measures the volume of associated gas being delivered from the GPF to the PNG LNG Gas Pipeline. A pig launcher is located at the GPF Metering Station to launch pigs to the Gobe MLV pig receiver. Power and water are provided from the adjacent OSL GPF.

The Kopi Scraper Station enables the PNG LNG Gas Pipeline to be cleaned and the physical integrity of the PNG LNG Gas Pipeline to be internally inspected. It includes a pig launcher and receiver as well as an MLV, a pipeline blowdown vent and two cathodic protection beds. It also includes an equipment shelter, emergency accommodation and a generator. A diagram of the Kopi Scraper Station is shown in Figure 5-8.

CP1 and CP2 provide additional cathodic protection beds and include equipment, emergency accommodation and generators.

5.15 Associated gas pipelines

Associated gas from the oilfield operated by OSL at Kutubu is delivered to the PNG LNG Gas Pipeline via a DN 300 (12-inch) diameter pipeline (the Kutubu Gas Pipeline). This pipeline is approximately 2.4 kilometres long and the ROW extends from the Kutubu CPF Metering Station to the tie-in at the Kutubu MLV. The Condensate Pipeline to the Kutubu CPF Metering Station is located within the same ROW as the Kutubu Gas Pipeline. Due to the short length and lack of low spots, pigging of the Kutubu Gas Pipeline is not normally required.

Associated gas from the oilfield operated by OSL at Gobe is delivered to the PNG LNG Gas Pipeline via a DN 250 (10-inch) diameter pipeline (the Gobe Gas Pipeline), which follows the road from the GPF Metering Station to the Gobe MLV, over a distance of approximately 9.5 kilometres. The Gobe Gas Pipeline is pigged as required via a pig launcher at the GPF Metering Station and a pig receiver at the Gobe MLV.

The routes of the Kutubu Gas Pipeline and the Gobe Gas Pipeline are shown in Figure 1-2.

5.16 Pipeline and Above Ground Installation access tracks

Several access tracks to the AGIs that were put in place during construction of the condensate and gas pipelines, are required during production and remain in place. The access tracks are described in Section 17.0.

5.17 Moro B Camp

A support camp is based at Moro in the Southern Highlands Province. Moro B Camp includes: accommodation units; recreation building; administration office and canteen building; medical centre; laundry; muster and smoking shelters; sanitary WWTP; incinerator; and other associated infrastructure. A diagram of the Moro B Camp is shown in Figure 5-9.

5.18 Telecommunications

Telecommunication towers that contain equipment owned by EMPNG are located at HGCP, Hides 1, Iagifu, Komo Airport, Kakatumai, Mt Hee, Gobe and Moran Peak. Equipment owned by EMPNG include telecommunication towers (HGCP, Komo Airport, and Hides 1 only), support buildings, diesel generators and/or other associated infrastructure.

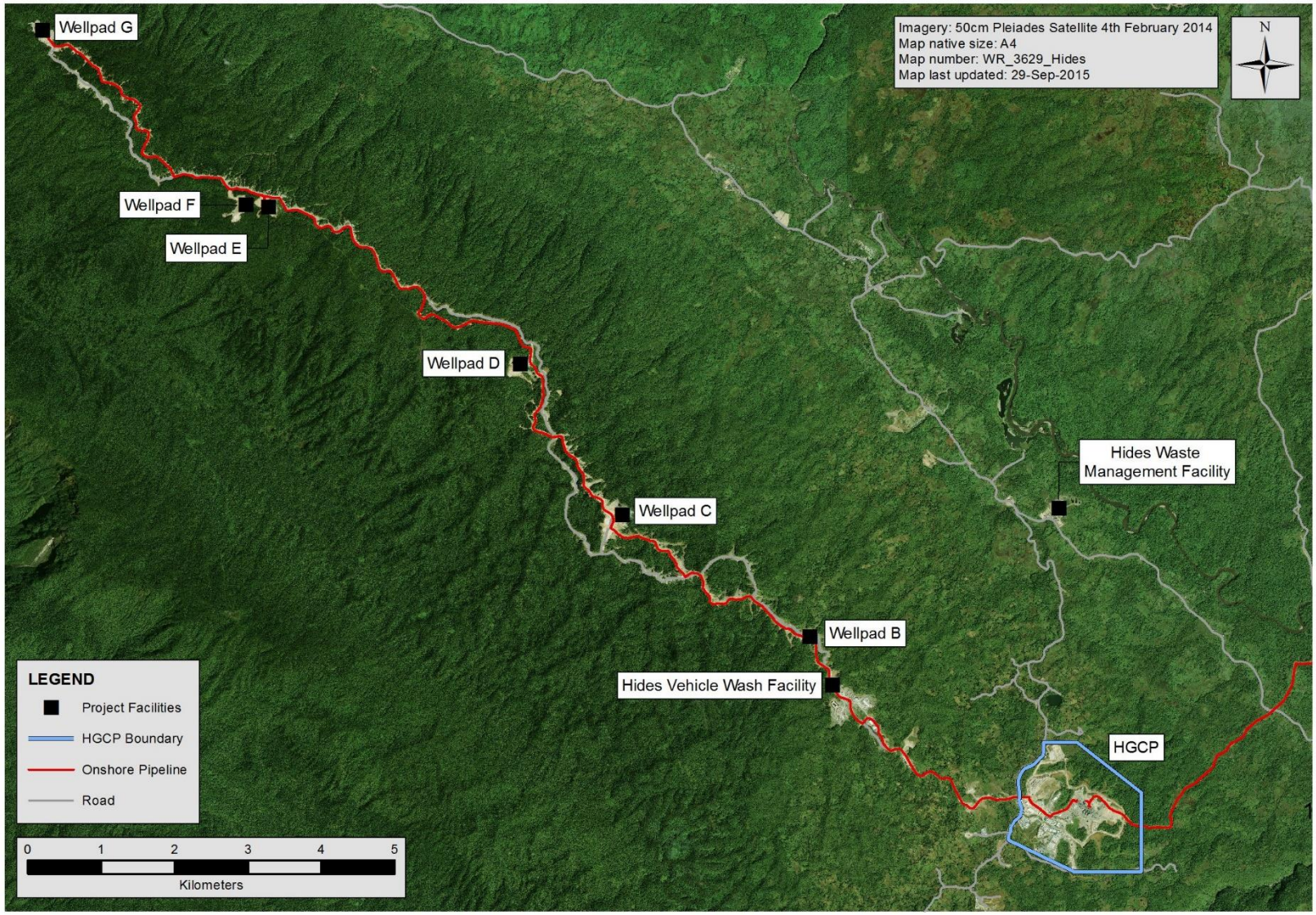

Figure 5-1: Hides Wellpads and Hides Wellpad Access Road layout

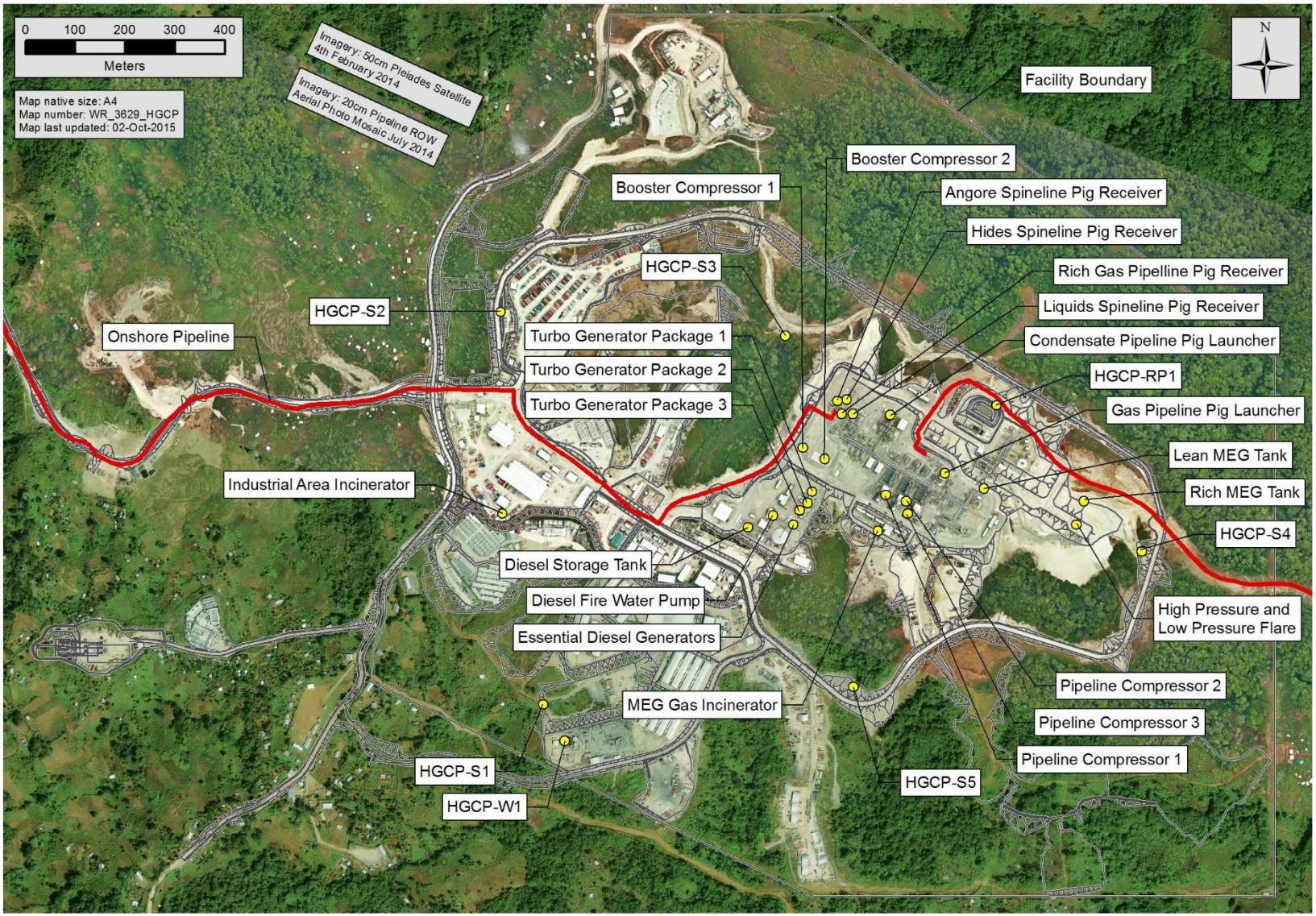

Figure 5-2: Hides Gas Conditioning Plant layout

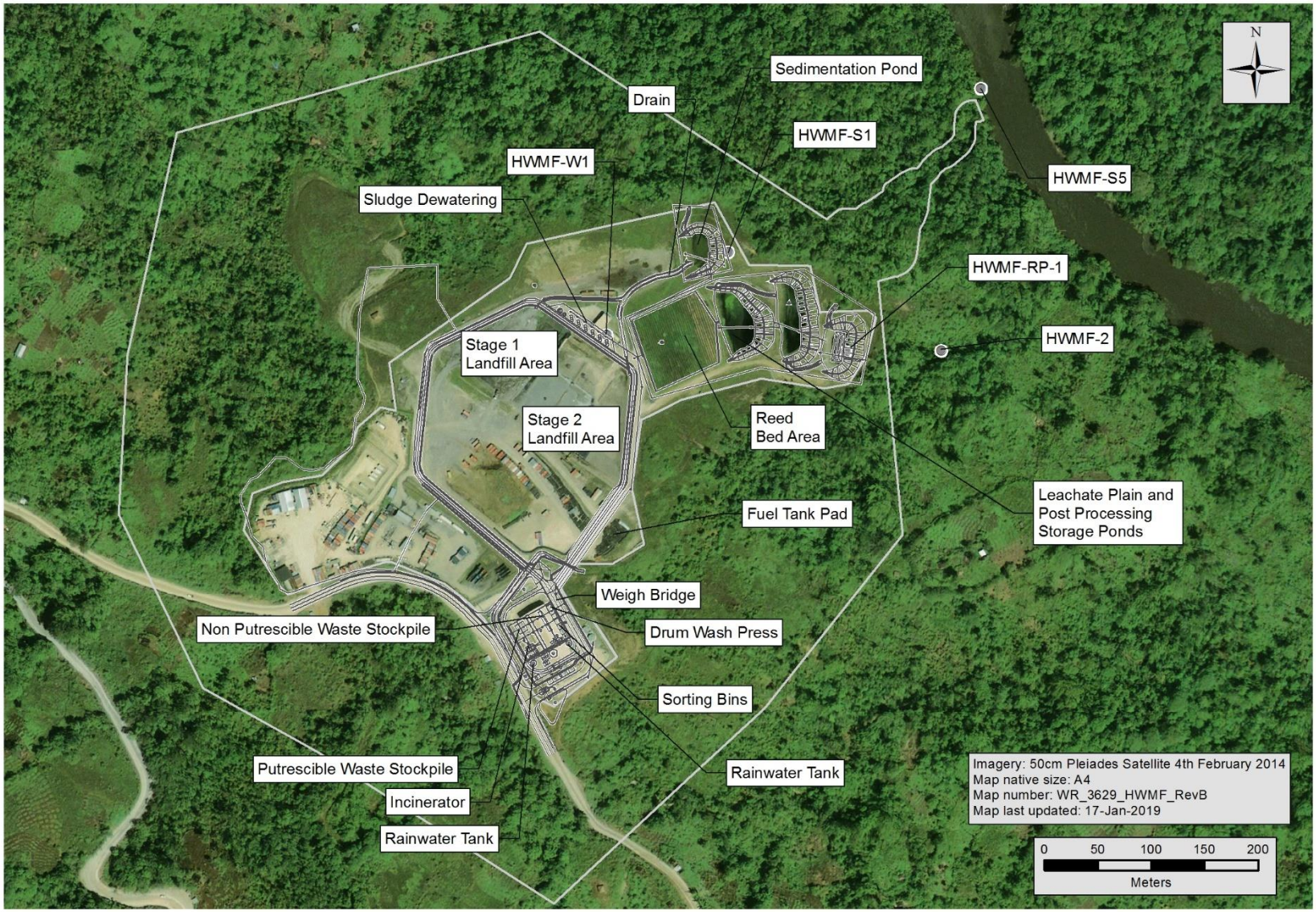

Figure 5-3: Hides Waste Management Facility layout

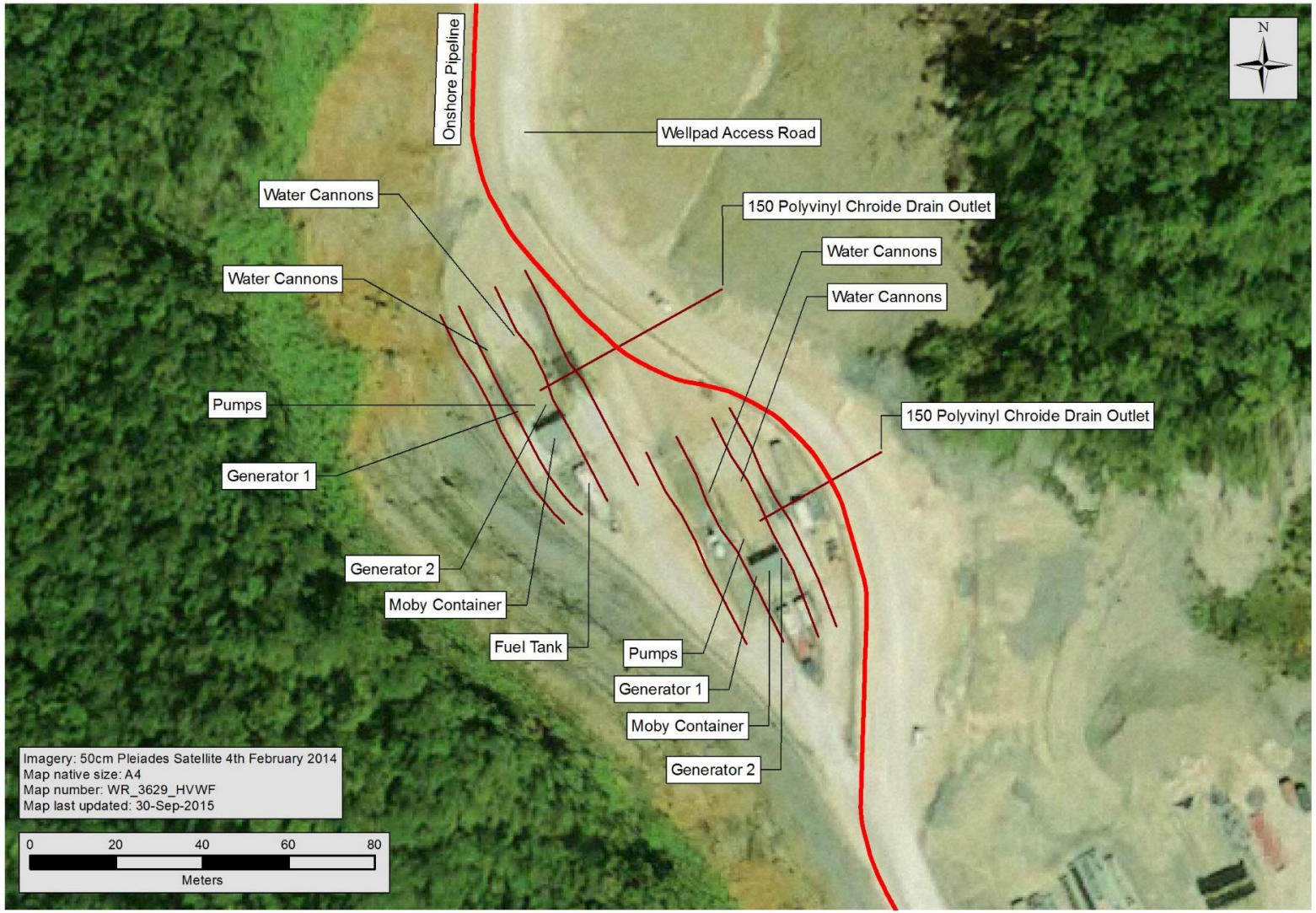

Figure 5-4: Hides Vehicle Wash Facility layout

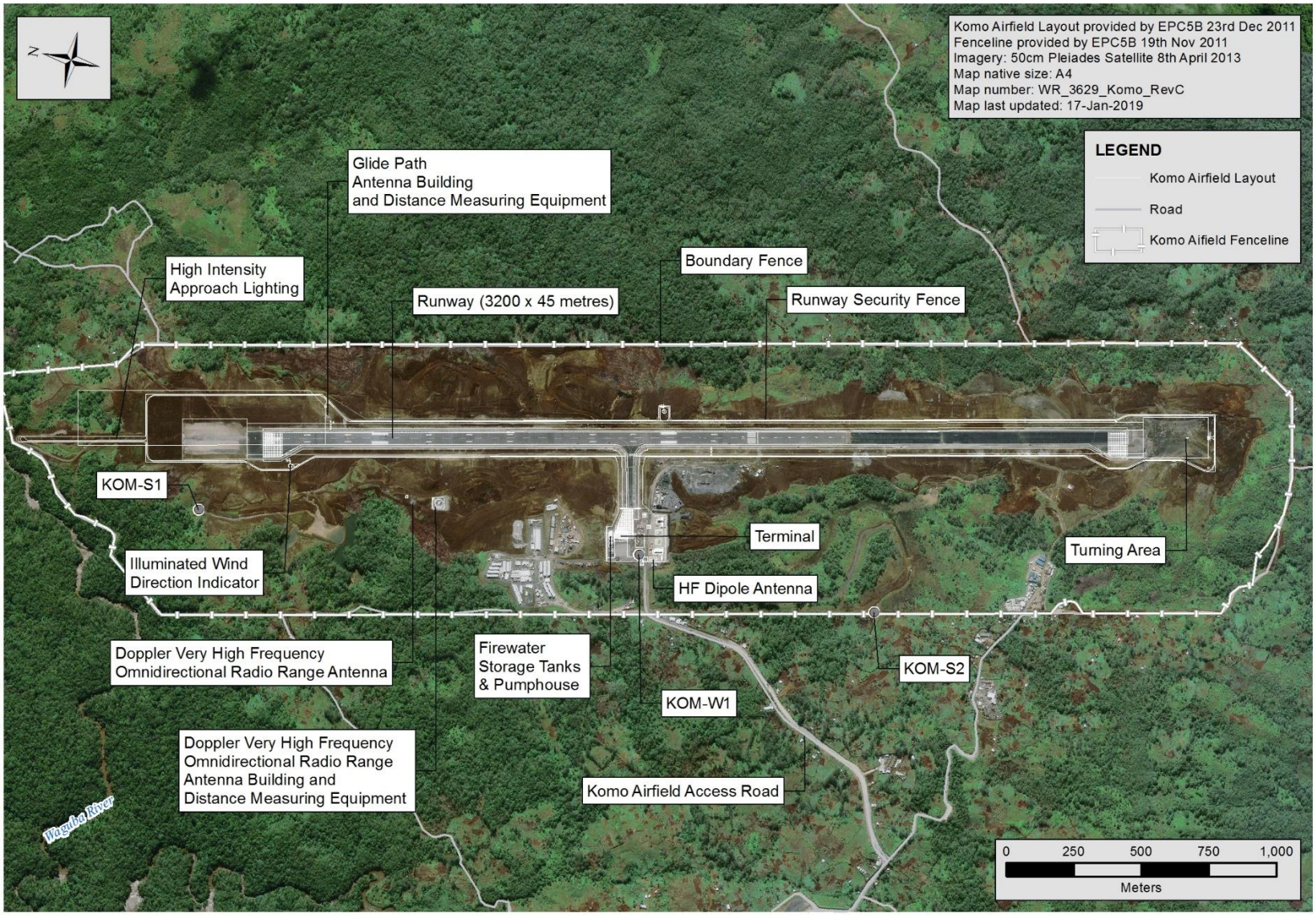

Figure 5-5: Komo Airfield layout

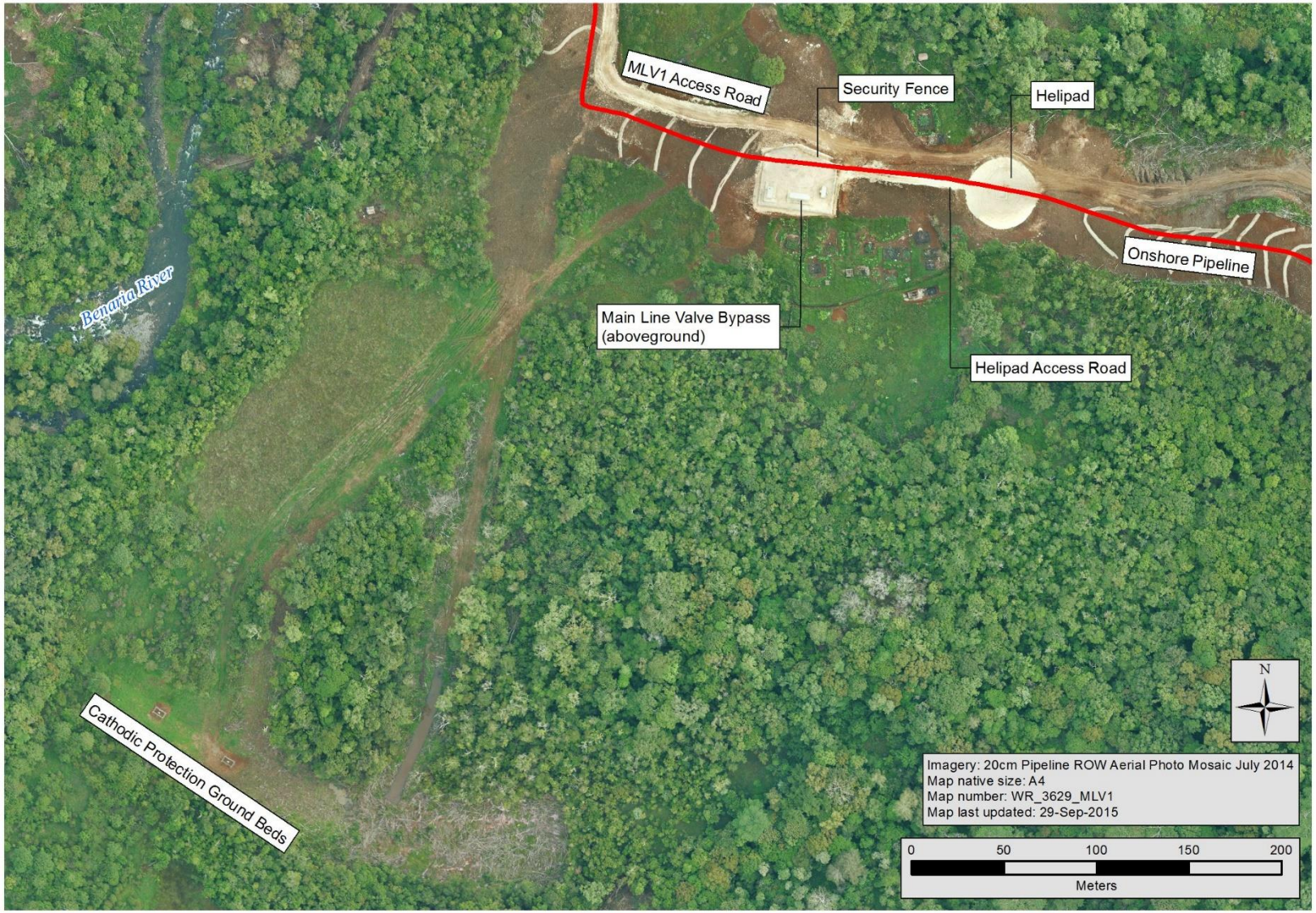

Figure 5-6: Main Line Valve 1 layout

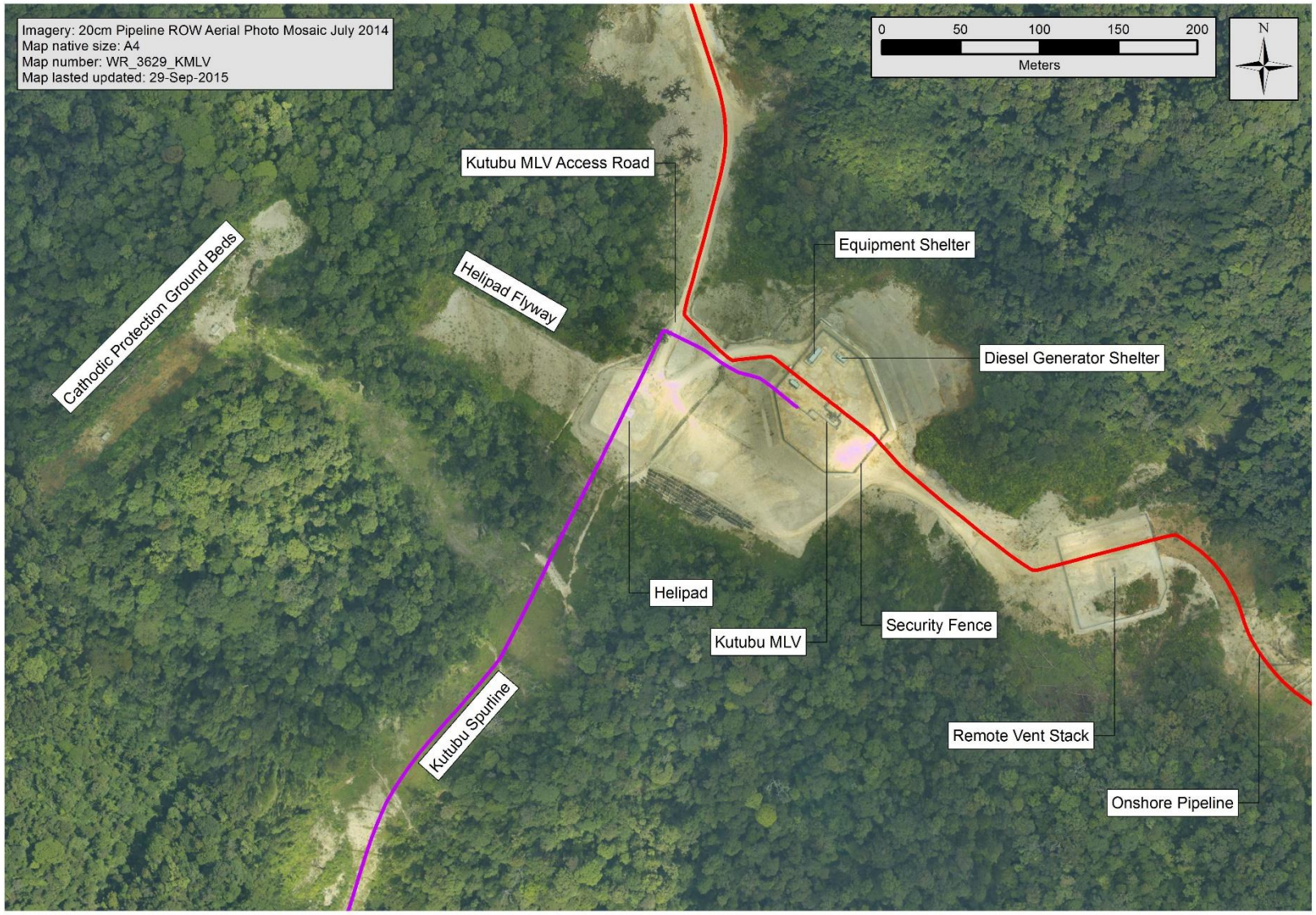

Figure 5-7: Kutubu Main Line Valve layout

Figure 5-8: Kopi Scraper Station layout

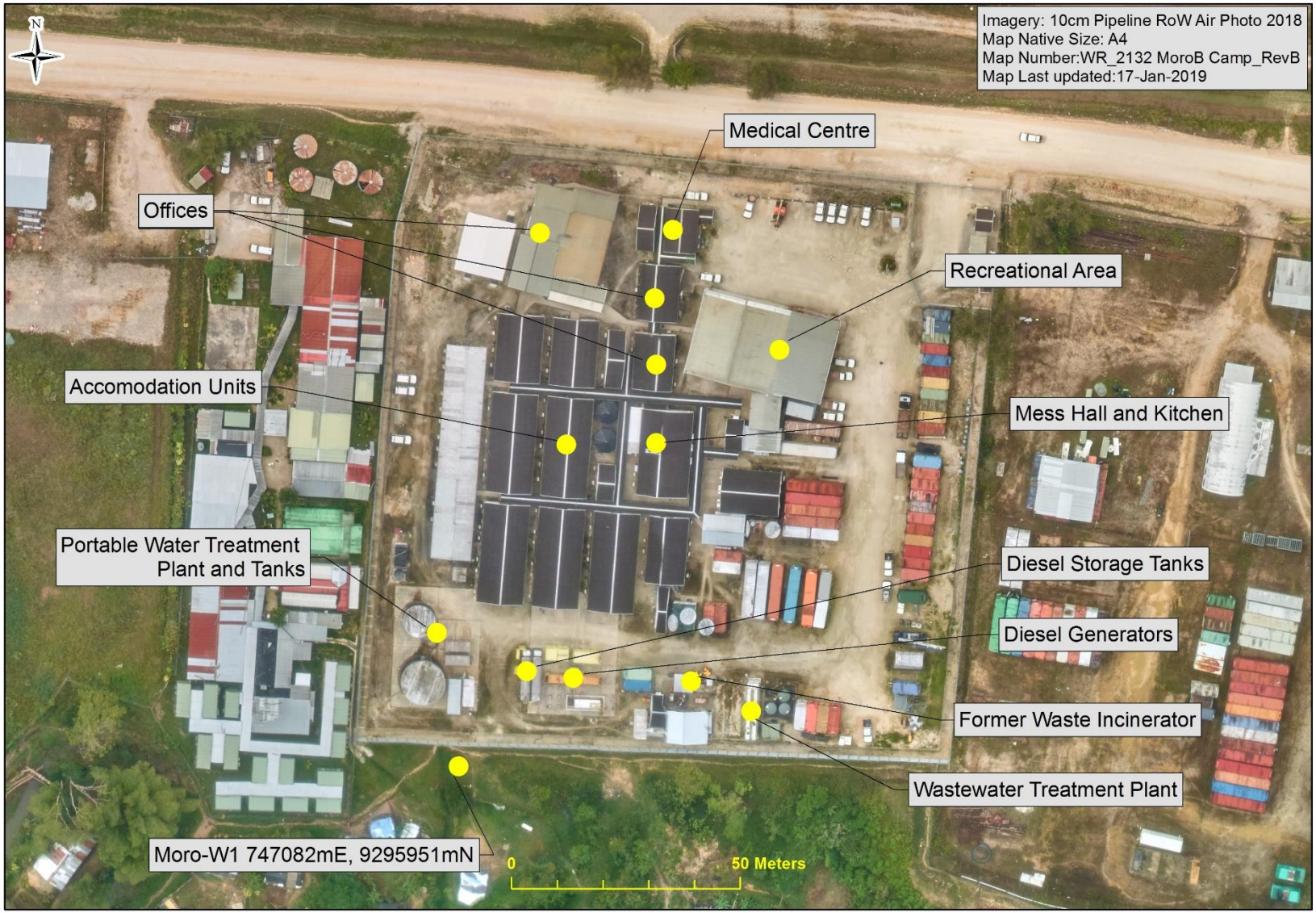

Figure 5-9: Moro B Camp Layout

6.0 EMISSIONS TO AIR

EMPNG's objectives are to avoid significant impacts associated with the release of pollutants to air and meet applicable emissions and air quality criteria.

Information relevant to emissions to air during production including a description of emission sources, applicable emissions criteria/guideline values and relevant design and operational controls, is provided in this section.

Operation of the facilities within the scope of this EMP gives rise to non-polluting and polluting emissions to air. Only polluting emissions are discussed herein. Non-polluting emissions, such as nitrogen, oxygen and water are not addressed.

Emissions from mobile sources (including vehicles) is not addressed below, however fuel use in mobile sources is recorded and polluting emissions from fuel use are monitored and reported. In addition, equipment is serviced regularly and low sulphur diesel will be used in the HGCP Diesel System where commercially available and not cost prohibitive.

Ambient air quality is discussed in Section 7.0.

Provisions for emissions monitoring are set out in Section 19.0.

A summary of emissions to air is provided in Appendix 2.

6.1 Hides and Angore wellpads

Emissions from the Hides and Angore wellpads are associated with the pig launchers and vent knockout pots/drums located at each wellpad. The pig launchers are operated intermittently as required.

Emissions are intermittent and *de minimis*[2] and not considered further in this EMP.

6.2 Produced Water Reinjection Well

There are no emissions to air from the PWRW.

6.3 Hides Gas Conditioning Plant

Emission sources at the HGCP, including continuous and intermittent sources during normal and abnormal operating conditions, are listed in Table 6-1. The location of each emission source is shown in Figure 5-2. A description of each emission source, applicable emissions criteria and control measures, including design and operational controls is provided in the following sections.

Several sources direct gas to the flare systems and some examples of these are given in Table 6-1.

Table 6-1: HGCP emission sources

SOURCE	EMISSION POINT REFERENCE	TYPE
Gas Turbine Compressor/Waste Heat Recovery Unit 1	HGCP-A1	Continuous
Gas Turbine Compressor/Waste Heat Recovery Unit 2	HGCP-A1	Continuous
Gas Turbine Compressor/Waste Heat Recovery Unit 3	HGCP-A1	Continuous
Main Power Generator 1	HGCP-A2	Continuous
Main Power Generator 2	HGCP-A2	Continuous
Main Power Generator 3	HGCP-A2	Continuous

[2] A term used by the United States Environmental Protection Agency to describe emissions levels which are negligible and for which no conformity levels are established.

SOURCE	EMISSION POINT REFERENCE	TYPE
MEG Vent Gas Incinerator	HCGP-A3	Continuous
Low Pressure Flare Stack (Purge and Pilot Gas)	HGCP-A4	Continuous
Low Pressure Flare Stack	HGCP-A4	Pressure Relief
Produced Water Skimmer/Degasser (to Low Pressure Flare)	HGCP-A4	Intermittent
Flotation Unit (to Low Pressure Flare)	HGCP-A4	Intermittent
Slop Oil Tank (to Low Pressure Flare)	HGCP-A4	Intermittent
High Pressure Flare Stack (Purge and Pilot Gas)	HGCP-A5	Continuous
High Pressure Flare Stack	HGCP-A5	Pressure Relief
Spineline Pig Receiver (to High Pressure Flare)	HGCP-A5	Intermittent
Condensate Pipeline Pig Launcher (to High Pressure Flare)	HGCP-A5	Intermittent
Gas Pipeline Pig Launcher (to High Pressure Flare)	HGCP-A5	Intermittent
Slop Oil Tank Pressure Vacuum Safety Valve	HGCP-A6	Pressure Relief
Produced Water Buffer Tank 1 Pressure Control Valve	HGCP-A7	Pressure Relief
Produced Water Buffer Tank 2 Pressure Control Valve	HGCP-A7	Pressure Relief
Produced Water Buffer Tank 1 Pressure Vacuum Safety Valve	HGCP-A8	Pressure Relief
Produced Water Buffer Tank 2 Pressure Vacuum Safety Valve	HGCP-A8	Pressure Relief
MEG Flash Drum Pressure Control Valve	HGCP-A9	Pressure Relief
Lean MEG Storage Tank Pressure Control Valve	HGCP-A10	Pressure Relief
Lean MEG Storage Tank Pressure Vacuum Safety Valve	HGCP-A11	Pressure Relief
Diesel Storage Tank Atmospheric Vent	HGCP-A12	Continuous
Diesel Firewater Pump Day Tank Atmospheric Vent	HGCP-A13	Continuous
Corrosion Inhibitor Tank Atmospheric Vent	HGCP-A14	Continuous
Reverse Demulsifier Tank Atmospheric Vent	HGCP-A15	Continuous
Oxygen Scavenger Tank Atmospheric Vent	HGCP-A16	Continuous
Biocide Tank Atmospheric Vent	HGCP-A17	Continuous
Drag Reducing Agent Storage Atmospheric Vent	HGCP-A18	Continuous
Essential Services Generator 1	HGCP-A19	Intermittent
Essential Services Generator 2	HGCP-A20	Intermittent
Diesel Firewater Pump Engine	HGCP-A21	Intermittent
Industrial Waste Incinerator	HGCP-A22	Intermittent

6.3.1 Gas turbine compressor exhausts

Gas is compressed to the required inlet pressure via the pipeline compression system consisting of compression packages operating in parallel, each including a gas turbine driven two-stage centrifugal compressor. The compressor drivers are fitted with dry low emission combustion systems.

Fuel gas is supplied directly from the Dew Point Conditioning Unit. Hot exhaust gases from the gas turbines are directed to Waste Heat Recovery Units (WHRUs), which provide heating for the HGCP hot oil system.

During steady state operations, emissions from the three WHRU stacks are continuous and the relevant pollutant is oxides of nitrogen. Table 6-2 shows the design emissions

specification for the gas turbine compressors/WHRU and the applicable emission guideline values.

Table 6-2: Gas turbine compressors/Waste Heat Recovery Unit emissions

PARAMETER	DESIGN EMISSION SPECIFICATION	EMISSION GUIDELINE VALUE
Oxides of nitrogen	25 ppm	25 ppm
Source: Based on Environmental, Health, and Safety General Guidelines (IFC, 2007), Table 1.1.2 - Small Combustion Facilities Emissions Guidelines. Emission guideline values stated in parts per million (ppm). Emission guideline values at reference conditions of 15 percent oxygen, dry gas. Emission guideline values apply during steady state operations, and not to startup, shutdown and abnormal operations.		

The stack height of each WHRU is 33 metres above grade which, in addition to the low emission combustion system, serves to control ground level concentrations of nitrogen dioxide and achieve applicable ambient air quality criteria.

6.3.2 Main power generator exhausts

The main power generators supply electrical power to the HGCP and the Hides Wellpads through a low and high voltage electrical distribution network. The system consists of three dual fuel, dry, low emission combustion turbine generators.

Two turbine generators operate in parallel, with one spare. Fuel gas is supplied to each turbine generator from the Dew Point Conditioning Unit via a dedicated fuel gas conditioning system. Automatic switch to back-up diesel fuel is provided in the event of a fuel gas supply problem, with diesel supplied via transfer line direct from the HGCP Diesel System.

During steady state operations, emissions from the turbine generators are continuous and the relevant pollutant is oxides of nitrogen. Table 6-3 shows the design emissions specification for the turbine generators and the applicable emission guideline values.

Table 6-3: Main power generator emissions

PARAMETER	DESIGN EMISSION SPECIFICATION	EMISSION GUIDELINE VALUE
Oxides of nitrogen	25 ppm	42 ppm
Source: Based on Environmental, Health, and Safety General Guidelines (IFC, 2007), Table 1.1.2 - Small Combustion Facilities Emissions Guidelines. Emission guideline values at reference conditions of 15 percent oxygen, dry gas. Emission guideline values apply during steady state operations, and not to startup, shutdown and abnormal operations.		

The stack on each turbine generator is 19 metres above grade which, in addition to the low emission combustion system, serves to control ground level concentrations of nitrogen dioxide and achieve applicable ambient air quality criteria.

While operating with diesel as a back-up fuel, emissions of oxides of sulphur from the turbine generators are relevant. Environmental, Health, and Safety General Guidelines (IFC, 2007), Table 1.1.2 - Small Combustion Facilities Emissions Guidelines state that low sulphur fuel (0.5 percent or lower) should be used if commercially available without significant excess fuel cost. Accordingly, low sulphur diesel will be used in the HGCP Diesel System where commercially available and not cost prohibitive.

6.3.3 MEG Vent Gas incinerator

Regeneration of MEG at the HGCP involves distillation of rich MEG and produces vapours/vent gas, consisting mainly of water with some hydrocarbons (<1 percent) including benzene, toluene, ethylbenzene, and xylene (BTEX) components.

To ensure safe disposal, this vent gas is directed, via a vent gas blower, to a high temperature MEG Vent Gas (MEGVG) incinerator. The MEGVG incinerator is fuel gas fired and is sized to handle the maximum flow of vent gas during operation of both MEG regeneration units.

The MEGVG incinerator is designed to attain a combustion temperature in excess of 750 degrees Celsius to achieve thermal destruction of BTEX (the incinerator has a design 98 percent destruction efficiency). There are no applicable emission guideline values.

The MEGVG incinerator stack height is 30 metres above grade which, in addition to the destruction efficiency of the system, serves to control ground level concentrations of BTEX in ambient air.

6.3.4 Industrial park incinerator

A high temperature incinerator has been installed at the HGCP to dispose of combustible waste streams. The incinerator has a capacity of 100 kilograms per hour. It is diesel fired, with diesel supplied to the burners from the HGCP Diesel System.

The incinerator is of dual combustion chamber design that achieves a minimum temperature of 850^{o}C, with the combustion temperature in both chambers maintained via automatic control. A minimum retention time in the secondary combustion chamber of two seconds is achieved via automatic control.

Flue gas from the incinerator is treated through a pollution control system consisting of an air quench, wet spray quench, and gas cleaning system. The temperature of the flue gases exiting the secondary combustion chamber is quenched in the air quench, further cooled by the water spray quench, with final cooling by a secondary air quench. The cooled flue gas is directed to a gas cleaning system consisting of a baghouse filter for the removal of particulates and adsorption of acid gas. Filters in the bag house remove particulates and acid gas is adsorbed by injection of a mixture of pulverised hydrated lime.

The height of the stack incinerator is sized which, in addition to the combustion efficiency and pollution control system, serves to control ground level concentrations of residual pollutants in ambient air.

The relevant emission guideline values are shown in Table 6-4.

Table 6-4: Incinerator emissions

PARAMETER	EMISSION GUIDELINE VALUE
Particulate Matter (PM)	70 mg/m^3
Carbon monoxide	157 ppm
Oxides of nitrogen	388 ppm
Oxides of sulphur	20 ppm
Hydrogen chloride	62 ppm
Cadmium	0.004 mg/m^3
Lead	0.04 mg/m^3
Mercury	0.47 mg/m^3
Dioxin/furan	0.41 ng/m^3
Opacity	10 percent
Source: Based on Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 60] (United States Environmental Protection Agency, 2008) Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units), including threshold for applicability relating to throughput, as referenced in Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007).	

Emission guideline values stated in ppm by dry volume, milligrams per standard cubic metre (mg/m^3) and nanograms per standard cubic metre (ng/m^3), as indicated above. Emission guideline values apply during normal steady state operations, and not to startup, shutdown and abnormal operations. Emission guideline values for dioxin/furan at toxic equivalency basis.

Emission guideline values except opacity are stated at reference conditions of 7 percent oxygen, dry basis at standard conditions.

6.3.5 Flare system

A low-pressure flare and a high-pressure flare operate at the HGCP. These flares are located on the same support structure. There is no routine flaring during steady state operations; however there are certain continuous, intermittent and relief-case emissions from both flare stacks, described below.

Continuous pilots are used to ignite all flares and the stacks are continuously purged with nitrogen to control oxygen levels. Pilot and purge gases consist of nitrogen, oxides of nitrogen, carbon monoxide, and light/volatile hydrocarbons and represent continuous, although *de minimis*, emissions.

Discharges from the slop oil tank, produced water skimmer/degasser and flotation unit are intermittently directed to the low-pressure flare, resulting in intermittent and *de minimis* emissions.

Discharges from the Hides Spineline pig receiver, Condensate Pipeline launcher and PNG LNG Gas Pipeline are intermittently directed to the high-pressure flare, resulting in intermittent and *de minimis* emissions.

During startup, shutdown and conditions of excessive pressure, the low-pressure flare system provides relief from equipment operating at low pressure (below 1000 kilopascals) and the high-pressure flare system provides relief from equipment operating at high pressure (reliefs, vents and blowdown with a pressure greater than 1000 kilopascals).

Polluting emissions from the flare stacks during the design worst-case relief are oxides of nitrogen, carbon monoxide, and light/volatile hydrocarbons. There are no applicable emission guideline values.

The flares are designed to achieve up to 98 percent thermal destruction efficiency and are designed for smokeless flaring over their operating range. The flare tips are located at 97 metres above grade which, in addition to the high efficiency design, serves to control ground level concentrations of pollutants in ambient air. The high-pressure flare is fitted with a high-pressure sonic tip to control noise emissions.

6.3.6 Pressure control valves and pressure vacuum safety valves

A number of pressure control valves and pressure vacuum safety valves operate at the HGCP to provide pressure relief. Discharges from the pressure control valves are directed to the flare systems, resulting in intermittent and *de minimis* emissions and are not considered further in this EMP. Emissions from the pressure vacuum safety valves are not routine (only in case of pressure relief), *de minimis* and not considered further in this EMP.

6.3.7 Atmospheric vents

A number of atmospheric vents operate at the HGCP. Emissions from these vents are *de minimis* and are not considered further in this EMP.

6.3.8 Diesel engines

Essential services generators are available for startup or when main power generators are unavailable, catering for essential loads at the HGCP and Hides wellpads. A diesel engine driven firewater pump is provided as back up to the electrically driven primary firewater pump. For maintenance purposes, generators and firewater pump engines are regularly serviced and operated for several hours per week. In addition, low sulphur diesel will be used

in the HGCP Diesel System where commercially available and not cost prohibitive. Emissions from the diesel engines are intermittent and *de minimis* and are not considered further in this EMP.

6.4 Hides Waste Management Facility

Emission sources at the HWMF, including continuous and intermittent sources during normal and abnormal operating conditions, are listed in Table 6-5. The location of each emission source is shown in Figure 5-3. A description of each source, applicable emissions criteria and control measures, including design and operational controls is provided in the following sections.

Table 6-5: Hides Waste Management Facility emission sources

SOURCE	EMISSION POINT REFERENCE	TYPE
Incinerator	HWMF-A1	Intermittent
Diesel engine generators	HWMF-A2	Continuous

6.4.1 Incinerator

The main source of emissions to air at the HWMF is a high temperature incineration package, which operates to process combustible waste streams. Waste management is further discussed in Section 12.0.

The incineration package is diesel fired, with diesel supplied to the burners via a reticulation line from a diesel day storage tank. Low sulphur diesel is used where commercially available and not cost prohibitive.

The incinerators are of dual combustion chamber design, which achieves a minimum temperature of 850^{o}C to enable optimum combustion and destruction of pollutants, with the combustion temperature in both chambers maintained via automatic control. A minimum retention time in the secondary combustion chamber of two seconds is achieved via automatic control.

Flue gas from the incinerators is treated through a pollution control system consisting of a primary air quench, wet spray quench, secondary air quench and gas cleaning system.

The temperature of the flue gases exiting the secondary combustion chamber of each incinerator is immediately quenched in the primary air quench. Flue gas is then directed to the water spray quench for further cooling and subsequently to the secondary air quench unit for final cooling.

The cooled flue gas from each incinerator train's water spray quench chamber is combined and directed to a common gas cleaning system consisting of a baghouse filter for the removal of particulates and adsorption of acid gas. Filters in the bag house remove particulates and acid gas is adsorbed through the injection of a mixture of pulverised hydrated lime and powder activated carbon.

The relevant emission guideline values are shown in Table 6-4.

The stack on each incinerator is sized which, in addition to the combustion efficiency and pollution control system, serves to control ground level concentrations of residual pollutants in ambient air.

A second, smaller, packaged biohazardous waste incinerator is installed at the HWMF. This incinerator is also diesel-fired and its dual-chamber combustion achieves high exhaust temperatures in excess of 1000°C with a residence time in excess of two seconds. Due to the volume of waste and intermittent operation of this incinerator, emissions are considered *de minimis* and are not considered further in this EMP.

6.4.2 Diesel engines

Generators driven by diesel engines operate at the HWMF to provide power to the facility. One generator operates continuously, with the other providing additional duty when necessary. Polluting emissions from the diesel engines are oxides of nitrogen, carbon monoxide, and sulphur dioxide.

In the absence of emission guideline values applicable to the operation of the diesel engine generators, preventive maintenance supports operation of the generators in accordance with manufacturer specifications and control the release of pollutants. Low sulphur diesel will be used where commercially available and not cost prohibitive.

6.4.3 Landfill emissions

Polluting emissions from landfills include methane and carbon dioxide. A landfill gas collection system that vents to atmosphere will be installed when the landfill cells are capped. Given that the majority of putrescible waste is either digested via the wastewater treatment plants (food waste) or incinerated, and only a minimal amount is sent directly to landfill, the venting of landfill gas emissions are considered *de minimis* and not considered further in this EMP.

6.5 Hides Vehicle Wash Facility

Diesel engine driven generators operate at the HVWF to provide power to the facility. One generator operates continuously, with the other providing additional duty when necessary. Polluting emissions from the diesel engines are oxides of nitrogen, carbon monoxide, and sulphur dioxide. In the absence of emission guideline values applicable to the operation of the diesel engine generators, a program of preventive maintenance ensures the generators operate in accordance with manufacturer specifications and control release of pollutants. Low sulphur diesel is used where commercially available and not entailing excessive cost.

6.6 Komo Airfield

Emission sources at Komo Airfield, including continuous and intermittent sources during normal and abnormal operating conditions, are listed in Table 6-6. The location of each emission source is shown in Figure 5-5. A description of each source, applicable emissions criteria and control measures, including design and operational controls is provided in the following sections.

Table 6-6: Komo Airfield emission sources

SOURCE	EMISSION POINT REFERENCE	TYPE
Diesel engine generators	KA-A1	Continuous
Essential services generators	KA-A2	Intermittent
Firewater pump diesel engines	KA-A3	Intermittent
Aircraft emissions	N/A	Intermittent
Note: KA = Komo Airfield		

6.6.1 Diesel engines

Generators driven by diesel engines operate at the Komo Airfield to provide power to the facility. The power generation system comprises several diesel engine generators. Three generators provide power, with one generator operating continuously, another providing additional duty when necessary, and a third providing redundancy. Polluting emissions from the diesel engines are oxides of nitrogen, carbon monoxide, and sulphur dioxide.

An essential services generator is available at the Komo Airfield as back up to the main power generators, catering for essential loads including runway lighting and navigation aids. For maintenance purposes, the essential services generator is operated for up to two hours per

week. Emissions from the essential services generator are intermittent and *de minimis* and are not considered further in this EMP.

Four diesel engine driven firewater pumps are provided to serve the Komo Airfield fire protection system. For maintenance purposes, the firewater pumps are operated for up to two hours per week. Emissions from the firewater pumps are intermittent and *de minimis* and are not considered further in this EMP.

In the absence of emission guideline values applicable to the operation of the diesel engine generators, preventive maintenance ensures they operate in accordance with manufacturer specifications and control release of pollutants. Low sulphur diesel is used where commercially available and not cost prohibitive.

6.6.2 Aircraft emissions

The Komo Airfield serves operations of fixed and rotary wing aircraft and is primarily used for the transport of personnel. Due to the low frequency and short duration of aircraft movements, aircraft emissions are considered to be intermittent and *de minimis* and are not considered further in this EMP.

6.7 Pipelines and Above Ground Installations

There are no significant emission sources during operation of the pipelines and AGIs, with the main source being diesel engine generators.

6.7.1 Emissions from diesel engines

Generators driven by diesel engines operate at the MLVs, the Kopi Scraper Station and the CP stations.

Kopi generators that operate the Fibre Optic Local Equipment Room (FOLER) operate on a 24 hour basis. At all other sites, the diesel engine generators operate as required but only for a maximum of eight hours during the daytime. Acoustic attenuation devices are installed on the generators as appropriate.

Polluting emissions from the diesel engine generators are oxides of nitrogen, carbon monoxide, and sulphur dioxide.

In the absence of emission guideline values applicable to the operation of the diesel engine generators, preventive maintenance supports operation of the generators in accordance with manufacturer specifications and control release of pollutants. Low sulphur diesel will be used where commercially available and not cost prohibitive.

6.7.2 Emissions from blowdown vents

Blowdown vents at the Gobe MLV, Kutubu MLV and Kopi Scraper Station will operate should the PNG LNG Gas Pipeline require depressurisation during upset conditions, such as in the event of a release or other damage to the pipeline. Depressurisation, which involves emptying the pipeline of gas in isolated sections, is considered an unlikely event.

Emissions from the depressurisation process are not routine (only in case of pressure relief) and *de minimis* and are not considered further in this EMP.

6.8 Moro B Camp

Generators driven by diesel engines operate at the Moro B Camp to provide power to the facility. The power generation system comprises two diesel engine generators. One generator operates continuously, while the other provides additional duty when necessary. Polluting emissions from the diesel engines are oxides of nitrogen, carbon monoxide, and sulphur dioxide. Polluting emissions from the diesel engine generators are oxides of nitrogen, carbon monoxide, and sulphur dioxide.

In the absence of emission guideline values applicable to the operation of the diesel engine generators, preventive maintenance supports operation of the generators in accordance with manufacturer specifications and control release of pollutants. Low sulphur diesel will be used where commercially available and not cost prohibitive.

A smaller packaged biohazardous waste incinerator is installed at the Moro B Camp. This incinerator is also diesel-fired and its dual-chamber combustion achieves high exhaust temperatures in excess of 1000°C with a residence time in excess of two seconds. Due to the volume of waste and intermittent operation of this incinerator, emissions are considered *de minimis* and are not considered further in this EMP.

6.9 Telecommunications

EMPNG owned generators driven by diesel engines operate at the HGCP, Mt Hee, Gobe and Moran Peak to provide power to the equipment rooms at the telecommunications facilities. The power generation system at each site comprises one diesel engine generator. The diesel engine generators operate as required. Acoustic attenuation devices are installed on the generators as appropriate. Polluting emissions from the diesel engines are oxides of nitrogen, carbon monoxide, and sulphur dioxide.

In the absence of emission guideline values applicable to the operation of the diesel engine generators, preventive maintenance supports operation of the generators in accordance with manufacturer specifications and control release of pollutants. Low sulphur diesel will be used where commercially available and not cost prohibitive.

6.10 Fugitive emissions

Fugitive source air emissions refer to emissions that are distributed spatially over a wide area and not confined to a specific discharge point. There are no significant sources of fugitive emissions anticipated during operation of the facilities within the scope of this EMP.

Minor fugitive emissions arise from piping and valves, pig receivers and launchers, pipeline blowdown vents, diesel storage tanks, the condensate drain at the Kutubu CPF Metering Station, and the laboratory emissions (e.g. fumehoods). Valves, pipes and tanks, etc. are regularly inspected and maintained to reduce the potential for fugitive volatile organic compound emissions. Fugitive emissions are *de minimis* and are not considered further in this EMP.

6.11 Greenhouse gas emissions

The primary greenhouse gas emissions associated with the operation of the Upstream facilities include:

- combustion of natural gas used by turbines for power generation and heaters/boilers
- flaring of natural gas (including pilot flare and assist gas)
- combustion of diesel by waste incinerators
- combustion of diesel by vehicles and mobile equipment operated by EMPNG and contractors
- leaks and accidental releases of gas from gas piping, pipelines or equipment (which only occur under abnormal conditions)
- biogases from wastewater treatment facilities and landfills

Minimising greenhouse gas emissions was considered during engineering design and procurement of equipment for the HGCP. Waste heat is recovered and used as an energy source at the HGCP, which reduces fuel gas consumption and greenhouse gas emissions that would otherwise be associated with providing an alternative heat source (e.g. via a gas-fired heater or boiler). At the HGCP, waste heat from the exhaust of the pipeline gas turbine compressors is also used to provide heat to the thermal-fluid–based hot-oil system.

Greenhouse gas emissions are tracked and reported to internal and external stakeholders as part of EMPNG's environmental performance reporting requirements. Site emission sources are accounted for, including generators, turbine compressors, flares, process vents, aviation sources and mobile sources such as vehicles. Direct process fuel usage is used with approved emission factors to calculate the final greenhouse gas emissions. Year-on-year trends are reviewed and any differences noted are used to understand any potential changes in operations.

Greenhouse gas emissions from wastewater treatment and waste disposal are considered to be *de minimis* due to the limited scale and are not considered further in this EMP.

6.12 Dust

Dust may be generated in dry conditions, including around soil and spoil stockpiles. To reduce the occurrence of dust, appropriate vehicle speed limits are applied within EMPNG facilities and on public roads. In the event that dust causes a nuisance, appropriate control measures (for example road dampening, covering stockpiles) will be implemented.

6.13 Light

Light has the potential to disturb nocturnal fauna. Potential impacts of perimeter and other lights will be reduced by directing light to where it is required for operations and security and where practical avoid directing it to surrounding areas.

7.0 AMBIENT AIR QUALITY

EMPNG's objectives are to avoid impacts associated with the release of pollutants to air and meet applicable emissions and air quality criteria.

The ambient air quality guidelines applicable to EMPNG's operations are described in this section. Ambient air quality monitoring is discussed in Section 19.0.

Emissions to atmosphere from the Upstream facilities, infrastructure and pipelines have the potential to result in localised effects on ambient air quality.

Applicable ambient air quality guideline values, designed for protection of human health and the environment, are shown in Table 7-1.

Table 7-1: Ambient air quality guidelines

	AVERAGING PERIOD			
	1 HOUR ($\mu G/M^3$)	**24 HOUR ($\mu G/M^3$)**	**ANNUAL ($\mu G/M^3$)**	**OTHER**
Sulphur dioxide	-	20	-	10 minute average: 500
Nitrogen dioxide	200	-	40	-
Carbon monoxide	30,000	-	-	15 minute average: 100,000 30 minute average: 60,000 8 hour average: 10,000
Hydrogen sulphide	-	-	-	No offensive odour at boundary: <5 mg/m^3
PM_{10}	-	150	70	-
$PM_{2.5}$	-	75	35	-
Total suspended particulates	-	150-230	60-90	-
Ozone	-	-	-	8 hours, daily max: 100 (not to be exceeded more than 24 times per year)
Source: Based on Air Quality Guidelines (World Health Organization, 2006), as cited in the Environmental, Health, and Safety General Guidelines (IFC, 2007), Table 1.1.1 - WHO Ambient Air Quality Guidelines. Ambient air quality values are expressed in micrograms per cubic metre ($\mu g/m^3$) unless otherwise stated. PM 24-hour value is the 99^{th} percentile.				

Several air quality assessments, including the air quality assessments undertaken as part of the PNG LNG EIS and subsequent air quality and dispersion modelling undertaken during detailed design show that the air quality guideline values shown in Table 7-1 are achievable.

8.0 NOISE

EMPNG's objectives are to avoid significant noise impacts to community and fauna and meet applicable noise criteria.

The noise guidelines applicable to production are described in this section.

Noise from the Upstream facilities has the potential to cause localised noise impacts to nearby receptors. Noise guidelines applicable to steady state operation of the Upstream facilities are shown in Table 8-1.

Conditions that are not considered to be part of steady state operations of the Upstream facilities include plant startup, plant shutdown, maintenance (planned or unplanned), process upset and any emergency situation.

Table 8-1: Noise guidelines

RECEPTOR	**ONE HOUR EQUIVALENT CONTINUOUS SOUND PRESSURE LEVEL IN A-WEIGHTED DECIBELS (dBA)**	
	DAY	**NIGHT**
Residential, Institutional Educational	55	45
Industrial, Commercial*	70	70
Source: Based on Environmental, Health, and Safety General Guidelines (IFC, 2007), Table 1.7.1 Noise Level Guidelines. *Industrial/commercial Guidelines given as reference only, neighbouring environments to Upstream locations are residential and hence Residential Guidelines apply. IFC noise level guidelines state that noise should not exceed the guideline levels above or result in a maximum increase in background levels of 3dBA at the nearest off-site receptor, whichever is greater. Day is 07.00-22.00 hours. Night is 22.00-07.00 hours.		

The noise guidelines shown in Table 8-1 are deemed to apply at the nearest receptor beyond the land access boundary of each facility. The extent of the land access boundary and the layout of noise generating equipment at each facility have been designed to achieve these criteria.

The criteria shown in Table 8-1 will be achieved with the exclusion of background noise, more specifically; background noise will be subtracted such that only point source noise from the facility will be accounted for. Conformance will be demonstrated through noise modelling, supplemented by noise monitoring, as discussed further in Section 19.0.

In addition to the above steady state criteria, planned short-term high intensity noise events will be limited and potentially affected communities will be notified in advance of the intended work and its duration where possible.

9.0 DISCHARGES TO WATER AND WATER QUALITY

EMPNG's objectives are to avoid significant impacts associated with the release of pollutants to surface water and groundwater and meet applicable discharge criteria.

Information about the discharge of wastewater during production is provided in this section, including a description of the discharges and the applicable discharge criteria/water quality criteria.

Also described below are relevant control measures, including design and operational controls. Monitoring of discharges and water quality is discussed in Section 19.0.

A summary of discharges to water is provided in Appendix 2.

9.1 Hides and Angore wellpads

There are no discharges to water from the Hides Wellpads or Angore wellpads.

Stormwater from uncontaminated areas of the Hides and Angore wellpads is sloped to allow natural drainage flows without collection. Uncontaminated stormwater collected within the wellpads' cellars is sampled and periodically discharged directly to the environment without further treatment. In the event water collected within the wellpad cellars is impacted, then the water is collected and transferred to the open drain sump at the HGCP.

Water collected in the vent knockout drum drains (open drain sump) is collected periodically and transferred to the open drain sump at the HGCP.

9.2 Produced Water Reinjection Well

Formation water produced from the wellstream will be separated at the HGCP and sent to a produced water reinjection well (PWRW). Prior to injection, the produced water will pass through two filters designed to remove course and fine sediment from the water. Retained and backwashed water from the filters will be routed to the beginning of the produced water train to form a closed loop. No produced water will be disposed of external to the well stream process train.

9.3 Hides Gas Conditioning Plant

Discharges to water at the HGCP are listed in Table 9-1. The location of each emission source is shown in Figure 5-2. A description of each source and the relevant control measures, including design and operational controls is provided in the following sections.

Table 9-1: Hides Gas Conditioning Plant discharge points

SOURCE	DISCHARGE POINT REFERENCE	TYPE
Stormwater	HGCP-S1	Intermittent
Stormwater	HGCP-S2	Intermittent
Stormwater	HGCP-S3	Intermittent
Stormwater	HGCP-S4	Intermittent
Stormwater	HGCP-S5	Intermittent
Retention pond	HGCP-RP1	Intermittent
WWTP	HGCP-W1	Intermittent

9.3.1 Open and closed drain systems

The drain system at the HGCP enables separate management of clean and potentially contaminated water.

A stormwater system collects stormwater from uncontaminated areas at the HGCP and is graded and sloped to allow natural drainage directly to the environment without treatment at several locations.

An open drain system collects stormwater, wash-down, spillage, and firewater from potentially contaminated areas at the processing facility and discharges to an open drain sump.

The open drain sump provides retention time for initial solids separation, oily water separation, and a corrugated plate interceptor to further separate oily water. Separated oil from the open drain sump is collected via a weir system and pumped to a slop oil tank, and separated water is directed to the retention pond.

For those areas which contain significant volumes of MEG (including the MEG regeneration package area and the MEGVG incinerator area) stormwater is retained in a first flush containment sump, enabling it to be checked for MEG contamination. MEG-contaminated water is removed from the sump via vacuum truck and disposed of either to the PWRW, HWMF or offsite via an EMPNG approved third party waste provider. Uncontaminated stormwater is directed to the open drain sump.

For those areas which contain bulk lube oil (for example the gas turbine compressor area and main power generator area) or where chemicals are required to be drained, a lube oil and chemical drain discharges directly to the closed drain system.

The closed drain system connects to a closed drain header and subsequently to the low pressure flare drum. The contents of the low pressure flare drum are periodically directed to the slop oil tank. The contents of the slop oil tank are periodically directed to the HGCP inlet separation system.

9.3.2 Retention pond

The retention pond receives discharges from the open drain sump. It provides retention time to further separate (settle) sediment and also further separate residual oils and greases, which are manually skimmed from the surface using a portable device and directed back to the open drain sump (upstream of the corrugated plate interceptor).

Water entering the retention pond flows through a riser to ensure the stable water level in the retention pond is not disturbed. The retention pond is provided with a high density polyethylene liner to prevent release of its contents to the environment. Clean water from the retention pond is discharged to the environment via the HGCP stormwater system.

9.3.3 Sewage

A packaged WWTP operates at the HGCP to treat sanitary wastewater and is operated in accordance with the manufacturer's specifications. The WWTP is based on activated sludge technology and has a capacity of 180 cubic metres per day and allows sediment to settle prior to discharge.

A contingency plan is available for the management of sewage should WWTP becomes unavailable, to ensure no discharge of untreated sewage to the environment.

Waste sludge from the bio-treatment unit will normally be dewatered and either incinerated and/or directly landfilled, dependent upon sludge quality and subject to EMPNG approval. Disposal of sludge directly to landfill is also available during incinerator maintenance or shutdown.

9.4 Hides Waste Management Facility

Discharges to water at the HWMF are listed in Table 9-2. The location of each discharge source is shown in Figure 5-3. A description of each source and the relevant control measures, including design and operational controls is provided in the following sections.

Table 9-2: Hides Waste Management Facility discharge points

SOURCE	DISCHARGE POINT REFERENCE	TYPE
Stormwater	HWMF-S1	Intermittent
Sludge Dewatering System	HWMF-W1	Intermittent
Leachate Treatment System	HWMF-RP1	Intermittent

9.4.1 Stormwater

Stormwater from uncontaminated areas at the HWMF is graded and sloped to allow natural drainage directly to the environment without treatment at several locations.

9.4.2 Process building wastewater

Wastewater from potentially contaminated areas within the HWMF's Process Building (i.e. covered building housing the incinerator, where wastes may be temporarily stored) is drained to an initial treatment system which provides retention time for solids separation, and oily water separation. The partially treated wastewater then drains by gravity to the leachate treatment system.

9.4.3 Sludge dewatering system

A sludge dewatering system operates at the HWMF to dewater sludge received from the WWTPs in the Upstream area. It consists of six geotubes and skips, a sludge holding tank, a thickener tank and an ozone treatment and rainwater collection tank. Depending on sludge quality and subject to EMPNG approval, the sludge is either directly landfilled, or incinerated with the resultant ash routed to the landfill for final disposal. Effluent from the sludge dewatering system is routed to a water treatment system that provides disinfection (ozone treatment) before being pumped to the leachate treatment system.

9.4.4 Leachate treatment system

The leachate treatment system receives effluent from the process building, sewage sludge dewatering system and landfill leachate. Leachate from the landfill collects in a sump at the low point of the landfill and is manually pumped to the leachate treatment system.

The leachate treatment system consists of a series of sediment ponds and a reed bed system, where treatment is achieved by directing the leachate through a bed of reeds which are designed to take up water, nutrients and heavy metals from the leachate.

9.5 Hides Vehicle Wash Facility

There are no discharges to water from the HVWF, which normally operates using a closed loop system, where all wash water is recycled, although an overflow pipe discharges any excess water to ground.

Stormwater from uncontaminated areas runs directly off without collection.

9.6 Komo Airfield

Discharges to water at the Komo Airfield are listed in

Table 9-3. The location of each discharge source is shown in Figure 5-5. A description of each source and the relevant control measures, including design and operational controls is provided in the following sections.

Table 9-3: Komo Airfield discharge points

SOURCE	DISCHARGE POINT REFERENCE	TYPE
Stormwater (northern drain)	KOM-S1	Intermittent
Stormwater (southern drain)	KOM-S2	Intermittent
WWTP	KOM-W1	Intermittent

9.6.1 Stormwater

A stormwater system collects stormwater from uncontaminated areas at the Komo Airfield and is graded and sloped to allow natural drainage directly to the environment without treatment at several locations.

9.6.2 Open drain system

An open drain system collects stormwater, washdown, spillage, and firewater from potentially contaminated areas at the Komo Airfield, including the hangar building, aircraft refuelling area locations on the apron, helicopter pads and fuel depot. The open drain system discharges to open drain sumps, which provide retention time for oily water separation. Separated oil from the open drain sumps will be collected periodically and transferred to the HWMF for treatment and disposal.

9.6.3 Sewage

A packaged WWTP is at the Komo Airfield to treat sanitary wastewater generated on-site at the guardhouse, terminal, hangar and fire station buildings. Wastewater from these buildings is pumped to the WWTP. The WWTP has a capacity 4000 litres per day and provides biological treatment followed by clarification, sediment settling and chlorination disinfection. The WWTP is operated in accordance with the manufacturer's specifications. During WWTP down-time, sewage is collected and transferred to the HGCP WWTP for treatment.

Treated wastewater from the WWTP is discharged to the environment via the Komo Airfield stormwater system. Sludge from the WWTP will be stored and transferred to the HWMF for treatment and disposal.

9.7 Pipelines and Above Ground Installations

There are no discharges to water during operation of the pipelines and AGIs. Environmental aspects to consider are stormwater run-off and sanitary wastewater.

9.7.1 Stormwater

Stormwater from uncontaminated areas at the AGIs is graded and sloped to allow natural drainage directly to the environment without collection. That is, there are no point source discharges.

Wastewater from potentially contaminated areas drains to collection sumps and will be removed as required for treatment and disposal at an EMPNG approved facility.

9.7.2 Sanitary wastewater

Although the AGIs are not normally staffed, emergency accommodation is provided at the MLV, Kopi Scraper Station and CP stations. Portable toilets are provided to receive sanitary wastewater. The contents of the portable toilets are removed as required for treatment and disposal at an EMPNG approved facility.

9.8 Moro B Camp

A packaged WWTP operates at Moro B Camp to treat sanitary wastewater. The WWTP has a capacity of 35 cubic metres per day and provides biological treatment followed by clarification, sediment settling and chlorination disinfection. The WWTP is operated in accordance with the manufacturer's specifications. The location of the discharge point is shown in Figure 5-9.

Treated wastewater from the WWTP is discharged to the environment (discharge reference point: MORO-W1). A sludge dewatering system is present at Moro B camp. Dewatered waste sludge is transferred to HWMF, or an EMPNG approved third party facility, for further treatment and/or final disposal.

During WWTP down-time, sewage is collected and transferred to the HGCP WWTP or an EMPNG approved third party facility for treatment.

9.9 Wash water

The washing of equipment, vehicles or machinery near or within watercourses is prohibited. Washing is only to occur in nominated areas as approved by EMPNG.

Wash-water generated during the maintenance of process equipment is characterised and dependent upon water quality, is appropriately treated. For example through the HGCP's open/closed drain system, or disposed of either to the PWRW, HWMF or offsite via an approved third party waste provider.

9.10 Water quality and discharge criteria

9.10.1 Receiving water quality criteria

Annex 2 of the Environment Permit sets out applicable fresh water quality criteria, as shown in Table 9-4 and Table 9-5. Discharges to receiving waters should not cause a lowering of receiving water quality below the criteria shown in Table 9-4. Table 9-5 shows maximum permitted criteria of ammonia-nitrogen for protection of freshwater aquatic life.

Table 9-4: Water quality criteria: freshwater receiving environment

PARAMETER	WATER QUALITY CRITERIA (FRESHWATER)
pH	6.5 – 9 (pH units)
Temperature	No alteration greater than 2 degrees Celsius
Turbidity	No alteration greater than 25 NTU or no change of more than 10 percent above background levels at any particular time (whichever is greater)
Total Suspended Solids	50 mg/L or no change of more than 10 percent above background levels at any particular time (whichever is greater)
Dissolved oxygen	Not less than 6 mg/L or no change of more than 10 percent below background levels at any particular time (whichever is smaller)
Chemical oxygen demand	125 mg/l
Biological oxygen demand	25 mg/l
Sulphate as $SO4^{2-}$	400 mg/l
Sulphide as HS-	0.002 mg/l
Ammonia-nitrogen	Dependent on pH and temperature (Table 9-5)

PARAMETER	WATER QUALITY CRITERIA (FRESHWATER)
Nitrate	45 mg/l
Potassium	5.0 mg/l
Barium	1.0 mg/l
Boron	1.0 mg/l
Cadmium	0.01 mg/l
Chromium (as hexavalent)	0.05 mg/l
Cobalt	Limit of detection
Copper	1.0 mg/l
Iron	1.0 mg/l
Lead	0.005 mg/l
Manganese	0.5 mg/l
Mercury	0.0002 mg/l
Nickel	1.0 mg/l
Selenium	0.01 mg/l
Silver	0.05 mg/l
Tin	0.5 mg/l
Zinc	5.0 mg/l
Glycol^	0.33 mg/l
Oil and grease	No visible film (for stormwater runoff and construction discharges) 10 mg/l (for production discharges)
Phenol^	0.085 mg/l
2-chlorophenol^	0.340 mg/l
4-chlorophenol^	0.160 mg/l
2,4-dichlorophenol^	0.120 mg/l
2,4,6-trichlorophenol^	0.003 mg/l
2,3,4,6-tetrachlorophenol^	0.010 mg/l
Pentachlorophenol^	0.0036 mg/l
Faecal contamination risk	Faecal coliform: Not to exceed 200 colonies per 100 ml or no change greater than 10 percent above background levels at any particular time (whichever is greater) **OR** Not to exceed medium faecal contamination risk (refer to Table 9-6 and Table 9-7). **OR** Residual chlorine: as close as possible to 1 mg/l

Primary source: Annex 2 of the Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection.

Metal concentrations are for dissolved substances (passing through a nominal 0.45 µm medium).

Cobalt (as 'limit of detectability') uses graphite furnace atomic absorption spectrometry.

^Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000). Trigger values adopted for a slightly to moderately disturbed aquatic ecosystem with a high conservation value (99 percent species level protection).

Table 9-5: Water quality criteria: ammonia-nitrogen (mg/l)

TEMPERATURE (DEGREES CELSIUS)	pH UNITS		
	7	8	9
5	16.1	1.6	0.2
10	11	1.1	0.1
15	7.5	0.8	0.09
20	5.2	0.5	0.07
25	3.6	0.4	0.06
30	2.6	0.3	0.05
35	1.6	0.2	0.04
Source: Annex 2 of the Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection.			

Table 9-6: Faecal contamination risk trigger thresholds

FAECAL CONTAMINATION RISK PARAMETERS	TRIGGER THRESHOLDS	WEIGHTED ASSIGNED VALUES
E.coli	Equivalent to or not to exceed 1000 per 100ml	0.415
Enterococci	Equivalent to or not to exceed 500 per 100 ml	0.289
Ammonia as N	Not to exceed 0.1 mg/l	0.149
Turbidity	Equivalent to or not to exceed 5 NTU	0.25
Total Weighted Risk Value = sum of the weighted assigned values		
Source: Ecowise Environmental 2010, *Smart Water Fund, Characterisation of human health risks derived from stormwater*		

Table 9-7: Faecal contamination risk ranking

TOTAL WEIGHTED RISK VALUE	FAECAL CONTAMINATION RISK	ACTION
<0.25	Low	No further testing
0.25 – 0.8	Medium	Verification testing
>0.8	High	Verification testing
Source: Ecowise Environmental 2010, *Smart Water Fund, Characterisation of human health risks derived from stormwater*		

Different types of wastewater are discharged from the Upstream facilities. Not all of the water quality criteria prescribed in Annex 2 of the Environment Permit is relevant to each of these discharge types. The criteria relevant to each discharge type are set out in

Table 9-8, Table 9-9, Table 9-10 and Table 9-11.

The *Environment (Water Quality Criteria) Regulation 2002* prescribes that a permit that provides for a mixing zone within its terms and conditions shall specify the location and size of the mixing zone and the corresponding water quality criteria that apply at the boundary of the mixing zone. The Environment Permit does not specify a mixing zone.

9.10.2 Discharge criteria: stormwater

Discharges of stormwater from uncontaminated areas of the Hides Wellpads, Angore Wellpads, HGCP, HWMF, and Komo Airfield will, at the point of discharge to surface waters, meet the criteria set out in

Table 9-8.

Table 9-8: Discharge criteria: stormwater

PARAMETER	DISCHARGE CRITERIA
pH	6.5 – 9 (pH units)
Turbidity	No alteration greater than 25 NTU or no change of more than 10 percent above background levels at any particular time (whichever is greater)
Dissolved oxygen	Not less than 6 mg/l or no change of more than 10 percent below background levels at any particular time (whichever is smaller)
Total Suspended Solids	50 mg/l or no change of more than 10 percent above background levels at any particular time (whichever is greater)
Oil and grease	No visible film
Primary source: Annex 2 of the Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection, as deemed relevant to the discharge of stormwater from uncontaminated areas.	

9.10.3 Discharge criteria: process wastewater

Discharges of process wastewater at the HGCP will, at the point of discharge to surface waters, meet the criteria set out in Table 9-9.

Table 9-9: Discharge criteria: process wastewater

PARAMETER	WATER QUALITY CRITERIA
pH	6.5 – 9 (pH units)
Temperature	No alteration greater than 2 degrees Celsius
Total Suspended Solids	50 mg/l
Dissolved oxygen	Not less than 6 mg/l or no change of more than 10 percent below background levels at receiving environment (whichever is smaller)
Chemical oxygen demand	125 mg/l
Biological oxygen demand	25 mg/l
Sulphate as $SO4^{2-}$	400 mg/l
Sulphide as HS-	0.002 mg/l
Ammonia-nitrogen	Dependent on pH and temperature (Table 9-5)
Nitrate	45 mg/l
Potassium	5 mg/l
Barium	1 mg/l
Boron	1 mg/l
Cadmium	0.01 mg/l
Chromium (as hexavalent)	0.05 mg/l
Cobalt	Limit of detection
Copper	1 mg/l
Iron	1 mg/l
Lead	0.005 mg/l
Manganese	0.5 mg/l
Mercury	0.0002 mg/l
Nickel	1 mg/l

PARAMETER	WATER QUALITY CRITERIA
Selenium	0.01 mg/l
Silver	0.05 mg/l
Tin	0.5 mg/l
Zinc	5 mg/l
Glycol^	0.33 mg/l
Oil and grease	10 mg/l
Phenol^	0.085 mg/l
2-chlorophenol^	0.340 mg/l
4-chlorophenol^	0.160 mg/l
2,4-dichlorophenol^	0.120 mg/l
2,4,6-trichlorophenol^	0.003 mg/l
2,3,4,6-tetrachlorophenol^	0.010 mg/l
Pentachlorophenol^	0.0036 mg/l

Primary source: Annex 2 of the Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection, as deemed relevant to the discharge of process wastewater.

Metal concentrations are for dissolved substances (passing through a nominal 0.45 µm medium).

Cobalt (as 'limit of detectability') uses graphite furnace atomic absorption spectrometry.

^Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000). Trigger values adopted for a slightly to moderately disturbed aquatic ecosystem with a high conservation value (99 percent species level protection).

9.10.4 Discharge criteria: Sanitary wastewater Treatment Plants

For discharges from WWTPs treating sewage at the HGCP, Komo Airfield and satellite support camps operated by EMPNG (e.g. Moro B Camp), the discharges will, at the point of discharge to surface waters, meet the criteria set out in Table 9-10.

WWTPs using biological digestion technology require a period of stabilisation in order to achieve steady operations. In the event WWTPs treating sewage are replaced or repaired, then the discharge criteria set out in Table 9-10 does not apply at the end of pipe (at the discharge location), during the 90-day commissioning period. However, the quality of the receiving water body must meet the criteria below.

Table 9-10: Discharge criteria: Sanitary wastewater Treatment Plants

PARAMETER	DISCHARGE CRITERIA
pH	6.5 – 9 (pH units)
Biological oxygen demand	25 mg/l
Chemical oxygen demand	125 mg/l
Ammonia nitrogen	Dependent on pH and temperature (Table 9-5)
Total Suspended Solids	50 mg/l
Oil and grease	10 mg/l
Faecal contamination risk	Faecal coliform: Not to exceed 200 colonies per 100 ml **OR** Not to exceed medium faecal contamination risk (refer to Table 9-6 and Table 9-7).

	OR Residual chlorine: as close as possible to 1 mg/l
Primary source: Based on Annex 2 of the Environment Permit as deemed relevant to the discharge of WWTPs.	

9.10.5 Discharge criteria: leachate treatment system

Discharges from the HWMF's final leachate retention pond will, at the point of discharge to surface waters meet the criteria set out in Table 9-11.

Table 9-11: Discharge criteria: HWMF Leachate Retention Pond

PARAMETER	WATER QUALITY CRITERIA
pH	6.5 – 9 (pH units)
Temperature	No alteration greater than 2 degrees Celsius
Dissolved oxygen	Not less than 6 mg/l or no change of more than 10 percent below background levels at any particular time (whichever is smaller)
Total suspended solids	50 mg/L
Chemical oxygen demand	125 mg/l
Biological oxygen demand	25 mg/l
Sulphate as $SO4^{2-}$	400 mg/l
Sulphide as HS-	0.002 mg/l
Ammonia-nitrogen	Dependent on pH and temperature (Table 9-5)
Nitrate	45 mg/l
Potassium*	50 mg/l
Barium	1 mg/l
Boron	1 mg/l
Cadmium	0.01 mg/l
Chromium (as hexavalent)	0.05 mg/l
Cobalt	Limit of detection
Copper	1 mg/l
Iron	1 mg/l
Lead	0.005 mg/l
Manganese	0.5 mg/l
Mercury	0.0002 mg/l
Nickel	1 mg/l
Selenium	0.01 mg/l
Silver	0.05 mg/l
Tin	0.5 mg/l
Zinc	5 mg/l
Oil and grease	10 mg/l
Phenol^	0.085 mg/l
2-chlorophenol^	0.340 mg/l
4-chlorophenol^	0.160 mg/l

PARAMETER	WATER QUALITY CRITERIA
2,4-dichlorophenol^	0.120 mg/l
2,4,6-trichlorophenol^	0.003 mg/l
2,3,4,6-tetrachlorophenol^	0.010 mg/l
Pentachlorophenol^	0.0036 mg/l
Faecal contamination risk	Faecal coliform: Not to exceed 200 colonies per 100 ml **OR** Not to exceed medium faecal contamination risk (refer to Table 9-6 and Table 9-7).

Source: Annex 2 of the Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection, as deemed relevant to the discharge of process wastewater.

*Source: Site-specific criteria approved by CEPA in their letter dated 24 November 2016 (reference: PM-GN3-2016-10537-1).

Metal concentrations are for dissolved substances (passing through a nominal 0.45 µm medium).

Cobalt (as 'limit of detectability') uses graphite furnace atomic absorption spectrometry.

^Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000). Trigger values adopted for a slightly to moderately disturbed aquatic ecosystem with a high conservation value (99 percent species level protection).

10.0 SPILL PREVENTION AND RESPONSE

EMPNG's objectives are to prevent spills of hydrocarbons and chemicals and to respond effectively to spills should they occur.

Management measures to prevent the spillage or release of fuels and chemicals, including hazardous chemicals, to the environment, and actions to be taken in the event of a spill or release, are described in this section.

The control measures set out in this section, including design and operational controls, have been developed in accordance with the requirements and using the methods prescribed under OIMS. Relevant OIMS processes include OIMS System 2-1 Risk Assessment and Management, OIMS System 6-5 Environmental Management, OIMS System 9-1 Incident Management and OIMS System 10-2 Emergency Preparedness and Response.

10.1 Transport of fuel and chemicals

Fuel and chemicals will generally be delivered to EMPNG's facilities in the Hides area by third party suppliers primarily from Lae, Mount Hagen and other locations along the Highlands Highway. EMPNG will take responsibility for purchased fuel and chemicals upon receipt.

As part of the procurement process, the agreements in place between EMPNG and third party suppliers include minimum requirements relating to spill prevention, preparedness and response. Third party suppliers of fuel and chemicals are subject to prior assessment and approval. Follow-up assessments of third parties will be undertaken periodically.

Transport of fuel and chemicals to the Condensate Pipeline and PNG LNG Gas Pipeline AGIs will generally be undertaken by EMPNG by road or via helicopter.

In the case of transfer by helicopter, fuel and chemicals will be transported using totes which are purposely designed for the transfer of hazardous materials. The totes will be regularly inspected and maintained as part of preventive maintenance. Flight paths will be designed to avoid populated areas where feasible.

In the case of transfer by road by EMPNG directly or its contractors, fuel will be transported in purpose-built tankers and chemicals will be transported in fit-for-purpose vehicles and containers. Vehicles used for the transport of fuel and chemicals will carry spill kits appropriate for the type of cargo. Vehicles, and containers will be regularly inspected and maintained as part of preventive maintenance. Drivers responsible for the transport of fuel and chemicals will receive appropriate training, including spill response and leak prevention; and drivers will have the required driving licence.

Where fuel and chemicals are delivered to the AGIs by third party suppliers, EMPNG will take responsibility for purchased fuel and chemicals as per the written agreement with the supplier. The above described assessment and approval process applies.

10.2 Fuel storage and transfer

Diesel storage facilities at the HGCP include the diesel tanks (i.e. fuel depot), the essential services generators day tank and the firewater pump day tank. The helicopter refuelling facility includes two aviation fuel storage tanks. All storage tanks are located within secondary containment sufficient to enable containment of 110 percent of the storage capacity of the largest vessel present. Integrity of diesel transfer facilities, including transfer lines, vehicles, associated pumps and couplings, will be routinely inspected as part of preventive maintenance and appropriate procedures are in place for their use. Spill kits are regularly inspected, replenished and readily available for all fuel storage and transfer areas. Nominated personnel will receive appropriate training, including spill response and leak prevention.

At the Moro B Camp and HWMF, diesel is stored in day tanks located within secondary containment sufficient to enable containment of 110 percent of the tank's inventory and

supplied via an above ground transfer line to the generators. Spill kits are regularly inspected, replenished and readily available for all fuel storage and transfer areas.

At the Komo Airfield, a diesel day tank is located adjacent to each generator and firewater pump. The tank is located within secondary containment sufficient to enable containment of 110 percent of the tank's inventory. Diesel will be transferred to the diesel day tank using supply trucks and supplied via above ground transfer lines to the generators/pumps. Diesel is stored at a fuel depot containing three storage tanks located within secondary containment sufficient to enable containment of 110 percent of a single tank's inventory, and supplied via an above ground transfer line to the generators. The Komo fuel depot also contains three aviation fuel storage tanks. The storage tanks are double walled and located within secondary containment sufficient to enable containment of 110 percent of a single tank's inventory. Spill kits are regularly inspected, replenished and readily available for all fuel storage and transfer areas.

Diesel fuel is stored in tanks at all MLVs, CP stations, the Kopi Scraper Station and telecommunication towers. The diesel tanks at the MLVs and CP stations have a maximum capacity of 7 cubic metres whilst the diesel tanks at the telecommunication towers have a maximum capacity of 3 cubic metres. A 20 cubic metre diesel tank is located at the Kopi Scraper Station. All of these diesel tanks are purpose-built above ground and include secondary containment sufficient to enable containment of 110 percent of the storage capacity of the largest vessel present. Integrity of fuel transfer facilities, including transfer lines and vehicles and associated pumps and couplings, will be routinely inspected as part of preventive maintenance. Diesel tanks at the AGIs and telecommunication towers are refuelled as needed. Refuelling will be undertaken by appropriately trained personnel with a minimum of two persons present. Drip trays will be used where appropriate during refuelling and a spill kit will be available.

A drain tank is located at the Kutubu CPF Metering Station to collect condensate from pigging activities. This tank has a maximum capacity of 6 cubic metres and is housed within a concrete pit below ground level to allow draining of the pigging skids via gravity. The tank is double skinned and has a visual level indicator and a level transmitter relaying to the HGCP. The tank will be emptied when required by vacuum truck and transported to the HWMF or OSL-operated facility.

Any additional fuel storage that may be required at the Upstream facilities will ensure that the vessels are at a minimum above ground, secure, purpose-built and have sufficient secondary containment (minimum of 110 percent of the largest vessel). In addition, temporary fuel storage that may be required at remote locations will not be located less than 30 m from any surface waters unless approved by EMPNG on a case by case basis. Refuelling will be undertaken by appropriately trained personnel with a minimum of two persons present. Drip trays will be used where appropriate during refuelling and a spill kit will be available.

10.3 Chemical storage and transfer

Chemicals are used and stored at various locations at the Hides and Angore wellpads, HGCP, HWMF, HVWF, Komo Airfield, Moro B camp and the Condensate Pipeline/PNG LNG Gas Pipeline AGIs. At all locations, chemical storage facilities are purpose-built and include appropriate secondary containment and access to spill response measures appropriate for the size and type of chemical being stored. Integrity of chemical transfer facilities, including transfer lines and vehicles and associated pumps and couplings, will be routinely inspected as part of preventive maintenance. Spill response kits are regularly inspected and replenished as required. Any future chemical storage installations will ensure that the same measures are implemented.

Most chemicals are used and stored at the HGCP, as summarised below. These packages are all located within bunded areas away from watercourses, all pumps include controlled

volume metering and dual diaphragm pump heads, and appropriate procedures are in place for their use.

- A mobile methanol injection package operates to counter hydrate formation (hydrates are crystals which form under certain conditions and may cause line plugging). Methanol is stored in intermediate bulk containers of 1 cubic metre, located within a bunded area. Appropriate emergency response equipment is readily available.
- An oxygen scavenging and biocide injection package is provided to inhibit bio-fouling and minimise oxygen induced corrosion of the PWRW and slop oil/condensate tank. The oxygen scavenger and biocide are stored in skid-mounted intermediate bulk containers of approximately 1.5 and 10 cubic metres, respectively.
- A reverse demulsifier package operates to chemically enhance oil separation as part of the produced water treatment process. The chemical is stored in a skid-mounted intermediate bulk container of approximately 1.5 cubic metres.
- A drag reduction agent package maintains the appropriate inlet pressure for the Condensate Pipeline. This chemical is stored in a skid-mounted intermediate bulk container of approximately 8 cubic metres.

Corrosion inhibitor is continuously injected into the well flowlines to prevent corrosion. The chemical is delivered to and stored at the HGCP in double-skinned containers of 20,000 litres each, and transferred (pumped) to the Hides and Angore wellpads through the MEG pipelines (MEG is used as the carrier fluid for corrosion inhibitor).

Chemicals not in use will be stored in the chemical and hazardous material storage shelter.

10.4 Spill response

Third party suppliers of fuels and chemicals are responsible for responding to a spill or release at their own facilities or while in transit. EMPNG will assess third party suppliers prior to approval and will review spill response arrangements. The agreements in place between EMPNG and third party suppliers will include minimum requirements relating to spill preparedness and response. Follow-up assessments of third parties will be undertaken periodically.

EMPNG will respond to a spill or release of fuel or chemical at EMPNG facilities, or while in transit by EMPNG or its contractors between EMPNG facilities, or when agreed to in writing by a third party. The level of spill response is dependent upon the potential impact of the spill. In general, spills are categorised as Tier 1 (within the capability of EMPNG to respond on-site), Tier 2 (exceeds the capability of EMPNG's on-site resources) and Tier 3 (exceeds available resources in Papua New Guinea and requires resources to be mobilised internationally). EMPNG will respond to Tier 1 spills directly using on-site resources. In the case of a Tier 2 spill, EMPNG will respond using on-site resources and resources mobilised from other EMPNG facilities in the Hides/Komo area.

An appropriate number of staff will be trained in the handling of emergency response and spill scenarios.

Further details about EMPNG's prevention and response to spills of hydrocarbons are provided in EMPNG's Oil Spill Contingency Plan.

Subsequent to a spill where significant site contamination has occurred, action will be taken to remediate the site and prevent any further impacts to the environment, or human health risks. A site-specific assessment will be undertaken to identify human health and environmental risks associated with the contaminated site. Corrective actions and monitoring needs will be evaluated as part of the assessment. Appropriate management and monitoring plans will be developed using information gathered during the inspection.

11.0 MATERIALS MANAGEMENT

EMPNG's objectives are to avoid significant impacts associated with the procurement and use of raw materials and to use materials that are less hazardous or otherwise preferable from an environmental perspective, where practical.

Controls necessary to achieve the above objectives relating to the use and management of materials, including prohibited substances, hazardous materials, water, aggregate and quarry materials and timber, are described in this section.

11.1 Materials review

Materials used during production will be reviewed periodically to determine whether alternative materials are available which are less hazardous or otherwise preferable from an environmental perspective, and to evaluate opportunities for waste reduction.

11.2 Prohibited substances

EMPNG will avoid the use of chemicals and hazardous materials subject to international bans or phase-outs due to their high toxicity to living organisms, environmental persistence, potential for bio-accumulation, or potential for depletion of the ozone layer, consistent with the objectives of the *Stockholm Convention on Persistent Organic Pollutants*, *Montreal Protocol on Substances that Deplete the Ozone Layer* and *Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade*.

EMPNG will also avoid the use of lead-based coatings, primers, paints and lubricants; leaded thread compound; fluorescent lights containing high levels of mercury; asbestos; chlorinated solvents (for example carbon tetrachloride); chromate corrosion inhibitors and heavy metals (such as in reverse emulsion breakers and grit blast).

11.3 Hazardous materials

EMPNG will seek to reduce the use of hazardous materials by evaluating opportunities to use alternative materials that are less hazardous or otherwise preferable from an environmental perspective.

Where the use of a hazardous material (including radioactive material, spontaneously combustible materials) is unavoidable, product-specific controls will be implemented. Controls may include engineering (such as alarms, shut-off systems) or operational controls commensurate with the nature of the hazard.

In general, hazardous materials will be stored separately pursuant to compatibility requirements, within a covered area. Hazardous materials containers and vessels will be clearly labelled with the name and description of the hazardous material. Material Safety Data Sheets will be readily available and prominently displayed in relevant storage areas. Personnel will be trained in the handling of hazardous materials in accordance with specific job responsibilities.

11.4 Surface water and groundwater abstraction

Water is taken from several permanent abstraction points in the Hides, Komo and Moro area.

There is no abstraction of water during normal operation of the pipelines and AGIs. In the case of the Kutubu CPF Metering Station and GPF Metering Station, water is supplied from adjacent OSL facilities. There is no water supply to the other AGIs.

Details of the abstraction points will be maintained in a register.

Where there is potential for water abstraction from a surface water course to have adverse effects on downstream users and/or environmental flows, generally when the proposed abstraction is in excess of 10 percent of indicative stream flow, EMPNG will conduct an environmental assessment and the abstraction will be managed so as to mitigate identified impacts.

Water abstraction permits will be obtained where necessary and conditions adhered to, pursuant to the Environment Permit.

In case of demonstrable disruption to community water supply as a result of water abstraction or other activity, EMPNG will provide alternate water supply, pursuant to the Environment Permit.

11.5 Aggregate and quarry material

New quarries developed by EMPNG or directly on behalf of EMPNG are permitted under the Environment Permit and additional permits are not necessary. Where practicable, EMPNG will reduce the number of quarries developed by using previously worked (old) quarries, and use limestone generated by construction activities.

Prior to the development of new quarries a pre-disturbance survey will be undertaken of the area to be affected and environmental and social sensitivities will be identified. Pre-disturbance surveys will be undertaken by competent professionals.

On the basis of the pre-disturbance survey results, site-specific mitigation and management measures will be adopted to avoid and/or otherwise mitigate identified sensitivities prior to and/or during exploitation of the quarry and render the quarry area safe upon abandonment.

Aggregate and quarry material (including concrete) purchased from third party suppliers will be sourced from legal quarries/borrow pits that are in possession of permits where necessary. To ensure that the facilities and operations of third party suppliers of aggregate and quarry material are fit-for-purpose, they are subject to prior assessment and approval.

Additional approvals will be sought in the event aggregate needs to be sourced from a water body, including ephemeral streams and flood plains (including aggregate purchased from third parties).

11.6 Timber

Timber and wood products purchased from third party suppliers will be sourced from legal, EMPNG-approved operations that are in possession of permits where necessary and operate in an environmentally acceptable manner.

To ensure that the operations of third party suppliers are fit-for-purpose, they are subject to prior assessment and approval.

EMPNG promotes to the extent practical the reuse of timber felled during any site clearing that may occur for construction type activities undertaken by or on behalf of EMPNG.

12.0 WASTE

EMPNG's objectives are to apply the waste management hierarchy and to manage and dispose of waste at EMPNG facilities and approved third party facilities only.

Measures to prevent, mitigate and otherwise control potential significant environmental impacts associated with waste are described below. Information about waste generated during production and a description of how waste will be managed, including design and operational controls, is also provided.

The control measures set out in this section, including design and operational controls, and waste management procedures, that have been developed in accordance with the waste management requirements prescribed in OIMS System 6-5 Environmental Management.

12.1 General provisions

EMPNG will apply the waste minimisation and management hierarchy where practical, by prioritising the avoidance and reduction of waste in the first instance, followed by reuse, recycling and recovery, with treatment and disposal being the least preferable options.

All third parties and third party facilities receiving EMPNG waste for purposes of reuse, recycling and recovery are subject to prior assessment and approval by EMPNG. EMPNG's assessment process documents whether potential third parties have in place the required regulatory, environmental, social and safety measures appropriate for the type of waste being processed.

EMPNG waste facilities or EMPNG approved third party facilities will be used for the treatment and disposal of wastes. Where wastes are transferred to a third party, duty of care applies and the transfer of wastes is subject to formal audit and approval by EMPNG.

Wastes are categorised as either non-restricted or restricted depending on their toxicity and treated accordingly at EMPNG or EMPNG approved third party facilities.

Non-restricted wastes are those that do not pose an immediate threat to health, safety and/or the environment (examples are, but not limited to, canteen waste, paper, cardboard, packing materials, scrap metal, rubble, timber and plastic).

Restricted wastes are those that are easily ignited, corrosive or reactive, toxic, pathogenic or otherwise hazardous (examples are, but not limited to, oils and greases, oil-contaminated rags, filters, degreasing agents, fluorescent tubes, batteries, and health care or bio-hazardous waste).

Appropriate technologies, including use of special containers, segregation and handling procedures apply to the treatment and disposal of biological, pharmaceutical and medical wastes.

An indicative inventory of wastes is shown in Table 12-1. An inventory of wastes will be maintained in a register.

The register describes and categorises each type of waste and sets out provisions for its management. It also includes a waste record section that describes the quantities and ultimate fate of each waste generated.

12.2 Waste avoidance and minimisation

The potential for waste generation will be considered at the early stage of materials selection. As discussed in Section 11.0, materials used during production will be reviewed periodically to evaluate opportunities for waste reduction.

12.3 Waste from third parties

EMPNG may accept waste (restricted and unrestricted) from third party sources. Prior to accepting waste from third parties, EMPNG will assess the type, volume, ability to store and

process the waste, any potential impact to EMPNG's ability to manage its own waste (current and future needs), and whether a net overall benefit exists to the community and environment by accepting such waste.

Third party waste accepted by EMPNG will undergo the same level of management and controls that are applied to EMPNG's own waste.

12.4 Waste collection

Non-restricted wastes will be separated at source into labelled receptacles. The contents of the receptacles will be collected periodically and transferred to the HWMF or EMPNG approved third party facilities.

Restricted wastes will be separated at source at designated restricted waste collection points, which enable appropriate segregation and storage of waste pursuant to compatibility requirements. The restricted waste collection points are secure and covered with appropriate containment to prevent release to the environment. The contents of the restricted waste collection points will be transferred periodically to the HWMF or EMPNG approved third party facilities.

Non-routine wastes will be categorised as part of the register of wastes and provisions for their management will be determined prior to transfer to the HWMF or EMPNG approved third party facilities.

Combustible wastes may be transferred directly to the high temperature incinerator at the HGCP or HWMF, or EMPNG approved third party facilities.

12.5 Waste storage

Wastes transferred to the HWMF will be verified and documented upon receipt in accordance with a waste acceptance protocol. Wastes will be screened to ensure only acceptable waste types are received. The weight of wastes will be recorded.

Wastes will then be directed to the storage area (Figure 5-3), which provides for the separate storage of non-restricted and restricted wastes in a manner which facilitates subsequent management (reuse, recycling, recovery, treatment and disposal).

Restricted wastes will be stored, separately pursuant to waste compatibility requirements, within a covered area with appropriate containment to prevent release to the environment.

Certain wastes will be transferred directly upon receipt at the HWMF to the point of treatment, for example waste oils for incineration which will be transferred to the liquid injection pump station, or sewage sludge which will be transferred to the sludge holding tank.

Combustible wastes transferred to the high temperature incinerator at either the HGCP or HWMF, or EMPNG approved third party facilities will be verified, documented and stored as necessary prior to incineration. The storage areas at HGCP and HWMF provides for separation pursuant to waste compatibility requirements, is covered and has appropriate containment to prevent release to the environment.

12.6 Waste reuse, recycling and recovery

In accordance with the waste minimisation and management hierarchy, wastes will be preferentially reused, recycled or recovered.

All third parties and third party facilities receiving EMPNG waste for purposes of reuse, recycling and recovery are subject to prior assessment and approval by EMPNG.

12.7 Waste treatment and disposal

Wastes that cannot be reused, recycled and/or recovered will be treated and disposed of at the HWMF, HGCP or EMPNG approved third party facilities.

The following are examples of waste management equipment and facilities that may be used at the HWMF: weighbridge, process building, drum crusher and cleaner, tyre debeader, shredder, sewage sludge dewatering system, incinerator packages, ash stabilisation system, landfill and leachate treatment system. Specific equipment and facilities may vary during production according to need.

The treatment and disposal process at the HWMF generally consists of the following key activities:

- treatment (pre-treatment as necessary in preparation for incineration/disposal)
- incineration (of combustible wastes and biohazardous waste)
- ash stabilisation (handling and stabilisation of bottom and fly ash from incineration)
- landfill (disposal of non-restricted waste that is not suitable for incineration and ash residues from the incineration process)
- landfarming (large volumes of hydrocarbon-impacted soil, sediment or sludge will be bioremediated)
- leachate treatment (treatment of landfill leachate).

12.7.1 Treatment

Treatment of solid wastes in preparation for incineration or disposal to landfill may include, as appropriate: crushing of metal and plastic drums; debeading of tyres; and shredding of plastic drums, debeaded tyres and timber. The sewage sludge dewatering system treats sludge prior to incineration and/or landfilling, and includes geotubes, sludge holding, thickening and ozone treatment.

12.7.2 Incineration

Combustible wastes (material that will burn effectively such as organics, paper, cardboard and plastics) will be incinerated. Biohazardous wastes will also be incinerated.

12.7.3 Ash stabilisation

Bottom and fly ash from the incineration process is subject to the toxicity characteristic leaching procedure to determine its hazard category. Ash categorised as non-restricted will be directed to landfill without further treatment. Ash categorised as restricted will be stabilised in cement, tested, and directed to an EMPNG or EMPNG-approved landfill.

12.7.4 Landfill

The landfill is intended to receive non-restricted wastes. It is constructed with a barrier liner of high density polyethylene geo-membrane liner and geo-synthetic clay layers.

The design of the landfill provides for up to five separate cells, which will be developed sequentially over time as required, with each cell being filled and covered prior to the next cell being commissioned. The cells will be separated by internal bunds which will provide for stormwater and leachate management and each will be provided with a leachate sump.

In order to avoid damage to the geo-membrane liner, waste will be placed with care (for example, avoidance of rigid wastes) over the entire base of the cell until a sufficiently compacted base has been established. Waste will then be added to the active face and compacted from the base up in layers. A cover of earthen material (with low clay and organic content) will be placed periodically over the waste that has been added in order to prevent wind-blown litter and suppress odour. When a cell reaches capacity, an interim cover of earthen material will be put in place to secure the surface.

Final covering of landfill cells will be undertaken in stages, but in general will occur as soon as practicable in order to reduce ingress of rain and hence generation of leachate and to collect and vent landfill gases. The final cover will consist of landfill gas distribution venting, and appropriate cover.

12.7.5 Landfarming

Large volumes of hydrocarbon impacted soil, sediment or sludge shall be bioremediated on site through landfarming and/or other biopiling techniques. Bioremediated material will be sampled and categorised depending on analytical results obtained. Depending on categorisation, bioremediated material will be reused onsite or landfilled.

12.7.6 Leachate treatment

Leachate collected in the active landfill cell is pumped from the leachate sump through a leachate riser (a large diameter riser pipe containing a pump) and routed to the leachate treatment system, which comprises a leachate plain and a series of retention ponds.

The leachate plain is a gently sloping and irrigated reed bed populated with monto vetiver (*Chrysopogon zizanioides*). Leachate from the landfill passes through the leachate plain, where the reeds absorb water, nutrients and pollutants such as heavy metals.

The treated water is then collected in a series of ponds downstream of the leachate plain to allow retention time for solids separation. Treated water is discharged from the final pond to the environment. In case the treated water does not meet the discharge requirements shown in Table 9-11, it can be recycled through the leachate plain and ponds.

12.8 Waste tracking and documentation

Wastes will be tracked and documented through all stages of the management process, from the point of generation and collection, through to storage, treatment and final disposal at the HWMF or HGCP, or transferred to EMPNG approved third party facilities for reuse, recycling, recovery and/or final disposal.

A waste manifest will be completed upon collection of wastes. The manifest identifies the point of generation and the type, volume/quantity and categorisation of the waste.

Upon receipt of the wastes at the HWMF or HGCP, the wastes will be inspected and the waste manifest verified as part of the waste acceptance process. The waste manifest will be completed and closed with details of the immediate fate of the wastes (for example immediate incineration, transfer to storage, transfer to liquid injection pump station, or transfer to landfill).

A waste incineration record is maintained for all incinerator burn cycles to track the type and quantity of incinerated wastes (both at the HWMF or HGCP). A landfill acceptance record is maintained to track the type and quantity of all wastes disposed of to landfill.

Waste transferred to third party facilities for reuse, recycling and/or recovery will be accompanied by a waste transfer record which identifies the type and quantity of wastes and provides details and signatures of the shipper and receiver.

Information from the waste manifest, waste incineration record, landfill acceptance record and waste transfer record documents will be compiled in the register of wastes.

12.9 Waste monitoring

EMPNG will undertake periodic inspections of the waste management process from point of generation and collection, through storage, treatment and final disposal. Inspections are discussed further in Section 20.0.

12.10 Export of restricted waste

EMPNG may at its discretion export certain restricted wastes for treatment and disposal. In such cases, applicable provisions of the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* and the *Waigani Convention: Convention to Ban the Importation of Hazardous and Radioactive Wastes into Forum Island Countries and to Control the Transboundary Movement and Management of Hazardous Waste within the South Pacific Region* will be applied.

Third parties and third party facilities receiving exported restricted waste are subject to prior assessment and approval by EMPNG.

Table 12-1: Typical waste types, treatment and disposal methods

WASTE TYPE	WASTE DESCRIPTION	TREATMENT	DISPOSAL
Non-restricted	Incinerator ash (HGCP and/or HWMF units)	No onsite treatment required where non-restricted	Landfill
	Water based drill cuttings/fluids	Dewater	Landfill
	Barrels/containers, including plastic and metal drums	Clean, contain	Reuse on site
		Clean, crush and/or shred	Landfill
	Tyres	De-bead	Reuse on site
		De-bead, shred, incinerate	Incinerator ash to landfill
	Metals (equipment/parts/offcuts)	Contain	Third party recycle
		Shred	Landfill
	Rubber	Shred, incinerate	Landfill
	Timber	Contain	Reuse on site
		Shred, compost	Reuse on site
		Shred, incinerate	Incinerator ash to landfill
	Putrescible	Liquid food composter	Water treatment plant
		Compost	Reuse on site
		Incinerate	Incinerator ash to landfill
	Green waste	Compost	Reuse on site
		Incinerate	Incinerator ash to landfill
	Construction and demolition debris	Segregate, contain	Reuse on site or third party recycle
		No onsite treatment required	Landfill
	General refuse	Incinerate	Incinerator ash to landfill
		Contain	Third party recycle
	Electrical goods	Shred	Third party recycle or landfill
	Concrete washings	pH adjusted, sediments removed	Treated water discharges to ground

WASTE TYPE	WASTE DESCRIPTION	TREATMENT	DISPOSAL
Restricted	Landfill leachate	Leachate treatment system	Treated water is discharged to environment via retention pond
	Sewage	Water treatment plants	Treated water discharges to ground
	Incinerator ash (HGCP and HWMF units)	Stabilise	Landfill
	Batteries	Recycle or stabilise	Landfill (where proven to be stabilised)
	Chemicals (including MEG)	Recycle or stabilise and/or incinerate	Landfill (where proven to be stabilised) Incinerator ash to landfill
		Contain	Third party
		Filter	Re-inject into the process system (e.g. MEG)
	Produced water or similar	Filter	Injection via PWRW
	Sanitary sludge	Dewater/conditioned, and either incinerate or directly landfill	Incinerator ash to landfill or direct landfill
	Fluorescent tubes/light bulbs	Contain	Third party
		Crush, filter (mercury)	Filter cartridges – third party Crushed glass/components - landfill
	Oil based drilling fluids/cuttings; drilling brines	Contain	Third party
		Filter	Down-hole disposal**
	Contaminated soil and absorbent	Incinerate	Incinerator ash to landfill
	Aerosol canisters	Crush	Landfill
		Contain	Third party recycle
	Oils and greases	Incinerate	Incinerator ash to landfill
		Stabilise e.g. polymerization of grease trap waste	Landfill
		Contain	Third party recycle

WASTE TYPE	WASTE DESCRIPTION	TREATMENT	DISPOSAL
	Process sludges	Incinerate	Incinerator ash to landfill
	Oily debris and oil filters	Incinerate	Incinerator ash to landfill
	Other filters	Incinerate	Incinerator ash to landfill
	Paint (oil-based)	Stabilise and/or incinerate	Landfill (where proven to be stabilised) Incinerator ash to landfill
	Paint (water-based)	Dewater, stabilise and/or incinerate	Landfill (where proven to be stabilised) Incinerator ash to landfill
	Medical /biohazardous waste	Incinerate	Incinerator ash to landfill
Note: Actual waste types and treatment/disposal methods may vary. An inventory of actual wastes and treatment/disposal methods is maintained in the register of wastes. **downhole disposal dependent upon type and quality of drilling fluids			

13.0 EROSION AND SEDIMENT CONTROL

EMPNG's objectives are to control significant erosion and prevent sedimentation of surface waters.

Land disturbed for temporary facilities and infrastructure, along with land in the immediate vicinity of permanent facilities and infrastructure, were reinstated following construction. Reinstatement works included temporary and permanent measures to control erosion.

Provisions for ongoing monitoring and maintenance of permanent erosion control works and measures to control potential environmental impacts associated with erosion and sedimentation are described in the following sections.

13.1 Inspection

EMPNG will conduct inspections within and in the immediate vicinity of the Upstream facilities, infrastructure and pipelines. The integrity of permanent erosion control structures and other measures in place to control erosion will be checked as part of the inspections. Particular attention will be paid to areas in the vicinity of surface waters, where sedimentation could occur.

Inspections undertaken by EMPNG may be supplemented by monitoring undertaken by a landowner/community service provider.

13.2 Maintenance and remedial action

Where deemed necessary, for example to protect asset integrity and/or prevent sedimentation of surface waters, EMPNG will respond to erosion, slope stability and/or sedimentation issues.

Response may include remedial work to permanent erosion control structures, and/or the installation of temporary control measures, where appropriate, in particular where there is potential for sedimentation of surface waters.

Controls implemented by EMPNG may be supplemented by controls undertaken by the service provider, under direction from EMPNG.

13.3 New disturbance

Where operations and/or maintenance activities involve new or additional disturbance of land (beyond the already disturbed footprint), the area to be disturbed will be assessed with respect to erosion and sedimentation potential and will consider:

- the type of soil (e.g. weak soils, acid sulphate soils)
- terrain evaluation
- location of surface waters and drainage lines
- presence of tributary headwalls along ridges and over-steepened slopes in gorges
- existence of past instabilities (e.g. landslides).

For areas to be cleared/disturbed, site-specific erosion and sediment controls will be implemented, which as a minimum, will include the following measures:

- assess and establish erosion and sediment control requirements (particularly in relation to site preparation earthworks, site access, site drainage, spoil management, watercourse crossings, in-stream surface water works, watercourse diversions), in accordance with industry good practice (for example International Erosion Control Association guidelines), detailing specific erosion and sediment controls to be implemented and maintained (e.g. diversion drains, sediment ponds and fabric silt curtains)
- restrict site clearing and incidental site disturbance as far as practical by demarcating areas that require clearing and by confining traffic to designated tracks and laydown areas

- use land-clearing techniques that preserve rootstock of removed vegetation in the ground, and where possible, trim riparian trees rather than whole tree removal
- storage of topsoil, discarded vegetation and rocks, pebbles from water courses where possible for later reuse in reinstatement
- minimise the period surfaces are exposed to rainfall-based erosion and scour, and reinstate areas no longer required with priority given to areas prone to erosion
- reduce disturbance of natural drainage channels and avoid blocking channels with material
- install diversion drains to intercept uncontaminated surface run-off around facilities and away from disturbed areas where necessary
- control sediment run-off from stockpiles and cleared areas by installing control structures to intercept sediment-laden surface run-off to reduce sediment delivery to surface waters
- installation of erosion control structures to prevent subsidence
- avoid stockpiling spoil and/or topsoil materials close to surface waters (maintain a minimum of 10 metres from waterline)
- control potential scouring at culverts through drainage and energy dissipation devices, such as rock mattresses or gabions
- stabilise disturbed batter slopes and cleared banks to facilitate reinstatement
- where practicable, avoid sidecasting onto landslides and into open valleys, headwaters, waterways and sinkhole swamps on Hides Ridge
- mitigate impacts from sidecasting in steep terrain areas, for example implementing sediment control measures downstream of sidecast material where practical
- monitoring of erosion and sediment control structures (including stockpiled soil) until adequate stabilisation, sediment control and subsidence control has been achieved.

Additional measures that shall be adopted as necessary to minimise erosion and sediment at individual watercourse crossings and/or work areas adjacent to surface waters, include:

- assess and establish erosion and sediment control measures requirements in accordance with industry good practice (for example International Erosion Control Association guidelines), detailing specific sediment and erosion controls to be implemented and maintained at watercourse crossings
- the design and construction of watercourse crossings will consider hydraulics, stability and potential flow disruptions of surface waters and fish migration
- culvert designs will accommodate flows and mitigate potential sedimentation and debris blockages
- maintain pipeline ROWs and access way alignments to watercourse crossings as close to right angles as possible to limit disturbances to the banks
- grade the ROW and access way alignments adjacent to watercourses away from surface waters
- limit watercourse crossings in areas of high, unstable banks
- limit the clearing of riparian vegetation to the width required to safely accommodate ROW, access ways and watercourse crossings
- minimise the number of watercourse crossings to limit riparian soil erosion and sediment delivery to surface waters
- time surface water works during periods of low flow, and limit the duration of in-stream construction activities
- remove trees, debris or soil inadvertently deposited below the high water mark of surface waters where safe to do so and in a manner that reduces disturbance of the bed and banks
- maintain a minimum of 10-metre vegetation buffer zone from surface waters and avoid stockpiling spoil and/or topsoil materials close to surface waters (i.e. maintaining a minimum of 10 metres from waterline)
- avoid placement of fill material in surface waters

- monitor erosion at reclaimed watercourse crossings and remediate as necessary.

14.0 REINSTATEMENT AND REGENERATION

EMPNG's objectives are to promote regeneration of temporary work areas disturbed during construction and achieve vegetation succession according to established benchmarks.

Land disturbed for temporary facilities and infrastructure, along with land in the immediate vicinity of permanent facilities and infrastructure, was reinstated following construction. For instance during construction, the standard pipeline ROW width for the PNG LNG Project was 30 metres with a 5-metre wide buffer on either side. Following construction, the ROW was allowed to naturally regenerate except for 15 metres, to allow for a gap in the canopy for aerial surveillance of the pipeline. On Hides Ridge, the spineline ROW had an 18m ROW width during construction and was allowed to naturally regenerate except for a 10-metre wide gap for maintenance access.

The overall objective of the construction phase reinstatement program was to establish stable landform conditions and create ground conditions conducive to natural regeneration. Reinstatement works included measures to control erosion and sedimentation and facilitate regeneration.

Measures to inspect and maintain permanent reinstatement works and reinstatement measures associated with new disturbance of land are described in the following sections.

14.1 Access control

Access to regenerating areas will be restricted where practical to prevent disturbance of regenerating areas and enable natural regeneration of vegetation. Due to customary land title prevalent in Papua New Guinea, EMPNG cannot prohibit access by landowners. Access will be discouraged and EMPNG will maintain statutory payments to the landowning communities for deprivation of use as a means to reduce encroachment on regenerating areas.

14.2 Inspection

EMPNG will conduct inspections of regenerating areas (including those in the Lake Kutubu Wildlife Management Area) to observe status of regeneration and check for evidence of encroachment on regenerating areas.

Where encroachment is identified, EMPNG will engage with the relevant party/parties in an endeavour to achieve the necessary access control. It should be recognised that remedy may not be readily achievable and beyond EMPNG's ability to control.

14.3 Regeneration monitoring

The inspection process is supplemented by regeneration monitoring, which is based on surveys of regenerating areas to collect and analyse data relating to the succession of vegetation and condition of forest. The overall objective of the regeneration monitoring program is to evaluate regeneration performance.

The regeneration monitoring program uses fixed and random sampling and a benchmarking scoring system to evaluate the progression of plant community succession and informs the PNG LNG Biodiversity Implementation and Monitoring Program.

14.4 Maintenance and remedial action

EMPNG will use a risk-based approach to determine whether remedial action is required to address poor reinstatement and regeneration performance. Risk screening will be undertaken to identify relevant risks and identify appropriate remedial measures.

Remedial action may be readily achievable and within EMPNG's control. In such cases, remedial action, including assisted regeneration where appropriate, will be undertaken, with support from third party specialists and contractors as needed.

Certain circumstances may hinder EMPNG's ability to control outcomes, for example where landowners insist on access to a regenerating area. In these situations, EMPNG will engage with the relevant party/parties and endeavour to achieve desired outcomes.

14.5 New disturbance

Where operations and/or maintenance activities involve new or additional disturbance of land (beyond the already disturbed footprint), site-specific reinstatement controls will be implemented, which as a minimum, will include the following measures:

- storage of topsoil for use in subsequent reinstatement
- storage of cleared vegetation for use in subsequent reinstatement
- storage of rocks, pebbles and gravel from watercourses where applicable for subsequent reinstatement
- use of land-clearing techniques which preserve vegetation root and seed stock to facilitate natural regeneration
- spread topsoil, mulch and discarded vegetation debris (including natural seed stock) on reclaimed or rehabilitated disturbed land surfaces to facilitate natural revegetation
- de-compaction and ripping of disturbed areas to enable seed penetration and promote natural regeneration
- prompt reinstatement of land and watercourses, reducing the time surfaces are exposed
- establishment of stable landforms and ground conditions conducive to natural regeneration
- active works to re-establish vegetation in areas that may be slow or difficult to regenerate naturally, difficult to stabilise or prone to erosion.

15.0 INVASIVE SPECIES AND PLANT PATHOGENS

EMPNG's objectives are to prevent invasive species (i.e. priority weeds and pests) and plant pathogens from entering or becoming established in or in the vicinity of EMPNG's facilities and infrastructure; and contain existing priority weeds, pests and plant pathogens already present.

Measures to prevent, mitigate or otherwise control potential environmental impacts associated with priority weeds, pests and plant pathogens are described in this section.

15.1 Invasive species: identification

Weeds are categorised according to their potential for environmental harm and hence priority for management, as shown in Table 15-1.

Table 15-1: Categorisation of invasive weeds

PRIORITY	DESCRIPTION
Priority 1	Exists in the natural environment but has the ability to suppress and displace most native species especially in new disturbed areas.
Priority 2	Exists in the natural environment but has the ability to become locally dominant with potential to outcompete some native species.
Priority 3	Exists in the natural environment with the potential to proliferate in new disturbed areas.

Details of invasive species (i.e. both priority weeds and pests) identified in EMPNG's area of operations, including categorisation, location and degree of occurrence, are included in a register.

To facilitate identification and management, details of Priority 1 and Priority 2 weeds, including photographs and appropriate control measures, are included in a weed identification manual.

15.2 Invasive species: management and monitoring

Based on the occurrence, distribution and trends of invasive species in the area of EMPNG's operations, weed management zones have been established. For each management zone, specific management and monitoring priorities are established.

Weed management zones relevant to this EMP are summarised in Table 15-2.

There is a notable reduction of documented invasive species from a certain altitude upwards (KP 3.5) on the Hides Ridge. To prevent the ingress of weeds and plant pathogens beyond KP 3.5, all vehicles will be washed at the HVWF and logged in a register. Vehicle washdown facilities are maintained and sediment/seed is collected and disposed of appropriately.

Transportation of live animals, plants or seeds to the Hides Ridge area is prohibited.

EMPNG will conduct inspections in and around the immediate vicinity of the Upstream facilities, infrastructure and pipelines. The presence of priority weeds will be checked as part of the inspections in accordance with the priorities established in the weed management zones. Inspections will focus on the potential occurrence of previously unrecorded species and the potential expansion or increase in abundance. Priority classifications for weeds are also reviewed and updated where supported by monitoring results and increased scientific knowledge. Refer to the invasive species register for the latest priority classifications.

Other invasive species (i.e. pests) are monitored in the EMPNG's area of operations. Inspections will focus on the potential occurrence of previously unrecorded species and their potential expansion. Results of these inspections are included in the invasive species register.

Inspections undertaken by EMPNG may be supplemented by monitoring undertaken by a landowner/community service provider.

Further mitigation measures undertaken to prevent the introduction and spread of priority weeds during operations and/or maintenance activities include:

- limiting work vehicles and machinery to designated access and worksites
- prohibiting the washing of equipment, vehicles or machinery near or within watercourses
- prohibiting the establishment of gardens with introduced plant species (unless approved by EMPNG for landscaping purposes), and the introduction of exotic plants or animals by EMPNG staff and contractors.

Table 15-2: Weed management zones

ZONE	ECOLOGICAL UNIT	OBJECTIVES
Hides Ridge	Montane forest (1,800-2,850 metres above sea level)	Exclude Priority 1 and Priority 2 weed species
Hides Wellpad Access Road between HGCP and HVWF (Hides Ridge quarantine zone)		Develop HGCP to HVWF (i.e. clean/dirty line) as a quarantine zone
HGCP-Lake Kutubu (including HGCP, Angore Spineline, Angore Wellpads, Komo Airfield and Hides landfill sites; excluding Lake Kutubu (Moro) area)	Montane forest (900-1,700 metres above sea level)	Control Priority 1 weed species
Homa-Benaria	Montane forest (1,800-2,850 metres above sea level)	Exclude Priority 1 and Priority 2 weed species
Lake Kutubu (Moro)	Wetlands/swamp forest (900 metres above sea level)	Control Priority 1 weed species
Lake Kutubu-Mubi River	Upland forest (70-900 metres above sea level)	Control Priority 1 weed species. Control Priority 1 and Priority 2 weed species from roadsides between Mubi River and Kantobo
Mubi River-Kikori River	Lowland forest (25-70 metres above sea level)	Control Priority 1 weed species Manage zone as a quarantine buffer between lowland and upland/highland sections
Kikori River-Omati	Lowland forest/swamp forest (0-25 metres above sea level)	Manage Priority 1 weed species within EMPNG facilities as needed and put in measures to manage the further introduction of Priority 1 weed species

15.3 Invasive species: remedial action

Where intervention is required in accordance with the priorities established in the areas of operations for pests and/or weed management zones, EMPNG will implement invasive species controls, which may include physical removal, trapping, slashing (cut stump), mulching and/or application of EMPNG approved herbicides where considered to be most effective control/s.

Controls implemented by EMPNG may be supplemented by controls undertaken by a landowner/community service provider, under direction from EMPNG.

The occurrence, distribution and trends of invasive species in the area of EMPNG's operations are subject to periodic assessment by an independent expert advisor. As part of these assessments, the advisor will provide recommendations for the remedy of any identified problems and update the weed management zones as appropriate.

15.4 Plant pathogens: identification

The only known plant pathogen of relevance in EMPNG's area of operations is *Phytophthora cinnamomi,* which is best described as a fungus. There are known to be two different types of *Phytophthora cinnamomi* in Papua New Guinea, referred to as type A1 and type A2, although research suggests that they may be different species.

Type A1 is thought to have occurred in Papua New Guinea for tens of thousands of years and is usually associated with remote undisturbed areas (although it also occurs in disturbed areas), whereas type A2 is only associated with anthropogenic disturbance and the cultivation of exotic plants.

Both types appear to be associated with tree senescence (tree death or dieback). It is thought that the type A1 association with senescence, if any, is only a function of tree health and environmental factors which may predispose a tree to infection. In the case of type A2, it is thought that native trees in Papua New Guinea have not yet developed a natural defence to the fungus due to its relatively recent occurrence and hence it is likely to cause senescence.

Current scientific thinking was upheld by the results of surveys and studies undertaken by EMPNG during construction. Type A1 *Phytophthora cinnamomi* was identified in many locations throughout the Upstream area, including relatively undisturbed locations such as Hides Ridge, and no association with senescence was observed. Type A2 *Phytophthora cinnamomi* was found only at certain locations and associated with exotic plant species under cultivation or forests subject to anthropogenic disturbance and senescence was observed in its proximity.

15.5 Plant pathogens: management and monitoring

Phytophthora cinnamomi can be spread by the movement of soil containing the pathogen.

Based upon current scientific research, coupled with recommendations from an independent expert advisor, EMPNG manages *Phytophthora cinnamomi* by preventing the spread or introduction of Type A2 into unaffected areas, in particular ecologically sensitive areas which are susceptible to senescence.

Of particular relevance to this EMP is the high altitude forest on Hides Ridge which comprises Papua New Guinea Oak *Castanopsis acuminatissima* and Antarctic Beech *Nothofagus rubra*, *Nothofagus pullei* and *Nothofagus grandis*, both of which are vulnerable to infection by *Phytophthora cinnamomi* and senescence.

While senescence of *Castanopsis acuminatissima* and *Nothofagus* sp. may not be associated with Type A2 *Phytophthora cinnamomi*, EMPNG applies the precautionary principle in this regard. To prevent the ingress of *Phytophthora cinnamomi* to the Hides Ridge, all vehicles are washed at the HVWF and logged in a register.

EMPNG will conduct ground and aerial inspections within and in the immediate vicinity of the Upstream facilities, infrastructure and pipelines. The health of forests and evidence of senescence will be checked as part of the inspections. Videography will be used where appropriate.

Inspections undertaken by EMPNG may be supplemented by monitoring undertaken by a landowner/community service provider.

15.6 Plant pathogens: remedial action

Based on the results of inspections, sampling may be required to determine the cause of the observed senescence and the occurrence of *Phytophthora cinnamomi*. Where *Phytophthora cinnamomi* is confirmed as the cause, EMPNG will consult with an independent expert advisor to determine appropriate mitigation measures.

Remedial action may be readily achievable and within EMPNG's control, for example soil hygiene measures to prevent movement of Type A2 *Phytophthora cinnamomi.* In such cases controls will be implemented by EMPNG, where necessary supported by specialist third parties and/or a landowner/community service provider.

Certain circumstances may hinder EMPNG's ability to control outcomes, for example where landowners insist on access to an infected area. In these situations, EMPNG will engage with the relevant party/parties and endeavour to achieve desired outcomes.

15.7 New disturbance

Where operations and/or maintenance activities involve new or additional disturbance of land (beyond the already disturbed footprint), a pre-disturbance survey of the area to be affected will be undertaken. As part of the pre-disturbance survey, the occurrence of invasive species (i.e. priority weeds and pests), and the occurrence of senescence and *Phytophthora cinnamomi* will be determined. Site-specific hygiene and other mitigation measures will be developed.

15.8 Quarantine

EMPNG has adopted quarantine requirements which aim to prevent the importation and spread of foreign invasive species (i.e. priority weeds and pests), pathogens or disease.

While responsibility for quarantine control rests with the Papua New Guinean National Agriculture Quarantine and Inspection Authority, EMPNG's quarantine requirements are designed to ensure that National Agriculture Quarantine and Inspection Authority requirements and international good practice for the import of goods are followed.

Requirements include avoidance of prohibited packaging materials, International Standards For Phytosanitary Measures No. 15 treatment and stamping for all timber packaging, cleaning of shipping containers at point of origin and maintenance of all necessary documentation to verify quarantine hygiene.

Suppliers and importers of goods directly and solely for EMPNG are required to inspect cargo, containers and break-bulk cargo at the point of origin, on the basis of perceived risk and accordingly, ensure quarantine hygiene measures, such as cleaning and fumigation, are applied as necessary to containers, container contents and break-bulk cargo (which must be as clean as new) at point of origin.

EMPNG may, at its discretion, audit suppliers and importers of goods.

Quarantine hygiene measures will be applied as necessary at the Komo Airfield (upon arrival of international flights).

Quarantine requirements are further described in the quarantine procedure.

16.0 ECOLOGY

EMPNG's objective is to avoid impacts to specific features of ecological importance.

Disturbance and/or harassment of wildlife, hunting of fauna, possession of hunting and fishing equipment, gathering of plants or bush foods, collection of firewood or possession of wildlife products by EMPNG staff and contractors is prohibited.

Speed limits are implemented on EMPNG controlled roads and access ways to reduce vehicle collisions with wildlife.

Focal habitats and other ecological sensitivities within and in the immediate vicinity of the Upstream facilities, infrastructure and pipelines were identified as part of the environmental pre-construction survey program undertaken during construction and informed the development of EMPNG's Biodiversity Strategy (www.pnglng.com). Site-specific mitigation and management measures were adopted to avoid and otherwise mitigate potential impacts where feasible.

Measures to monitor the condition of focal habitats and sensitive ecological features in the vicinity of the Upstream facilities, infrastructure and pipelines and prevent impacts to these features are described in this section.

It should be noted that direct impacts to focal habitats and sensitive ecological features during normal operations are expected to be negligible. In addition to avoiding new impacts to features of ecological importance, the focus of ecological management during operations is therefore monitoring for potential residual impacts from the construction phase, which may evolve or manifest during production.

16.1 Inspection

Details of focal habitats and other ecological sensitivities in the vicinity of the Upstream facilities, infrastructure and pipelines are included in a register.

EMPNG will conduct inspections within and in the immediate vicinity of the Upstream facilities, infrastructure and pipelines. The condition of focal habitats and other sensitive ecological features will be checked as part of the inspections.

Inspection of focal habitats and sensitive ecological features forms part of EMPNG's Biodiversity Implementation and Monitoring Program, which sets out the process which EMPNG will follow to monitor and evaluate the extent to which its biodiversity objectives are being achieved.

16.2 Remedial action

Where issues are noted, EMPNG will determine appropriate mitigation measures, in consultation with an independent expert advisor where needed.

Certain circumstances may hinder EMPNG's ability to control outcomes, for example where landowners insist on access to a focal habitat or ecological feature. In these situations, EMPNG will engage with the relevant party/parties and endeavour to achieve desired outcomes.

16.3 New disturbance

Where operations and/or maintenance activities involve new or additional disturbance of land (beyond the construction footprint), previously disturbed areas will be selected preferentially in order to avoid disturbance of old growth forest. In all cases, a pre-disturbance survey of the area to be affected will be undertaken. As part of the pre-disturbance survey, the existence of focal habitats or other potentially sensitive ecological features (including those identified in the Environment Permit) will be determined. Site-specific mitigation and management measures will be adopted to avoid and/or otherwise mitigate potential impacts to identified features (including caves providing habitat for bat colonies, lekking trees for birds-of-paradise or

bowerbirds, *Pandanus* sp. swamp forest, *Northofagus* sp. forest, and other sites or habitats of ecological significance) and species of conservation concern.

Mitigation measures will include, as appropriate:

- avoid where practicable environmental sensitivities identified during the pre-disturbance survey
- demarcate on technical drawings and in the field the extent of vegetation to be cleared and ensure that works and machinery do not exceed the approved disturbance footprint
- retain large trees (i.e. greater than 1m diameter breast height) when they are situated along worksite borders or where work can be undertaken around these trees, unless an exception is approved by EMPNG
- use tree felling methodologies (e.g. directionally felling) to reduce damage to adjacent vegetation and limit scraping of standing tree trunks by machinery
- avoid display grounds of birds-of-paradise and bowerbirds where possible
- maintain adequate surface flows and avoid redirection of stream flows where practical
- avoid unnecessary access and disturbance to caves with bat colonies
- if works require blasting, ensure controlled blasting measures are implemented where worksites are located within 100 m of known caves with bat colonies
- patrol open trenches to rescue and record any fauna that fall within
- locate ROW, access ways and facilities within or adjacent to existing disturbed areas, where practicable
- reduce the number of quarries developed by using previously worked (old) quarries
- reduce the number of special vehicle parks, and place in areas of existing disturbance, where practicable.

17.0 ACCESS

EMPNG's objectives are to prevent potential damage by third party activities (e.g. industrial logging) that have accessed EMPNG roads and infrastructure by vehicle. This will be achieved by establishing access controls and procedures that restrict vehicular access to EMPNG roads and infrastructure.

In most cases, roads and infrastructure put in place during the construction phase were temporary in nature and were removed, reinstated and/or made impassable at the end of construction. Details regarding the nature, location and fate of each temporary access road and infrastructure are included in a register.

In some cases sections of road and other infrastructure are required during production and remain in place. EMPNG employs a combination of physical control points, access monitors and local and regional monitoring programs, which when used in combination enable EMPNG to detect and address any potentially damaging third party activities. This section sets out measures to control vehicle access to permanent roads and infrastructure, as relevant to the scope of this EMP.

Table 17-1 lists the access in place during production to AGIs, the PNG LNG Gas Pipeline and Condensate Pipeline ROW and other roads and infrastructure. A description of each access is provided and the access controls are defined.

Access will generally be allowed only to EMPNG vehicles. Access by third party vehicles serving operational needs may be sanctioned subject to EMPNG approval. Access by landowner vehicles may be sanctioned subject to EMPNG approval. In both cases, access will be authorised only by designated EMPNG personnel. Vehicles will be inspected as deemed appropriate.

EMPNG will conduct inspections of the access controls described in Table 17-1. Where breach of access control is identified, EMPNG will engage with the relevant party/parties and endeavour to achieve access control. It should be recognised that a remedy may not be readily achievable and beyond EMPNG's ability to control.

Additional access points beyond those identified in Table 17-1 may be required and where this is the case appropriate controls will be adopted to prevent potentially damaging third party activities.

Access measures outlined in Table 17-1 are based on current ownership of road systems and facilities at the time of publication of this EMP. Should ownership change, EMPNG will continue to engage with relevant party/parties and endeavour to mitigate potential induced access impacts. It should be recognised that, in such cases, mitigation measures required may not be readily achievable and/or may be beyond EMPNG's ability to control.

Table 17-1: Access and access controls

FACILITY/INFRASTRUCTURE	ACCESS DESCRIPTION	ACCESS CONTROL
Hides Gathering System and Hides Spineline	Access to the Hides Gathering System and Hides Spineline is achieved via the HWPAR	Vehicle access to the HWPAR is controlled via a staffed gate.
Angore Gathering System and Angore Spineline	Access to the Angore Gathering System and Angore Spineline is achieved via the AWPAR	Monitor for third party activities adjacent to EMPNG facilities (e.g. ROW).
Condensate Pipeline CV1	CV1 is located on the combined gas/condensate pipeline ROW at KP 7.2, in the vicinity of the Tagari River. Vehicle access to CV1 is achieved firstly from the AWPAR, which connects to a pipeline access track that links with the ROW at KP 12, and then via a 5 kilometre section of pipeline construction track that is maintained operational between KP 12 and CV1	Vehicle access to CV1 is controlled via an unstaffed gate located at the junctions between the pipeline access track to the ROW at KP12 and the pipeline construction track between KP12 and CV1
Condensate Pipeline MLV1	MLV1 is located on the combined gas/condensate pipeline ROW at KP 27.5, in the vicinity of Benaria and within approximately 2 kilometres of an existing public road (Benaria Station Road). Vehicle access to MLV1 is achieved from the public road at KP 26 and subsequently via a 1.5-kilometre section of pipeline construction track, which is maintained operational	Vehicle access to MLV1 is to be controlled via an unstaffed gate at the junction between the public road and the pipeline construction track
Condensate Pipeline MLV2	MLV2 is located on the combined gas/condensate pipeline ROW at KP 53, in the vicinity of Homa. Vehicle access to MLV2 is achieved from an existing public road (known as the Homa Tax Credit Road), firstly via a 7.8 kilometre section of pipeline access track (the Homa Ridge Access Road) which links the public road with the ROW at KP 53	Vehicle access to MLV2 is controlled via an unstaffed gate at the junction between the public road and the pipeline construction track (Homa Ridge Access Road)
Condensate Pipeline MLV3	MLV3 is located on the combined gas/condensate pipeline ROW at KP 66.5, in the vicinity of Paua and within 1 kilometre of an existing public road (Homa-Moro Road). Vehicle access to MLV3 is achieved from the public road at KP 67 and then via a 500-metre section of pipeline construction track that is maintained operational	Vehicle access to MLV3 is controlled via an unstaffed gate located at the junction between the public road and the pipeline construction track
Condensate Pipeline MLV4 (and PNG LNG Gas Pipeline ROW KP 81.5 Access)	MLV4 is located on the combined gas/condensate pipeline ROW at KP 85, in the vicinity of Lake Kutubu. Vehicle access to MLV4 is achieved from an existing public road (Homa-Moro Road), firstly via a 1 kilometre section of pipeline access track which links the public road with the ROW at KP 81.5 and then via a 5-kilometre section of pipeline construction track, which is maintained operational between KP 81.5 and MLV4	Vehicle access to MLV4 is controlled via an unstaffed gate located at the junction between the public road and the pipeline access track

FACILITY/INFRASTRUCTURE	ACCESS DESCRIPTION	ACCESS CONTROL
Condensate Pipeline CV2	CV2 is located on the combined gas/condensate pipeline ROW at KP 95, in the vicinity of Moro, where the ROW runs adjacent to an existing OSL controlled access road. Vehicle access to CV2 is achieved directly from the road	N/A
Kopi Scraper Station	Kopi Scraper Station is located on the pipeline ROW at KP 266 in the vicinity of Kopi, at the intersection between the ROW and an existing public road leading to Kopi Shore Base. Vehicle access to Kopi Scraper Station is achieved directly from the public road	N/A
Kutubu MLV	Kutubu MLV is located on the pipeline ROW at KP 107.5, within approximately 3.5 kilometres of an existing OSL controlled access road. Vehicle access to the Kutubu MLV is achieved from the road and subsequently via a 3.5 kilometre section of pipeline construction track that is maintained operational	Vehicle access to Kutubu MLV is controlled via an unstaffed gate between the road and the pipeline construction track
CP1	CP1 is located on the pipeline ROW at KP 153, on a section where the ROW runs adjacent to an existing OSL controlled access road (Kutubu-Kantobo Road). Vehicle access to CP1 is achieved directly from the road.	N/A
Gobe MLV	Gobe MLV is located on the pipeline ROW at KP 192, in the vicinity of Gobe, within approximately 1 kilometre of an existing OSL controlled access road (Gobe-Kopi Road). Vehicle access to the MLV is achieved from the road and subsequently via a 1-kilometre section of pipeline construction track that is maintained operational	Vehicle access to Gobe MLV is controlled via an unstaffed gate at the junction between the road and the pipeline construction track
CP2	CP2 is located on the pipeline ROW at KP 227, just to the south of the Kikori River, within 1 kilometre of an existing public access track. Vehicle access to CP2 is achieved from the public access track and subsequently via a 1-kilometre section of pipeline construction track that is maintained operational	Vehicle access to CP2 is controlled via an unstaffed gate at the junction between the public access track and the pipeline construction track
ROW KP 101.8 Access	A pipeline access track of approximately 0.3 kilometres was installed during construction between the OSL controlled road near Agogo and the combined gas/condensate pipeline ROW at KP 101.8. This track has been retained for operational access to the pipeline ROW and the future Agogo tie-in and above ground valves	Access is controlled via an unstaffed gate at the junction between the pipeline access track and the OSL road
ROW KP 232 Access	A pipeline access track of approximately 1 kilometre was installed during construction between an existing public road (Kopi to Kaiam Road) and the pipeline ROW at KP 232. This track has been retained for access to the pipeline ROW during production	Access is controlled via an unstaffed gate at the junction between the pipeline access track and the public road

FACILITY/INFRASTRUCTURE	ACCESS DESCRIPTION	ACCESS CONTROL
Kantobo-Mubi River Road and Mubi River Bridge	A new road was installed during construction between Kantobo and Mubi River as part of the southern logistics route serving pipeline construction. The Kantobo-Mubi River Road is approximately 11.4 kilometres. A new bridge was also installed over the Mubi River. Both will remain in place during production	Access to the Kantobo-Mubi River Road and Mubi River Bridge is controlled from the north via OSL staffed gates located at KP95 and KP120. Access from the south is controlled at Gobe, as discussed below
Mubi River to Gobe Road	An existing road between Mubi River and Gobe was upgraded during construction as part of the southern logistics route serving pipeline construction. The Mubi River-Gobe Road is approximately 18 kilometres. The road runs directly adjacent to the OSL operated oil pipeline and, generally, to the pipeline and will remain in place during production	Access to the Mubi River-Gobe Road is controlled from the south via staffed gates located close to Gobe
Kikori River Bridge	A new bridge was installed during construction over the Kikori River as part of the southern logistics route serving pipeline construction. The Kikori River Bridge remains in place during production	Access to the Kikori River Bridge is controlled via a staffed gate

18.0 CULTURAL HERITAGE

EMPNG's objectives are to avoid impacts to cultural heritage sites, including archaeological and oral tradition sites and to manage cultural heritage sites in consultation with landowners.

Cultural heritage sensitivities within and in the immediate vicinity of the Upstream facilities, infrastructure and pipelines were identified as part of the PNG LNG EIS and the environmental pre-construction survey program during construction. Site-specific mitigation and management measures were adopted to avoid and otherwise mitigate potential impacts where feasible.

Measures to monitor the condition of cultural heritage sensitivities in the vicinity of the Upstream facilities, infrastructure and pipelines and prevent impacts to these features are described in this section.

Direct impacts to cultural heritage sensitivities during normal operations are expected to be negligible.

18.1 Inspection

Details of cultural heritage sensitivities in the vicinity of the Upstream facilities, infrastructure and pipelines are included in a register.

EMPNG will conduct inspections in and near the immediate vicinity of the Upstream facilities, infrastructure and pipelines. The condition of any nearby cultural heritage sensitivities will be checked as part of the inspections.

18.2 Remedial action

Based on the results of inspections, and where issues are noted, EMPNG will determine appropriate mitigation measures in consultation with landowners and where appropriate with the Papua New Guinea National Museum and Art Gallery and qualified archaeologists or other practitioners.

Where intervention is required and is within EMPNG's control, it will be undertaken by qualified archaeologists supported by EMPNG as needed.

Certain circumstances may hinder EMPNG's ability to control outcomes, for example where landowners insist on access to a cultural heritage site. In these situations, EMPNG will engage with the relevant party/parties and endeavour to achieve desired outcomes.

18.3 New disturbance

Where operations and/or maintenance activities involve new or additional disturbance of land (beyond the construction footprint), a pre-disturbance survey of the area to be affected will be undertaken. As part of the pre-disturbance survey, the existence of cultural heritage sensitivities will be determined by qualified archaeologists in possession of appropriate investigation permits obtained from the National Museum and Art Gallery. Site-specific mitigation and management measures will be developed, in consultation with landowners, to avoid and/or otherwise mitigate impacts to identified cultural heritage sensitivities.

In general, the following mitigations will apply, tailored as appropriate to the site-specific circumstances.

Sensitive sites identified by landowners as requiring protection will be avoided in all cases, access thereto prohibited and appropriate access control zones established.

Burial sites located within or close to a proposed area of disturbance will be avoided where possible, and if they cannot be avoided, will be moved prior to disturbance. In such cases, EMPNG will obtain prior consent from landowners or clan representatives for the relocation and agree responsibility for burial relocation. At the request of landowners or clan representatives, EMPNG will be responsible for the relocation. Should the burials located

within the proposed area of disturbance be identified by landowners or clan representatives as being particularly sensitive and requiring protection, they will be avoided, with access prohibited and appropriate access control zones established.

Spirit and other ceremonial sites located within or close to a proposed area of disturbance will be avoided where possible. If they cannot be avoided, EMPNG will consult with landowners or clan representatives to agree the appropriate mitigation measures (for example spirit moving ceremony or compensation). Should the spirit and other ceremonial sites located within the proposed area of disturbance be identified by landowners or clan representatives as being particularly sensitive and requiring protection, they will be avoided, with access prohibited and appropriate access control zones established.

Archaeological sites located within or close to a proposed area of disturbance will be avoided where possible. If they cannot be avoided, EMPNG will consult with landowners and the National Museum and Art Gallery to determine requirements for mitigation.

New disturbance has the potential to affect as yet unknown or unrecorded archaeological sites. These unknown archaeological sites, including skeletal remains, discovered during archaeological salvage or construction activities are referred to as chance finds. In addition to the site-specific measures discussed, EMPNG will implement a chance finds process to enable preservation and appropriate treatment of chance finds. A level of significance is assigned to each find (low, medium, and high significance, and burial with skeletal items) which guides the management and documentation of the find. Where a find is deemed to be of high significance and/or a burial with skeletal items, salvage protocols are applied in consultation with the National Museum and Art Gallery.

Details of the cultural heritage management program are provided in the cultural heritage management procedure. The chance finds process is documented in the archaeological chance finds procedure. The salvage process is documented in the archaeological salvage procedure.

18.4 Management of salvaged archaeological material

Archaeological salvage undertaken during construction was completed in accordance with the terms of the Permit for Salvage Archaeology (Upstream) issued by National Museum and Art Gallery on 30 September 2009.

The salvage process and the cultural material obtained from the salvage is documented and described in the Final Report on the Archaeological Salvage Excavations at the Hides Gas Conditioning Plant (Monash University, 2013) and all cultural material has been transferred to the National Museum and Art Gallery pursuant to the requirements of the *National Cultural Property (Preservation) Act 1965.*

Cultural heritage material recovered as part of any salvage work undertaken during production will be managed in consultation with National Museum and Art Gallery and in accordance with the terms of the Permit for Salvage Archaeology and the *National Cultural Property (Preservation) Act 1965.*

19.0 ENVIRONMENTAL MONITORING

The environmental monitoring program for production is described in this section. For the purposes of this EMP, environmental monitoring does not include the processes of verification, inspection, assessment and audit, which are discussed in Section 20.0.

The monitoring measures outlined have been developed in accordance with the requirements of, and using the methods prescribed in OIMS System 6-5 Environmental Management. Monitoring data collected as part of the objectives of this EMP may also contribute to EMPNG's Biodiversity Implementation and Monitoring Program.

19.1 Monitoring of emissions to air

Monitoring of emissions to air from relevant emission sources at the HGCP and the HWMF is outlined in Table 19-1.

Table 19-1: Monitoring of emissions to air

FACILITY	PARAMETER	EMISSION GUIDELINE VALUE	SUMMARY	FREQUENCY
HGCP gas turbine compressors	Oxides of nitrogen	25 ppm	Stack test	Note 1
HGCP main power generators	Oxides of nitrogen	42 ppm	Stack test	Note 1
HGCP MEGVG incinerator	BTEX	Note 2	Stack test	Note 1
HGCP industrial area incinerator HWMF incinerator	PM	70 mg/m^3	Stack test	Note 1
	Carbon monoxide	157 ppm	Stack test	Note 1
	Oxides of nitrogen	388 ppm	Stack test	Note 1
	Oxides of sulphur	20 ppm	Stack test	Note 1
	Hydrogen chloride	62 ppm	Stack test	Note 1
	Cadmium	0.004 mg/m^3	Stack test	Note 1
	Lead	0.04 mg/m^3	Stack test	Note 1
	Mercury	0.47 mg/m^3	Stack test	Note 1
	Dioxin/furan	0.41 ng/m^3	Stack test	Note 1
	Opacity	10 percent	Visual observation	Daily

Source (gas turbine compressors and main power generators): Environmental, Health, and Safety General Guidelines (IFC, 2007), Table 1.1.2 - Small Combustion Facilities Emissions Guidelines.

Source (waste incinerator): Based on Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 60] (United States Environmental Protection Agency, 2008), Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units), including threshold for applicability relating to throughput, as referenced in Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007).

Emission guideline values apply during normal steady state operations, and not startup, shutdown and abnormal operations.

Gas turbine compressors and main power generator parameters are stated at reference conditions of 15 percent oxygen, dry gas. Incinerator parameters are stated at reference conditions of 7 percent oxygen.

Note 1: Stack testing will be undertaken twice yearly for the first two years of operation. Thereafter, for each emission source, monitoring frequency and scope can be reduced such that:

- Stack testing is conducted every three years if monitoring results meet the required criteria; or annually if not until the required criteria is met; and
- A representative selection of air emission sources is included in each stack testing program.

Note 2: This is monitored for air emissions modelling purposes.

Emissions monitoring consists of periodic stack sampling undertaken on behalf of EMPNG by a competent specialist in accordance with standard industry methods and subject to the provisions set out in the stack emissions monitoring procedure.

19.2 Monitoring of ambient air quality

Monitoring of ambient air quality will be undertaken periodically in the vicinity of the HGCP and the HWMF to validate the predictions of the ambient air quality assessments (see Section 7.0) and evaluate conformance with the guideline values outlined in Table 7-1.

An initial monitoring campaign was undertaken at the HGCP once steady state operations had been achieved - within the first two years of production. Further ambient air quality monitoring will be conducted after major modifications to existing plant that will increase emissions affecting ambient air quality. Ambient air quality monitoring will be conducted on behalf of EMPNG by a competent specialist in accordance with standard industry methods. The focus of ambient air quality monitoring will be sensitive community receptors within the vicinity of the HGCP and the HWMF, as identified as part of baseline air quality assessments and dispersion modelling exercises.

19.3 Monitoring of noise

Monitoring of noise will be undertaken periodically at perimeter fence lines, including in line with sensitive receptors in the vicinity of the Upstream facilities, infrastructure and pipelines to evaluate conformance with the guideline values in Table 8-1. Noise monitoring will be undertaken in accordance with the method set out in the noise monitoring procedure.

19.4 Monitoring of water abstraction

The volume of water abstracted from each surface water and groundwater abstraction point is recorded and details maintained in a register. Monitoring of abstraction volumes will be undertaken where appropriate (i.e. where prior environmental assessment has determined the need for monitoring).

19.5 Monitoring of discharges to water

Monitoring of stormwater discharges from the Hides Wellpads, Angore Wellpads, HGCP, and HWMF consists of periodic in-situ sampling of the parameters shown in

Table 9-8. Monitoring will be undertaken in accordance with the method set out in the stormwater monitoring procedure.

Monitoring of discharges to water from relevant process sources at the HGCP consists of periodic in-situ sampling of the parameters shown in Table 9-9. Monitoring will be undertaken in accordance with the method set out in the effluent monitoring procedure.

Monitoring of discharges to water from WWTP treating sewage at the HGCP, HWMF, Komo Airfield and Moro B Camp consists of periodic in-situ sampling of the parameters shown in Table 9-10. Monitoring will be undertaken in accordance with the method set out in the WWTP effluent monitoring procedure.

Monitoring of discharges from the leachate treatment system at the HWMF consists of periodic grab samples of the parameters shown in Table 9-11. Monitoring will be undertaken in accordance with the method set out in the effluent monitoring procedure.

The criteria referenced in the above tables are considered applicable based on EMPNG's understanding of the discharge types and their respective constituents. In order to determine those parameters relevant to the discharges, EMPNG will undertake initial monitoring campaigns during the first two years of production which cover the full range of parameters prescribed in the *Environment (Water Quality Criteria) Regulation 2002*. Thereafter, only relevant parameters will be monitored.

For the purposes of monitoring, the criteria shown in

Table 9-8 (stormwater), Table 9-9 (process wastewater), Table 9-10 (WWTPs) and Table 9-11 (treated leachate) are deemed by EMPNG to apply end of pipe (at the discharge location) and not in the receiving water body. Should monitoring indicate that any of the criteria have not been met end of pipe, monitoring shall be undertaken in the receiving water body, where feasible, in order to evaluate compliance with the *Environment (Water Quality Criteria) Regulation 2002*.

19.6 Monitoring of surface water quality

Monitoring of surface water quality will be undertaken at select regional locations representative of potential effects resulting from HGCP discharges. This monitoring will be undertaken twice during the first two years of production (campaigns may be contiguous) and every five years thereafter. Parameters to be monitored are shown in Table 9-4. Monitoring will be undertaken in accordance with the method set out in the surface water quality monitoring procedure.

19.7 Monitoring of groundwater quality

Monitoring of groundwater quality in the vicinity of the landfill cells at the HWMF consists of periodic grab samples of the parameters shown in Table 19-2. Samples will be taken at one up-gradient well, two cross-gradient wells and two down-gradient wells in accordance with the method set out in the groundwater monitoring procedure.

Table 19-2: Monitoring of groundwater

PARAMETER	GUIDELINE VALUE	SUMMARY
pH	No alteration above site background ranges.	Grab sample at one up-gradient well, two cross-gradient wells and two down-gradient wells (relative to the landfill cells). Conducted every six months.
Dissolved oxygen		
Sulphate		
Ammonia-nitrogen		
Nitrates		
Major ions (calcium, magnesium, sodium, potassium)		
Electrical conductivity		
Arsenic		
Barium		
Boron		
Cadmium dissolved		
Chromium (as hexavalent)		
Cobalt		
Copper		
Iron (dissolved)		
Lead		
Manganese (dissolved)		
Mercury		
Nickel		
Selenium		
Silver		
Tin		

PARAMETER	GUIDELINE VALUE	SUMMARY
Zinc		
Total petroleum hydrocarbons		
Faecal coliforms		
Phenols		
Source: Annex 2 of the Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002,* Water Quality Criteria for Aquatic Life Protection.		

19.8 Monitoring of surface water ecology

Monitoring of ecological conditions will be undertaken at select locations representative of potential effects resulting from HGCP discharges. Monitoring will be undertaken in accordance with the method set out in the surface water ecology monitoring procedure.

19.9 Non-conformance and corrective action

Non-conformances identified through the environmental monitoring program will be tracked using an action tracking system. The action tracking system includes details of all environmental non-conformances, the remedial/corrective action(s) required, responsible parties assigned to actions/timings and the status of the remedial/corrective action(s).

20.0 ASSESSMENT AND AUDIT

Processes for environmental verification, inspection, assessment and audit are described in this section. The processes have been developed in accordance with the requirements prescribed in OIMS System 1-1 Management Leadership, Commitment and Accountability, OIMS System 6-5 Environmental Management and OIMS System 11-1 OIMS Assessment and Improvement.

20.1 Verification and inspection

EMPNG will undertake a field-based verification and inspection program to evaluate environmental aspects, verify and document the implementation, and in some cases the effectiveness, of environmental controls set out in this EMP.

The verification and inspection program will be undertaken by EMPNG in accordance with a pre-determined procedure that sets out the methods, frequency and scope of inspections. Frequency of inspections will be determined on the basis of need and environmental risk, but in general inspections will be carried out on a daily, weekly, monthly or quarterly basis as appropriate.

The procedure will be periodically reviewed, and adapted in response to inspection results, changing circumstances and lessons learned (for example practicality, interpretability and usefulness).

The field-based verification and inspection program will be documented in a register that includes details of the inspections undertaken and a summary of the findings and results.

The verification and inspection program is outlined in Table 20-1.

20.2 Assessment

EMPNG will undertake assessments to evaluate environmental aspects, verify and document the implementation, and in some cases the effectiveness, of environmental controls set out in this EMP. This involves an internal assessment, evaluating performance across a subset of aspects which occurs on a nominated frequency, with the completion of an evaluation of all aspects listed in the EMP after five years.

In addition to the above, OIMS assessments will be undertaken in accordance with OIMS System 11-1 OIMS Assessment and Improvement, to evaluate the degree to which OIMS requirements are met as part of the implementation of this EMP.

In addition to periodic assessments, EMPNG may conduct targeted assessments in response to particular circumstances.

Facilities and operations of third party suppliers of fuel and chemicals are subject to prior assessment and approval, as are facilities and operations of third party suppliers of aggregate and quarry material and third party suppliers of timber. Third parties and third party facilities receiving EMPNG waste are subject to prior assessment and approval. EMPNG may undertake assessments of other third party facilities and providers, as relevant to this EMP.

Assessments undertaken by EMPNG will be documented in a register including details of the assessments and a summary of the findings and results. EMP assessment results may also contribute to EMPNG's Biodiversity Implementation and Monitoring Program.

Table 20-1: Verification and inspection

ASPECT/CONTROL	GENERAL SCOPE OF VERIFICATION/INSPECTION
Emissions to air	• Visual inspection of flares • Stack emissions monitoring results • Incinerator operating conditions and combustion temperatures • Visual inspection of diesel engines • Diesel engine maintenance records • Fugitive emissions estimations • Greenhouse gas emissions tracking • Inspection of direction of perimeter and other lighting
Ambient air quality	• Ambient air quality monitoring results
Noise	• Noise monitoring results • Notification to affected communities of planned high intensity noise events
Discharges to water	• Visual inspection of stormwater systems and discharge locations • Visual inspection of open drain systems and discharge locations • Visual inspection of WWTP discharges • Visual inspection of leachate treatment system and discharges • WWTP operating conditions • Discharge monitoring results
Spill prevention and response	• Incident registers • Assessment reports from third party fuel and chemical transporters' activities • Inspection of fuel and chemical storage facilities • Fuel and chemical transfer facilities and operations • Spill response equipment
Materials management	• Registers • Prohibited substances • Hazardous materials controls and Material Safety Data Sheets • Register of water abstraction • Water abstraction locations • Third party supply of aggregate and quarry material • Third party supply of timber
Waste	• Registers • Waste avoidance and minimisation rates • Waste collection areas and process inspections • Waste storage areas and process inspections • Waste reuse, recycling and recovery rates • Inspections of waste transfer to third parties • Waste treatment areas and process inspections • Waste incineration area and process inspections • Ash stabilisation, including laboratory results • Landfill area and process inspections • Leachate collection and treatment process inspections • Waste tracking documentation
Erosion and sediment	• Condition of erosion control works • Condition of surface waters • Mitigations for new disturbance
Reinstatement and regeneration	• Condition of reinstatement works/devices • Status of reinstatement and regeneration • Inspections of encroachment of regenerating areas • Inspection of activities involving new disturbance

ASPECT/CONTROL	GENERAL SCOPE OF VERIFICATION/INSPECTION
Invasive species and plant pathogens	• Registers • Weed identification manual availability • Presence of new invasive species to the worksite • Increase in existing invasive species within the worksites • Evidence of tree senescence (e.g. widespread vegetation death/stress)
Ecology	• Register of focal habitats and ecological sensitivities • Condition of focal habitats and ecological sensitivities • Inspection of activities involving new disturbance
Access	• Registers • Access controls • Inspection of encroachment
Cultural heritage	• Registers • Condition of cultural heritage sensitivities • Inspection of activities involving new disturbance

20.3 Audit and review

The Independent Environmental and Social Consultant (IESC), on behalf of the Lender Group, will undertake an annual review of the environmental aspects set out in this EMP.

Co-venture parties may undertake environmental audits of the environmental aspects controls set out in this EMP.

CEPA may undertake environmental audits of the environmental aspects controls set out in this EMP.

Audits undertaken by external parties will be documented in a register that includes details of the audits and a summary of the findings and results.

20.4 Non-conformance and corrective action

Non-conformances identified through the field-based verification and inspection program, assessments and audits will be tracked using an action tracking system. The action tracking system includes details of all environmental non-conformances, the remedial/corrective action required, actions/timings assigned to responsible parties and status of the remedial/corrective action.

20.5 Performance indicators

In accordance with OIMS System 6-5 Environmental Management, EMPNG will steward environmental performance data through the use of performance indicators.

Performance indicators relevant to this EMP are shown in Table 20-2.

The performance indicators will be periodically compiled using data collected from the registers and monitoring, verification, assessment and audit processes.

Table 20-2: Performance indicators

ASPECT	OBJECTIVE	INDICATOR	MEASUREMENT note 1
Emissions to atmosphere and ambient air quality	Avoid significant impacts associated with the release of pollutants to the atmosphere	Occurrence of significant impacts to air quality/atmosphere	Number
	Meet applicable stack test emissions criteria	Exceedance of stack test emissions criteria	Total number of stack test related non-conformances and location
	Meet applicable ambient air quality criteria	Exceedance of ambient air quality criteria	Total number of ambient air quality related incidents and location
Noise	Avoid significant noise and vibration impacts to community and fauna	Noise and/or vibration related grievances	Number
	Meet applicable noise criteria	Exceedance of noise criteria	Number
Discharges to water	Avoid significant impacts associated with the release of pollutants to surface water and groundwater	Water quality within the natural surface water and/or groundwater shall not exceed applicable criteria	Total number of water quality related incidents and location
	Meet applicable discharge criteria	Exceedance of discharge criteria	Total number of water quality related non-conformances, location
Spill prevention and response	Prevent spills of hydrocarbons, chemicals and untreated sewage	Release of hydrocarbons, chemicals, and/or untreated sewage to the environment	Type and number* *Only environmental spills are included in this performance indicator. (Gaseous releases to atmosphere are not included)
	Respond quickly and effectively to spills should they occur		
Materials management	Avoid significant impacts associated with the procurement and use of raw materials	Use of chemicals and/or hazardous materials subject to international bans or phase-outs	Number and reason
	Use materials that are less hazardous or otherwise preferable from an environmental perspective, where practical		
Waste	Apply the waste management hierarchy	Waste managed and disposed of at EMPNG facilities and approved third party facilities only	Percent
	Manage and dispose of waste at EMPNG facilities and approved third party facilities only		

ASPECT	OBJECTIVE	INDICATOR	MEASUREMENT note 1
Erosion and sediment	Control significant erosion and prevent sedimentation of surface waters	Occurrence of significant erosion (i.e. remedial works required)	Number
		Sedimentation of surface waters	Number
Reinstatement and regeneration	Promote regeneration of vegetation in areas disturbed during construction and not required for production	Regeneration areas are achieving established regeneration benchmarks	Yes/No, reason
	Achieve established benchmarks for regeneration areas		
Invasive species and plant pathogens	Prevent invasive species (priority weeds and/or pests) from entering or establishing in areas affected by PNG LNG	Ingress of new Priority 1 weeds and/or pests into PNG LNG worksites	Type, abundance and distribution
	Contain invasive species (priority weeds and/or pests) already established in areas affected by PNG LNG	Increases in existing Priority 1 weeds, pests and/or plant pathogens in PNG LNG worksites	Type, abundance and distribution
Ecology	Avoid impacts to specific features of ecological importance	Observed degradation in condition of specific features of ecological importance	Significance of change to the condition of specific ecological features
Access	Control vehicle access to EMPNG roads and infrastructure to prevent potentially damaging third party activities	Unauthorised access to EMPNG roads and infrastructure	Number and frequency
Cultural heritage	Avoid impacts to cultural heritage sites, including archaeological and oral tradition sites	Cultural heritage sites disturbed	Number
	Manage cultural heritage sites in consultation with landowners	Cultural heritage sites managed in accordance with landowner direction	Number
Note 1: 'Number' in this column refers to number of occurrences.			

21.0 INCIDENT MANAGEMENT, NOTIFICATION AND REPORTING

Environmental incidents are managed, reported and notified as outlined in this section. These processes have been developed in accordance with the requirements prescribed in OIMS System 9-1 Incident Management.

21.1 Incident management

OIMS System 9-1 Incident Management defines the incident management process to be followed by EMPNG during production, including requirements for managing environmental incidents.

For the purposes of this EMP, an incident is defined as a specific event, sequence of events, or extended condition that has an unwanted or unintended impact on the environment. EMPNG's Incident Management Manual defines types of incidents and their severity level.

In general, environmental incidents will be managed as follows:

- reduce further harm where applicable to personnel, the environment and assets
- classify the incident and notify and/or report to internal and external stakeholders as appropriate
- investigate incidents, based on their severity or potential severity, to identify causes and implement corrective actions to prevent incident recurrence
- stimulate learning opportunities by sharing lessons learned internally and externally as appropriate.

Contractors and subcontractors will adhere to EMPNG's incident management requirements.

21.2 Incident notification and reporting

All environmental incidents will be documented, notified and reported in accordance with EMPNG's Incident Management Manual, which defines requirements for managing incidents, including environmental incidents and the method and timing required for the notification and reporting of incidents dependent upon classification of severity level.

21.2.1 Internal notification and reporting

Environmental incidents are notified and reported in accordance with the Incident Management Manual.

21.2.2 Statutory notification and reporting

Environmental incidents are notified to government agencies pursuant to statutory notification requirements.

A condition of the Environment Permit requires EMPNG to promptly report to CEPA any significant environmental incidents that occur.

The Department of Petroleum and Energy is notified of significant environmental incidents pursuant to the requirements of the *Oil and Gas Act 1998* and the associated *Oil and Gas Regulation 2002*. Section 8 of the *Oil and Gas Act 1998* requires immediate notification of all incidents involving spillage of hydrocarbons in excess of 10 barrels (1600 litres).

21.2.3 Notification and reporting to the IESC/Lender Group

The IESC/Lender Group is notified of environmental incidents pursuant to the requirements of the Common Terms Agreement.

Contractors and subcontractors will adhere to EMPNG's incident notification and reporting requirements.

22.0 ROLES AND RESPONSIBILITIES

Organisational roles and responsibilities relating to the implementation of this EMP are outlined in this section. These roles and responsibilities are defined in accordance with the requirements prescribed in OIMS System 1-1 Management Leadership, Commitment and Accountability, which contains requirements pertaining to the allocation of resources.

In general, and as mandated by OIMS, EMPNG will ensure sufficient resources are allocated on an ongoing basis to achieve effective implementation of this EMP. Organisational charts and individual job descriptions will be periodically reviewed.

EMPNG's E&R group is allocated primary responsibility for the implementation of this EMP. In addition to the E&R group and SHE department, other EMPNG production and maintenance personnel have defined roles and responsibilities regarding this EMP. Roles and responsibilities of key personnel are outlined in Table 22-1.

Table 22-1: Roles and responsibilities

ROLE	RESPONSIBILITY
Upstream Asset Manager	• Overall accountability for conformance with the requirements of this EMP • Ensure operational resources are allocated for the effective implementation of this EMP, in respect of the Upstream operations
SHE Manager	• Overall responsibility for conformance with the requirements of this EMP and Biodiversity Strategy
Logistics and Infrastructure Superintendent	• Accountable for conformance with the requirements of this EMP pertaining to the HWMF and other services provided by Logistics • Ensure operational resources are allocated to the effective implementation of this EMP in respect of the HWMF and other services provided by Logistics • Direct the HWMF Contractor
Procurement Supervisor	• Ensure resources are allocated to the effective implementation of the quarantine procedure
E&R Supervisor	• Ensure environmental resources are allocated to the effective implementation of this EMP and Biodiversity Strategy

23.0 COMPETENCY, TRAINING AND AWARENESS

Information relating to competency, training and awareness regarding the implementation of this EMP is provided in this section. EMPNG aims to ensure that personnel involved in the implementation of this EMP have the experience, knowledge and other skills necessary to meet the requirements of their specific job functions.

The processes set out in this section have been developed in accordance with the requirements prescribed in OIMS System 5-1 Personnel Selection, Placement and Competency Verification and OIMS System 5-2 Personnel Training.

23.1 Competency

In accordance with OIMS System 5-1 Personnel Selection, Placement and Competency Verification, EMPNG will define competency requirements for specific job functions and verify competency during personnel selection and placement.

Competency requirements for the job functions and roles involved in the implementation of this EMP will be specified and documented. Competency will be verified during personnel selection and placement to ensure that individual qualifications, knowledge and skills (namely competencies) are appropriate for the specific job requirements. Competency will also be verified on an ongoing basis through observation and performance assessments.

Where an individual does not meet all competency requirements required for his or her specific job function, appropriate training requirements will be identified.

23.2 Training and awareness

In accordance with OIMS System 5-2 Personnel Training, EMPNG will ensure that personnel responsible for the execution of the tasks and requirements contained within this EMP are trained, on an ongoing basis, and have the knowledge and skills necessary to meet the requirements of their specific positions.

Training and awareness associated with this EMP will be planned and documented by means of a training needs assessment, training program and training records. Training needs assessments and training programs will be reviewed periodically.

The training program will include several levels of competency and training, delivered as a function of job descriptions and individual duties, as summarised in Table 23-1.

Table 23-1: Training and awareness

TYPE OF TRAINING	DESCRIPTION
Induction	Induction directed at visitors, providing a summary of key aspects, controls and relevant instructions. This training is specific to each location and facility.
General awareness	Awareness and overview training is provided to personnel who do not have direct duties in relation to this EMP. The training includes a summary of key environmental aspects, controls and other relevant instructions.
Management awareness	Awareness, directed at management and superintendent-level personnel, covering the key aspects of this EMP.
Job-specific training	Job-specific training, given to personnel having direct duties in respect of this EMP, providing a detailed review of specific components of this EMP and a detailed description of individual duties.

Training will consist of on-the-job training, mentoring, self-study, classroom instruction, seminars, workshops, computer-based training and practical drills, as appropriate.

23.3 Training of third parties

EMPNG will ensure that third parties and service providers have the necessary competencies through the procurement and selection process, as outlined in OIMS System 8-1 Third Party Services.

In the case of landowner/community service providers involved in the management of erosion and sediment and invasive species (Section 13.0 and Section 15.0), EMPNG will provide training as necessary for landowner/community representatives.

24.0 DATA MANAGEMENT

Registers and data obtained from the monitoring, verification, assessment, audit and performance indicator processes described in this EMP will be managed using an electronic information management system.

The information management system acts as a repository for data relating to this EMP and is designed to handle and manipulate data as required (for example tracking and trend analysis) to facilitate reporting.

25.0 REPORTING

25.1 Internal reporting

Summary reports concerning the implementation of this EMP will be compiled periodically as necessary for the E&R Supervisor, SHE Manager or other EMPNG management.

The summary reports include qualitative and quantitative data, reporting against performance indicators, non-conformance and incident data, and other information as relevant.

25.2 External reporting

25.2.1 Reporting to the Conservation and Environment Protection Authority

Pursuant to the Environment Permit, EMPNG will submit periodic environmental reports to CEPA. The reports include qualitative and quantitative data, environmental monitoring data (sampling and analysis), non-conformance and incident data (including remedial and corrective actions), reporting against performance indicators, water extraction volumes and pre-disturbance surveys undertaken in the reporting period, and other information as relevant to this EMP.

25.2.2 Reporting to the Lender Group

Pursuant to the Common Terms Agreement, EMPNG will submit an annual PNG LNG Environmental and Social Report to the Lender Group and the IESC.

The PNG LNG Environmental and Social Reports will include qualitative and quantitative data, environmental monitoring summaries (sampling and analysis), verification, assessments and audits undertaken during the reporting period, non-conformance and incident data (including remedial and corrective actions), reporting against performance indicators, notifications made to the Lender Group, pre-disturbance surveys undertaken, and other information as relevant to this EMP.

26.0 REFERENCES

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Volume 1, The Guidelines. Sydney/Auckland: Australian Water Association/ NZ Water & Wastes Association

Esso Highlands Limited. (2009). *PNG LNG Project Environmental Impact Statement*. Report prepared by Coffey Natural Systems Pty Ltd for ExxonMobil. Brisbane: Esso Highlands Limited

IFC. (2006). *International Finance Corporation's Performance Standards on Social and Environmental Sustainability*. Washington, D.C.: IFC

IFC. (2007). *International Finance Corporation's Guidance Notes: Performance Standards on Social and Environmental Sustainability*. Washington, D.C.: IFC

IFC. (2007). *Environmental, Health, and Safety General Guidelines.* Washington, D.C.: IFC

IFC. (2007). *Environmental, Health and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities.* Washington, D.C.: IFC

IFC. (2007). *Environmental, Health and Safety Guidelines for Onshore Oil and Gas Development.* Washington, D.C.: IFC

IFC. (2007). *Environmental, Health and Safety Guidelines for Offshore Oil and Gas Development.* Washington, D.C.: IFC

IFC. (2007). *Environmental, Health and Safety Guidelines for Waste Management Facilities.* Washington, D.C.: IFC

International Organization for Standardization. (2004). *ISO 14001:2004 Environmental management systems - Requirements with guidance for use.* Genève, Switzerland: International Organization for Standardization

Monash University. (2013). *Final Report on the Archaeological Salvage Excavations at the Hides Gas Conditioning Plant.* Melbourne: Monash University

Ozone Secretariat United Nations Environment Programme. (2000). Montreal Protocol on Substances that Deplete the Ozone Layer

Secretariat of the Basel Convention. (1992). Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

Secretariat of the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. (2011). Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

TEAM Network. (2010). *Vegetation Protocol Implementation Manual, v. 1.5*. Tropical Ecology, Assessment and Monitoring Network, Science and Knowledge Division, Conservation International. Arlington: TEAM Network

The Office of Environment and Conservation. (2001). *The Environmental Code of Practice for Sanitary Landfill Sites, Papua New Guinea.* Papua New Guinea: The Office of Environment and Conservation

The Secretariat of the Stockholm Convention. (2009). Stockholm Convention on Persistent Organic Pollutants

United States Environmental Protection Agency. (2008). *Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources.* [40 CFR 60]

World Health Organization. (2006). *Air Quality Guidelines. Global Update 2005. Particulate matter, ozone, nitrogen dioxide, and sulfur dioxide*. Copenhagen: World Health Organization Regional Office for Europe

27.0 APPENDICES

Appendix 1: Environmental Impact Statement mitigation measures
Appendix 2: Summary of emissions and discharges

APPENDIX 1: ENVIRONMENTAL IMPACT STATEMENT MITIGATION MEASURES

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
Performance Standard 3: Pollution Prevention and Abatement Pollution Prevention, Resource Conservation and Energy Efficiency	M43*, M49, M180	Low mono-nitrogen oxides emissions equipment will be fitted on the turbine generators and gas compressors	Section 6.0
	M44*, M176	Diesel powered equipment will be regularly serviced and low-sulphur diesel used where practicable	Section 6.0
	M46*, M179	BTEX emissions will be treated by thermal destruction or industry good practice	Section 6.0
	M47	Regularly inspect and maintain valves, pipes and tanks, etc. to reduce fugitive volatile organic compound emissions	Section 19.0
	M168	At the HGCP, waste heat from the exhaust of the pipeline gas turbine compressors will be used to provide heat to the thermal fluid-based hot oil system	Section 6.0
	M171	Adhere to specific noise criteria that are aligned to the intent of the IFC and World Health Organization guidelines. Example: A boundary noise limit of 55 dBA Leq (day) and 45 dBA Leq (night) from noise sourced from the operation of the facilities will apply to protect the amenity of landowners (residential land use).	Section 8.0
	M174*	Notify potentially affected persons of intended high noise intensity work and its duration	Section 8.0
	M96*	Manage sewage in an appropriate manner to limit contamination and protect human health	Section 9.0
	M129*	Treat effluents to appropriate standards and allow time for sediment to settle prior to discharge	Section 9.0
	M133	Operate WWTPs in accordance with the manufacturer's specifications and comply with the conditions of discharge quality specified in the Environment Permit	Section 9.0
	M29*, M134, M135*, M149*	Treat all water and wastewater discharges as necessary to comply with the prescribed conditions for discharge quality established in the Environment Permit. Develop a contingency plan outlining actions to be taken should the discharge quality criteria not be met.	Section 9.0
	M136	Non-equipment areas at plant facilities will be graded and sloped to allow uncontaminated stormwater to drain naturally via the stormwater drains prior to routing off-site	Section 9.0
	M150	The washing of equipment, vehicles or machinery near or within watercourses will be prohibited	Section 9.0
	M159*	Site-specific surface water and stormwater management procedures will be implemented	Section 9.0
	M164*	Develop a water quality monitoring plan	Section 19.0

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
Performance Standard 3: Pollution Prevention and Abatement Hazardous Materials	M26*, M30*, M130*, M146*	Fuel and chemical storage systems shall be purpose-built, located in designated above ground areas away from watercourses, and provided with secondary containment. As appropriate, secondary containment will be designed to enable containment of 110 percent of the storage capacity of the largest container present	Section 10.0
	M99	Prohibit wash-down or fuel handling near or in streams	Section 9.0 and 10.0
	M100*	Establish appropriate procedures for fuel handling transport and storage	Section 10.0
	M101	Establish appropriate procedures for materials handling, storage and disposal	Section 10.0
	M102	Establish appropriate procedures for the storage and handling of radioactive materials	Section 11.0
	M131*	MEG slop storage tanks will be purpose-built full-containment tanks and bunded	Section 10.0
	M147*	Operational practices for vehicle/equipment refuelling, which includes the prevention of spillage and the use of spill containment and response equipment, are to be in place. To be included is the requirement for fuel delivery vehicles and equipment to contain spill kits and be routinely inspected so as to ensure the tank, pumps, pipe work and the vehicle itself are free from leaks and fit for purpose	Section 10.0
Performance Standard 3: Pollution Prevention and Abatement Emergency Preparedness and Response	M25*, M148	Vehicles and machinery are to be maintained to a high level of safety with respect to leaks. Drivers will be appropriately trained and have the required driving licence	Section 10.0
	M151	An appropriate number of staff will be trained in the handling of emergency response and spill scenarios	Section 10.0
	M27*, M209	Hydrocarbon spill prevention and response procedures will be detailed in the Oil Spill Contingency Plan and include staff training at induction to inform workers of their responsibilities under the Plan	Section 10.0 and 23.0
Performance Standard 3: Pollution Prevention and Abatement Waste	M92*	Dispose of waste to EMPNG-approved waste facilities	Section 12.0
	M95*	Establish waste management procedures to control and appropriately manage all waste	Section 12.0
	M97*, M128, M181*	Incinerate combustible waste at EMPNG-approved facilities; dispose of ash to EMPNG-approved landfills	Section 12.0
	M98*	Track all waste to be disposed or recycled	Section 12.0

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
	M103	Establish procedures for waste that comply with applicable parts of the Environmental, Health, and Safety General Guidelines (IFC, 2007) and Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007) and meet the intent of limits in Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 60] (United States Environmental Protection Agency, 2008), Subpart AAAA or CCCC as applicable	Section 6.0 and 12.0
	M132*	Treat and dispose of biological, pharmaceutical and medical wastes using appropriate technologies, including use of special containers, segregation and handling procedures	Section 12.0
Performance Standard 3: Pollution Prevention and Abatement Erosion and Sedimentation	M23*	Assess and establish erosion and sediment control requirements (particularly in relation to site preparation earthworks, road construction across watercourses, watercourse diversions, site drainage), detailing specific erosion and sediment controls to be implemented (e.g., diversion drains, sediment ponds and fabric silt curtains). The controls should limit the mobilization and dispersion of sediment into freshwater and estuarine environments	Section 13.0
	M32*	Limit erosion and dust effects of soil and spoil	Section 6.0 and 13.0
	M138*	Remove trees, debris or soil inadvertently deposited below the high water mark of watercourses where safe to do so and in a manner that reduces disturbance of the bed and banks	Section 13.0
	M140	Keep pipeline ROWs and access way alignment approaches to watercourses as close to right angles as possible to limit disturbances to the banks of watercourses, where practicable	Section 13.0
	M141*	Conduct fine-scale routing of the ROWs, access ways and spoil management areas to avoid erosion-prone areas, such as weak soils, tributary headwalls along ridges and over-steepened slopes in gorges, and reduce the number of watercourse crossings, where practicable	Section 13.0
	M153	Limit the duration of in-stream construction activities at watercourse crossings to shortest time practicable	Section 13.0
	M154	Consider the hydraulics of the watercourse in the design and construction of bridges, abutments and in-river bridge supports (where needed) and consider stability and flow disruptions	Section 13.0
	M155*	Implement industry good practice erosion and sediment control measures at watercourse crossings, as necessary	Section 13.0
	M156*	Mitigate impacts from sidecasting in steep terrain areas, for example by using fine particle size organic matting or lattice framework or similar in karst areas to trap organic matter across sidecast where practicable and implementing sediment control measures downstream of sidecast material where practicable	Section 13.0
	M157	Undertake terrain evaluation and mapping to identify past instabilities (e.g., landslides)	Section 13.0

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
	M158	River/stream crossings are to be limited in areas of high, unstable banks	Section 13.0
	M160	Management plans will be developed for all watercourse crossings to address the sensitivities of crossings on an individual watercourse basis. Plans will consider, where relevant: • watercourse diversions requirements • disturbance limits • equipment limitations • erosion control measures • fine-scale routing at crossing sites to limit disturbance of particularly large and established riparian vegetation and complex bank habitat structure • delay of clearing of banks for temporary vehicle crossing until the need for the crossing is imminent, where practicable	Section 13.0
Performance Standard 3: Pollution Prevention and Abatement Pesticide Use and Management	M80*	Use herbicides approved by EMPNG for the control of invasive weeds where this is considered the most effective form of control	Section 15.0
Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management	M1*, M54*	Establish and enforce a PNG LNG quarantine program	Section 15.0
	M2	Establish and enforce pest and weed management procedures as part of ecology, natural habitat and biodiversity plans	Section 15.0
	M4*, M64*	Limit the clearing of riparian vegetation to the width required to safely accommodate ROW, access ways and watercourse crossings. Reduce number of watercourse crossings to limit riparian soil erosion and sediment delivery to watercourses	Section 13.0
	M6*, M10*, M81, M244*	Prohibit works from exceeding the approved disturbance width and construction boundaries. Limit the movement of employees and contractors to within project-defined areas and designated traffic and transport routes or locations. Prohibit machinery from leaving the approved ROW or access ways to unnecessarily clear additional forest	Section 14.0 and 16.0
	M7*, M18*, M75*	Reduce the period surfaces are exposed, and reinstate areas no longer required for construction or support services. Where practicable, disturbed areas will be returned to former landforms and vegetation of exposed areas will occur as soon as practicable once construction activities are completed in any particular location, taking into account the nature of subsequent activities that will be undertaken at the same sites as well as agreed end uses. Areas prone to erosion will receive particular attention	Section 14.0

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
	M9, M57, M58	Prohibit disturbance/harassment of wildlife, hunting of fauna, gathering of plants or bush foods, collection of firewood or possession of wildlife products by EMPNG workers or contractors while working, travelling in EMPNG vehicles, and residing in PNG LNG field accommodation. Implement appropriate inductions and education to encourage staff to comply with regulations. Implement appropriate inductions to encourage staff to comply with hunting and collecting regulations.	Section 16.0
	M11*, M17	Develop site-specific reinstatement plans based on land systems or equivalent and address ground preparation activities, interim and permanent soil erosion and sediment management issues, and approaches to revegetation (natural regeneration versus intervention). Use cleared vegetation where practicable for dust control and reinstatement.	Section 14.0
	M14*, M15, M78, M79*, M86*	Retain large trees (greater than 1 m diameter breast height) when they are situated along worksite borders, or where works can be undertaken around these trees. Exceptions to be approved by the Company. Where trees are to be felled by hand, use directional felling for trees greater than 50 cm diameter breast height so they land in natural slots between standing trees or along the axis of tracks to reduce damage to the remaining forest, where practicable. Where tree removal is necessary for linear construction (roadways, ROW), limit damage to surrounding habitats by felling trees away from existing stands where practicable taking into account the value of the areas into which the trees are being felled, and safety factors. Limit the scraping of standing tree trunks by machinery as far as practicable	Section 16.0
	M22	At new or improved road crossings, maintain connectivity of wet season flow in watercourses, avoiding the creation of high-velocity 'chutes' or step-down cascades in order to enable fish migration	Section 13.0
	M50	Prohibit transportation of live animals, plants or seeds to the Hides Ridge area	Section 15.0
	M53*	Prohibit establishment of gardens with introduced plants (unless approved by EMPNG for landscaping purposes) and introduction of exotic plants or animals by PNG LNG workers and contractors	Section 15.0
	M56*, M59*	Implement speed limits on EMPNG-controlled roads and access ways to reduce vehicle collisions with wildlife. Patrol open trench to rescue and record fauna that fall into the open pipeline trench	Section 16.0
	M65*, M112	Locate ROW, access ways and facilities within or adjacent to existing disturbed areas, where practicable. Reduce the number of special vehicle parks, and place in areas of existing disturbance, where practicable	Section 16.0
	M68*, M69*	Reduce the number of quarries developed by using previously worked (old) quarries, where practicable, and using limestone generated by construction activities for road base material. Source quarry and aggregate material only from quarries approved by EMPNG.	Section 11.0

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
	M72	Promote the reuse of timber felled during ROW, roadways, support infrastructure sites, and facility site clearing for project uses to the extent practical	Section 11.0
	M74*, M119*, M121, M122*, M123*, M124*	Where practicable, utilize land-clearing techniques that preserve the rootstock of removed vegetation in the ground. Cleared vegetation and topsoil will be conserved and stockpiled in a manner that facilitates, respreading or salvaging, e.g. place on one side of cleared areas. Topsoil, mulch and discarded vegetation debris (including natural seed stock) will be spread on reclaimed or rehabilitated disturbed land surfaces to facilitate natural revegetation. Where appropriate, undertake active works to re-establish vegetation in areas that may be slow or difficult to regenerate naturally, difficult to stabilise or prone to erosion	Section 14.0
	M76*	The standard pipeline ROW width for the PNG LNG Project is 30 metres. The pipeline ROW disturbance area should be limited to a 5-metre wide buffer either side of the standard pipeline ROW, where practicable. Following construction the ROW will be allowed to naturally regenerate except for 15 metres, to allow for a gap in the canopy for aerial surveillance of the pipeline. If there is a requirement to exceed the ROW design width, the contractor shall seek approval through a formal procedure from EMPNG	Section 14.0
	M77*	The design criteria for ROW width on Hides Ridge is 18 metres. During production, the ROW will be allowed to regenerate except for a 10-metre wide access road required for ongoing drilling and maintenance access	Section 14.0
	M87*	Avoid where possible, caves with bat colonies and display grounds of bird-of-paradise and bower birds	Section 16.0
	M88*	Prevent potential damage by third party activities (e.g. industrial logging) that have accessed EMPNG roads and infrastructure by vehicle between Kopi and the HGCP, following completion of construction	Section 17.0
	M89*	Make the new EMPNG roadways and all pipeline ROW's between the Omati River Landfall and the Kopi deviation impassable at the end of PNG LNG construction, and those on Hides Ridge will be made impassable at the end of PNG LNG	Section 17.0
	M90*	Control vehicle access to Hides Ridge and implement a system to track vehicle access for the duration of production	Section 17.0
	M104*	Direct lighting at facilities to reduce illumination of the surrounding forest to reduce disturbance to nocturnal fauna, where security allows	Section 6.0
	M106*	Conduct surveys along ROW, facility sites and supporting infrastructure of sensitive features and develop appropriate mitigation measures	Section 16.0

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
	M107, M108	Establish cave management protocols to restrict access to caves with bats and prohibit unnecessary disturbance of bat colonies	Section 16.0
	M109*	Prohibit or implement controlled blasting measures at worksites located within 100m of known caves with bat colonies. Quarry sites will not be located near caves with colonies containing protected bat species	Section 11.0 and 16.0
	M111	Control speed limits via posted speed limit signs and keep vehicles to marked trafficable areas	Section 16.0
	M113*	Require that in-country timber is acquired from legal EMPNG approved sources	Section 11.0
	M117*	Maintain vehicle washdown facilities, contain the material washed from machinery/equipment for appropriate disposal, contain and treat washdown water as necessary	Section 15.0
	M118*	Maintain procedures to control invasive species and plant pathogens. Weed and exotic pest control management procedures that identify foreign and invasive weed and exotic pest threats will be implemented in the invasive species and plant pathogens monitoring procedure and appropriate control measures will be taken	Section 15.0
	M137	Water taken from watercourses or groundwater will meet Environment Permit conditions	Section 11.0
	M139*	Stabilise disturbed batter slopes and cleared banks to facilitate reinstatement	Section 14.0
	M152	Conduct post-construction inspections along the ROW within the catchment of Lake Kutubu including: checking for problematic erosion areas and implementing remedial works as appropriate, inspecting ditches and culverts and removing accumulated debris, where required and reviewing water quality monitoring results for advance warning of deteriorated water quality due to increased suspended sediment loading	Section 13.0
	M162, M165*	The construction and rehabilitation of the ROW in the Omati River swamp area will be managed to maintain natural hydrologic flows and connectivity in the surrounding area. Monitoring of vegetation condition in the vicinity of the ROW will be conducted to assess the need for post construction remedial works in this area	Section 13.0
Performance Standard 8: Cultural Heritage	M225*	Conduct Cultural Heritage Survey by systematically recording and mapping cultural heritage sites in all areas designated for disturbance during construction, including any areas that were characterised but not surveyed for the PNG LNG EIS	Section 18.0
	M226	Consult and liaise with the PNG National Museum and Art Gallery as required for surveys and check all surveys are supervised by appropriately-qualified archaeologists and cultural heritage specialists. Liaise with the National Cultural Commission through the PNG National Museum and Art Gallery as appropriate	Section 18.0

PERFORMANCE STANDARD THEME	MITIGATION MEASURE REFERENCE	MITIGATION MEASURE	EMP SECTION REFERENCE
	M227*, M230, M241*	Develop and implement a cultural heritage management plan in consultation with the National Museum and Art Gallery, archaeologists and cultural heritage specialists	Section 18.0
	M229	Conduct further research of appropriate archives as part of site pre-construction surveys, where relevant and required	Section 18.0
	M232*, M238*	Engage appropriately-qualified archaeologists and cultural heritage specialists to coordinate and direct salvage of known sites prior to disturbance, in consultation with the PNG National Museum and Art Gallery, as required	Section 18.0
	M233*	For significant sites encountered during construction, consult with PNG National Museum and Art Gallery as described in chance finds protocol	Section 18.0
	M239*	Periodically monitor cultural sites within the vicinity of pipelines and facilities to ensure EMPNG personnel are not disturbing these sites	Section 18.0
*Note: The language of some measures has been revised since the PNG LNG EIS to better reflect actual circumstances and provide greater clarity.			

APPENDIX 2: SUMMARY OF EMISSIONS AND DISCHARGES

SUMMARY OF EMISSIONS TO AIR						
LOCATION	**SOURCE** NOTE 1	**NATURE**	**POLLUTANTS** NOTE 2	**GUIDELINE**		**MONITORING**
HGCP	Gas turbine compressors	Continuous	Oxides of nitrogen	25 ppm NOTE 3		NOTE 4
	Main power generators			42 ppm NOTE 3		
	MEGVG incinerator		BTEX	N/A		N/A
	Low pressure flare (purge and pilot gas)		Oxides of nitrogen	N/A		N/A
	High pressure flare (purge and pilot gas)		Oxides of nitrogen	N/A		N/A
	Essential services generators	Intermittent	Oxides of nitrogen, carbon monoxide, sulphur dioxide	N/A		N/A
	Diesel firewater pump engine					
	Industrial waste incinerator		Waste dependent NOTE 5	PM	70 mg/m^3 NOTE 6	NOTE 4
				Carbon monoxide	157 ppm	
				Oxides of nitrogen	388 ppm	
				Oxides of sulphur	20 ppm	
				Hydrogen chloride	62 ppm	
				Cadmium	0.004 mg/m^3	
				Lead	0.04 mg/m^3	
				Mercury	0.47 mg/m^3	
				Dioxin/furan	0.41 ng/m^3	
				Opacity	10 percent	
HWMF	Incinerator					

SUMMARY OF EMISSIONS TO AIR					
LOCATION	**SOURCE** NOTE 1	**NATURE**	**POLLUTANTS** NOTE 2	**GUIDELINE**	**MONITORING**
	Diesel engine generators	Continuous	Oxides of nitrogen, carbon monoxide, sulphur dioxide	N/A	N/A
HWVF	Diesel engine generators				
Komo Airfield	Diesel engine generators				
	Essential services generators	Intermittent			
	Firewater pump diesel engines				
AGIs NOTE 7	Diesel engine generators	Continuous (day)			
Moro B Camp	Diesel engine generators	Continuous			

SUMMARY OF DISCHARGES TO WATER					
DISCHARGE TYPE	**SOURCE**	**NATURE**	**POLLUTANTS AND GUIDELINE VALUES** NOTE 8		**MONITORING**
Stormwater NOTE 9	HGCP HWMF Komo Airfield Above Ground Facilities	Intermittent	pH	6.5 – 9 (pH units)	Periodic in-situ sampling
			Turbidity	No alteration greater than 25 NTU or no change of more than 10 percent above background levels at any particular time (whichever is greater)	
			Dissolved oxygen	Not less than 6 mg/l or no change of more than 10 percent below background levels at the receiving environment (whichever is smaller)	
			Total Suspended Solids	50 mg/l or no change of more than 10 percent above background levels at the receiving environment (whichever is greater)	
			Oil and grease	No visible film	
Wastewater Treatment Plant NOTE 10	HGCP HWMF Sludge	Intermittent	pH	6.5 – 9 (pH units)	Periodic in-situ sampling
			Biological oxygen demand	25 mg/l	
			Chemical oxygen demand	125 mg/l	

SUMMARY OF DISCHARGES TO WATER					
DISCHARGE TYPE	**SOURCE**	**NATURE**	**POLLUTANTS AND GUIDELINE VALUES** NOTE 8		**MONITORING**
	Dewatering System Komo Airfield, Moro B Camp		Ammonia-nitrogen	Dependent on pH and temperature (Table 9-5)	
			Total Suspended Solids	50 mg/L	
			Oil and grease	10 mg/l	
			Faecal contamination risk	Faecal coliform: Not to exceed 200 colonies per 100 ml **OR** Not to exceed medium faecal contamination risk (refer to Table 9-6 and Table 9-7). **OR** Residual chlorine: as close as possible to 1 mg/l	
Process NOTE 11, NOTE 12	HGCP	Intermittent	pH	6.5 – 9 (pH units)	Periodic in-situ sampling
			Temperature	No alteration greater than 2 degrees Celsius	
			Dissolved oxygen	Not less than 6 mg/l or no change of more than 10 percent below background levels at any particular time (whichever is smaller)	
			Chemical oxygen demand	125 mg/l	
			Biological oxygen demand	25 mg/l	
			Sulphate as $SO4^{2-}$	400 mg/l	
			Sulphide as HS-	0.002 mg/l	
			Ammonia-nitrogen	Dependent on pH and temperature (Table 9-5)	
			Total suspended solids	50 mg/l	
			Nitrate	45 mg/l	
			Potassium	5.0 mg/l	
			Barium	1.0 mg/l	
			Boron	1.0 mg/l	
			Cadmium	0.01 mg/l	

SUMMARY OF DISCHARGES TO WATER					
DISCHARGE TYPE	**SOURCE**	**NATURE**	**POLLUTANTS AND GUIDELINE VALUES** NOTE 8		**MONITORING**
			Chromium (as hexavalent)	0.05 mg/l	
			Cobalt	Limit of detection	
			Copper	1.0 mg/l	
			Iron	1.0 mg/l	
			Lead	0.005 mg/l	
			Manganese	0.5 mg/l	
			Mercury	0.0002 mg/l	
			Nickel	1.0 mg/l	
			Selenium	0.01 mg/l	
			Silver	0.05 mg/l	
			Tin	0.5 mg/l	
			Zinc	5.0 mg/l	
			Glycol^	0.33 mg/l	
			Oil and grease	10 mg/l	
			Phenol^	0.085 mg/l	
			2-chlorophenol^	0.340 mg/l	
			4-chlorophenol^	0.160 mg/l	
			2,4-dichlorophenol^	0.120 mg/l	
			2,4,6-trichlorophenol^	0.003 mg/l	
			2,3,4,6-tetrachlorophenol^	0.010 mg/l	
			Pentachlorophenol^	0.0036 mg/l	
Treated leachate	HWMF	Intermittent	As for process wastewater above (NOTE 4), plus:		Periodic in-situ sampling
			Turbidity	No alteration greater than 25 NTU or <10 percent change from background levels at any particular time	

SUMMARY OF DISCHARGES TO WATER					
DISCHARGE TYPE	**SOURCE**	**NATURE**	**POLLUTANTS AND GUIDELINE VALUES** NOTE 8		**MONITORING**
			Potassium	50 mg/l NOTE 13	
			Faecal contamination risk	Faecal coliform: Not to exceed 200 colonies per 100 ml **OR** Not to exceed medium faecal contamination risk (refer to Table 9-6 and Table 9-7).	

Note 1: This table does not include emission sources associated with vents or pressure relief devices such as pressure control valves or pressure vacuum safety valves at HGCP, for details refer to Section 6.0.

Note 2: Includes only the key pollutants of relevance.

Note 3: Based on Environmental, Health, and Safety General Guidelines (IFC, 2007), Table 1.1.2 - Small Combustion Facilities Emissions Guidelines.

Note 4: Stack testing will be undertaken twice yearly for the first two years of operation. Thereafter, for each emission source, monitoring frequency and scope can be reduced such that:

- Stack testing is conducted every three years if monitoring results meet the required criteria; or annually if not until the required criteria is met; and
- A representative selection of air emission sources is included in each stack testing program.

Note 5: Incinerator emissions will depend upon the composition of the waste incinerated during each burn cycle.

Note 6: All incinerator parameters based on Title 40 – Protection of Environment, Part 60 – Standard of Performance for New Stationary Sources [40 CFR 60] (United States Environmental Protection Agency, 2008), Subpart CCCC (Standards of Performance for Commercial and Industrial Solid Waste Incineration Units), including threshold for applicability relating to throughput, as referenced in Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007).

Note 7: All MLVs, Kopi Scraper Station and the CP stations.

Note 8: Annex 2 of the Environment Permit, based on *Environment (Water Quality Criteria) Regulation 2002*, Water Quality Criteria for Aquatic Life Protection.

Note 9: The criteria shown are extracted from the Schedule 2 of the *Environment (Water Quality Criteria) Regulation 2002* as relevant to the discharge of stormwater from uncontaminated areas.

Note 10: The criteria shown are extracted from the Schedule 2 of the *Environment (Water Quality Criteria) Regulation 2002* as relevant to the discharge of WWTPs.

Note 11: Metal concentrations are for dissolved substances (passing through a nominal 0.45 µm medium). Cobalt (as 'limit of detectability') uses graphite furnace atomic absorption spectrometry.

Note 12: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000). Trigger values adopted for a slightly to moderately disturbed aquatic ecosystem with a high conservation value (99 percent species level protection).

Note 13: Source: Site-specific criteria approved by CEPA in their letter dated 24 November 2016 (reference: PM-GN3-2016-10537-1).