Environmental Assessment Document

Project Number: 41504-025

August 2016

PNG: Town Electrification Investment Program, Tranche 2

Initial Environmental Examination

Prepared by Papua New Guinea Power Limited for the Asian Development Bank.

ABBREVIATIONS

ADB	-	Asian Development Bank
AP	-	Affected Person
CAC	-	Community Advisory Committee
CEMP	-	Contractor's Environmental Management Plan
CEPA	-	Conservation and Environment Protection Authority
CPP	-	Consultation and Participation Plan
DDR	-	Due Diligence Review
DEC	-	Department of Environment and Conservation
DSC	-	Design and Supervision Consultant
ECOP	-	Environment Code of Practice
EHP	-	Eastern Highlands Province
EIA	-	Environmental Impact Assessment
EIS	-	Environmental Impact Statement
ELCOM	-	PNG Electricity Commision
EMP	-	Environmental Management Plan
ENB	-	East New Britain Province
EO	-	Environment Officer
EP	-	Environment Permit
GRM	-	Grievance Redress Mechanism
HP	-	Hydropower project
HSP	-	Health and Safety Plan
IEE	-	Initial Environmental Examination
IES	-	International environmental specialist
kW	-	kilowatt
L/s	-	litres per second
MSMP	-	Materials and Spoils Management Plan
NGO	-	Non-governmental organization
PH	-	Permit Holder
PMU	-	Project Management Unit
PNG	-	Papua New Guinea
PPE	-	Personal protective equipment
PPL	-	PNG Power Ltd
PPTA	-	Project Preparatory Technical Assistance
SPS	-	Safeguard Policy Statement (June 2009)
STI	-	Sexually Transmitted Infections
TEIP	-	Town Electrification Investment Program
UNDP	-	United Nations Development Program
WMP	-	Waste Management Plan
WUP	-	Water Use Permit
WNB	-	West New Britain Province
YTD	-	Yonki Toe of Dam

CONTENTS

EXECUTIVE SUMMARY

Three initial environmental examinations (IEE) for the Town Electrification Investment Program (TEIP) Tranche 1 covering Divune and Ramazon Hydro Power Projects in Oro (Northern) province and Autonomous Region of Bougainville (ABG) and Bialla – Kimbe Transmission Line have been completed. This IEE covers TEIP Tranche 2 components (subprojects) which include (i) Yonki Toe of Dam (YTD) Hydropower Project (HP) provision of surge chamber and repairs to penstocks, (ii) Lake Hargy HP upgrade (refurbishment) (iii) Warangoi HP refurbishment.

It is noted that Ramazon HP was transferred from Tranche 1 to Tranche 2 and review of the Tranche 1 IEE for Ramazon was undertaken and reported separately in Review of Feasibility Study of Ramazon HP. The review of Ramazon IEE and EMP concluded that the IEE and EMP including associated documentation in the tender document prepared under Tranche 1 remains valid and there is no need for any additional project preparation environmental due diligence required for Ramazon HP under Tranche 2.

The YTD surge chamber involves construction of a surge tank adjacent to the existing penstock. Penstock repairs involve replacing damaged sections and repairs to internal and exterior walls of penstocks. Lake Hargy HP upgrade involves refurbishment of the powerhouse, installation of a hoisting mechanism to lift the penstock gates, refurbishment of the intake gate, and grouting of joints in the headrace canal. Warangoi HP refurbishment involves river training works to reduce river migration and bank erosion, repairing spillway gates and sediment flushing system and refurbishment works in the powerhouse area including replacement of hydromechanical, mechanical and electrical equipment.

The IEE report has reviewed the environmental impacts associated with three Tranche 2 subprojects including undertaking of an environmental Due Diligence Review of existing operations and has developed three separate environmental management plans (EMPs) to address these activities.

The IEE concludes that the potential environmental impacts arising from design, construction, operation and maintenance of Yonki Toe of Dam HP Surge Chamber and penstock repairs, Lake Hargy HP Upgrade and Warangoi HP Refurbishment will be minor, localized and acceptable provided that the mitigation measures set out in the EMPs are incorporated into the design and implemented properly. Key findings are summarized below:

- The project involves refurbishment of two existing small hydropower projects and upgrading a third hydropower project with the provision of a surge tank along with repairs to penstocks. All works proposed are within the footprint of the existing schemes' boundaries.
- The only civil works to be undertaken is the construction of river bank protection works at the Warangoi headworks and excavation for the foundations of a surge tank at Yonki Toe of dam. All other works are associated with refurbishment of hydro-mechanical or electro-mechanical components of the three subprojects.
- The potential loss of an insignificant amount of highly modified habitat of low ecological value within the existing hydropower site boundaries of Yonki Toe of Dam and Warangoi HP and impact on terrestrial wildlife due to the project will be insignificant. Loss of habitat can be further minimized by reducing the vegetation clearance for the civil works components.
- Following completion of refurbishment works there will be no change to the existing operations of the three subprojects other than improved operational efficiency and improved environmental health and safety facilities and processes.

- Nearby communities consulted are happy for the project to be implemented. and
- Appropriate climate change adaptation and resilience needs to be incorporated into the design of refurbishment structures including suitable erosion protection to prevent scour around the Warangoi intake structures and enhancement armouring to the proposed river bank protection works at Warangoi.

An audit of the existing facilities and operations at each of the subprojects identified a number of key areas where environmental improvements are required to bring operations in line with ADB SPS and international standards. These and associated corrective actions recommended for PPL to implement to bring operations in line with SPS and international standards are as follows:

All subprojects

- PPL to make a formal request to CEPA using prescribed forms to obtain clarification regarding requirements for obtaining new or amended Environment Permits for the subprojects in light of refurbishment and upgrading works and taking account of any new EP requirements and procedures under the CEPA Act 2014.

Yonki Toe of Dam HP

- PPL to cease disposing of used oil to the ground at the Ramu 1 workshop and fuel/oil storage facility and establish a proper used oil storage facility and associated operational procedures for waste oil disposal to comply with the DEC Environment Code of Practice for Vehicle Machinery and Petroleum (Hydrocarbons) Storage/Resale/Usage Site DEC 1997.
- PPL to remove all dumped waste oil and associated contaminated soil from the site, decontaminate the area and dispose of the waste oil/ contaminated soil at an appropriate hazardous materials disposal facility
- PPL to prepare a waste management plan and environmental monitoring plan for approval of CEPA in accordance with the current EP (or amended EP if required).
- PPL to commence annual environmental performance monitoring as required under the EP (or amended EP if required)
- PPL to commence environmental performance reporting as required under the EP (or amended EP if required)

Lake Hargy HP and Warangoi HP

- PPL to introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at an authorized site and prevent burning of waste in line with the DEC environmental codes of practice.
- PPL to minimize impacts from incorrect storage and disposal of hazardous substances in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage.
- PPL to stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kimbe maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use.
- PPL to prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers.
- PPL to prepare and implement a Health and Safety Plan for the operation of Lake Hargy hydropower scheme. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines.

- PPL to ensure that workforce training for all workers will include environment, safety and environmental hygiene.
- PPL to maintain clean toilet facilities by cleaning daily and keeping flush toilets well maintained to allow effective operation.
- PPL to maintain consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public.
- It is recommended that upgrading of the existing transformer bays to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works

With these recommendations and corrective actions implemented the environmental impacts of the Tranche 2 subprojects current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards.

EMPs for each subproject have been prepared which will be updated based on detailed design and implemented during all phases of the Tranche 2 project. The EMPs identify potential environmental impacts arising from the project along with a corresponding schedule of mitigation measures to ensure potential impacts are maintained at insignificant levels and that international best practice is applied. They also include recommendations and corrective actions in respect of the due diligence review.

This IEE, including the subproject EMPs is considered sufficient to meet ADB's and government environmental safeguard requirements in respect of the Tranche 2 subprojects for TEIP. No further or additional impact assessment is considered necessary.

I. INTRODUCTION

The Government of Papua New Guinea (the government) has requested the Asian Development Bank (ADB) provide financing for Tranche 2 of the Town Electrification Investment Project (TEIP). Tranche 2 comprises four subproject components as follows (i) provision of a surge chamber at Yonki Toe of Dam (YTD) Hydropower Project (HP) located in Central Province, (ii) Upgrade (refurbishment) of Lake Hargy HP in West New Britain Province (iii) Refurbishment of Warangoi HP in East New Britain Province and iv) Construction of Ramazon HP in the Autonomous Region of Bougainville.

The executing agency for the TEIP is PNG Power Limited (PPL). It is also the implementing agency through a project management unit (PMU). PNG Power Ltd is a State Owned Enterprise (SOE) through the Independent Public Business Corporation (IPBC) that is responsible for the generation and distribution of electricity throughout PNG.

This initial environmental examination (IEE) presents the environmental assessment of three of TEIP Tranche 2 subprojects i) YTD HP Surge Chamber and repair of damaged penstocks, ii) Lake Hargy HP Upgrade and iii) Warangoi HP Refurbishment.[1] The IEE has been carried out in compliance with the ADB Safeguard Policy Statement 2009 (SPS).

The main purpose of the IEE is to assess the location and upgrading/refurbishment work of the three subprojects and undertake an environmental due diligence review of existing operations to ensure compliance with ADB Safeguard Policy Statement (SPS). The IEE has been submitted to the ADB by PNG Power Ltd. A separate report to meet government environmental requirements in accordance with the Environment Act 2000 and associated regulatory tools will be submitted to the Conservation and Environment Protection Authority (CEPA)[2] for evaluation and issuance of relevant environmental permits.

A. Overview

Approximately 90% of the population of PNG live in highly dispersed and culturally diverse rural settlements that are isolated from each other by rugged topography. While PNG has adequate hydropower resources the development and distribution of power from these resources is difficult due to the scattered population, low population densities, the rugged topography and low ability to pay. Electricity grids that do exist are isolated and clustered around the main population centres. Small provincial and district centres have traditionally relied on diesel generation. However, with increasing fuel prices and high maintenance costs many of these systems are now in need of replacement. PPL is now considering replacing or reducing reliance on these systems with hydropower generation.

B. Objectives and Scope of the IEE

The objectives of the IEE are to:

- Assess the location, design, construction and operation activities proposed at the three subproject sites to identify and evaluate any potential impacts, and determine their significance;
- Undertake an environmental due diligence review of the existing operations at the three subproject sites and identify any actions required to ensure compliance with ADB SPS;

[1] Ramazon HP was transferred from Tranche 1 to Tranche 2 and review of the Tranche 1 IEE for Ramazon was undertaken and reported separately in Review of Feasibility Study of Ramazon HP. The review of Ramazon IEE and EMP concluded that the IEE and EMP including associated documentation in the tender document prepared under Tranche 1 remains valid and there is no need for any additional project preparation environmental due diligence required for Ramazon HP under Tranche 2

[2] Formerly the Department of Environment and Conservation. CEPA is in operation from 2015 onwards.

- Propose appropriate mitigation and monitoring measures that can be incorporated into environmental management plans (EMPs) for each subproject that will avoid or minimize adverse impacts so that residual impacts are reduced to acceptable levels.

C. Report Structure

The report structure follows the format outlined in Annex to Appendix 1 of the SPS. The IEE consists of an executive summary and seven sections including: introduction; policy, and legal framework; description of the project; description of the environment (baseline data); environmental impacts and mitigation measures; information disclosure and consultation, and participation; EMP including grievance redress mechanism; and, conclusions and recommendations. The EMP matrices for the three subprojects along with Due Diligence Reviews are presented in Annexes 1 and 2.

II. POLICY AND LEGAL FRAMEWORK

The implementation of the project will be governed by the environmental laws and regulations of the Government of Papua New Guinea and the safeguard policies of the ADB.

D. PNG Requirements

Environmental impact assessment and management in PNG is provided for under the Environment Act 2000 and its accompanying regulatory instruments including the Environment (Prescribed Activities Regulation 2002 and the Guideline for Conduct of Environmental Impact Assessment and Preparation of an Environmental Impact Statement 2004. The Act and regulations is administered by the Conservation and Environment Protection Authority (CEPA) formerly the Department of Environment and Conservation (DEC).

The Environment Act 2000 caters for the sustainable management of the biological and physical components of the land, air and water resources of the country. Other related legislation administered by CEPA includes; the Fauna (Protection and Control) Act (1966) the Conservation Areas Act (1978), the International (Fauna and Flora) Trade Act (1978), the Crocodile Trade (Protection) Act (1978) and the National Parks Act (1984).

The Environment (Prescribed Activities) Regulation 2002 categorizes projects as "Prescribed Activities" in two schedules according to the anticipated potential environmental impact. Schedule 1 consists of Level 2 activities that are subdivided into two categories (Category A and B). Category B has 13 sub-categories with sub-category 10 addressing Energy Production. Item 10.1 in this sub-category includes Operation of hydroelectric plants with a capacity of more than 2 MW.

Additional Information for Schedule 1 Environment Permit Application Form, 2014: According to amended guidelines of CEPA for existing facilities a Permit Application is required to be completed for each of the Tranche 2 subprojects[3] and submitted to CEPA for its assessment. At this stage, the Tranche 2 subprojects fall into a level 1 activity requiring an Environmental Management Plan (EMP) only. PPL will be required to submit an Environmental Permit Application for CEPA to assess. The projects are existing projects with expired Permits and water use permits issued by the water resource department back in the 1980s and CEPA has now taken responsibilility over environment permiting of all projects. PPL has to apply for an amended permit to meet the current permit requiremnts and format.

[3] Henceforth in this report the IEE for Tranche 2 subprojects refers to i) Yonki Toe of Dam HP Surge Chamber, ii) Lake Hargy HP Upgrade and iii) Warangoi HP Refurbishment. The IEE prepared for Ramazon HP during Tranche 1 has been reviewed and is considered sufficient to meet ADB SPS and Government of New Guinea requirements and is not covered in this report.

Following approval of the application, CEPA will issue an Ammended Environmental Permit (EP). A project cannot proceed until the EP or amended EP has been granted.

The CEPA is responsible for the administration and enforcement of the Environment Act 2000 and its regulations. As the government's environmental management agency, the mission statement of CEPA is: To ensure PNG's natural resources are managed to sustain environmental quality, human well-being and support improved standards of living. The department consists of three divisions: Environment Protection which is responsible for environmental approvals, Sustainable Environment Management and Policy Coordination and Evaluation. The current organisation structure consists of about 200 positions and about 170 are currently occupied.

CEPA operates at the national level from its office based in Port Moresby. It does not have offices and personnel in the provinces. As part of the national government's decentralisation policy, CEPA has to work in close consultation with the various provincial governments through the respective provincial administrations to ensure implementation of environmental legislation at the provincial level. Certain environmental management and monitoring functions are delegated to provincial administrations if and when they have the resources and capacity to conduct these activities.

E. Other PNG Legislation

Other PNG legislations relevant to the project;

- The Forestry Act, 1991. The main objective of the Forestry Act is to manage, develop and protect the Nation's forest resources and environment in such a way as to conserve and renew them as an asset for succeeding generations.
- The Employment Act, 1978. An act relating to the employment of nationals and non-citizens. The act covers recruitment, conditions of employment as well as health and safety aspects
- The National Cultural Property (Preservation) Act 1965. An Act relating to the preservation and protection of objects of cultural or historical importance to PNG
- Road development, felling of trees, waste disposal, etc should abide by the PNG Logging Code of Practice and the Department of Works and Supply Roads and Bridges Design Specification.

F. ADB Safeguards Policy

The ADB Safeguard Policy Statement 2009 (SPS) has the objectives to (i) avoid adverse impacts of projects on the environment and affected people; (ii) where possible; minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. The environment safeguard requires due diligence which entails addressing environmental concerns, if any, of a proposed activity in the initial stages of project preparation.

The SPS categorizes potential projects or activities into categories of impact (A, B or C) to determine the level of environmental assessment required to address the potential impacts. The Project is categorized as environment Category B because potential adverse environmental impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed readily. Accordingly this IEE has been prepared as the requisite level of assessment to address the potential impacts in line with the SPS.

G. International Agreements

PNG is a signatory to the following international agreements with environment-conservation implications:

- International Plant Protection Convention, Rome 1951
- International Convention for the Prevention of Pollution of the Sea by Oil, London 1954
- Plant Protection Agreement for the South East Asia and Pacific Region, Rome 1956
- International Convention on Civil Liability for Oil Pollution Damage, Brussels 1969
- International Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, London, Mexico City, Moscow 1972.
- International Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington 1973 (CITES Treaty)
- Convention on the Conservation of Nature in the South Pacific, Apia 1976
- International Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques, New York 1976
- United Nations Convention on the Law of the Sea, Montego Bay 1982
- International Convention for the Protection of the Natural Resources and Environment of the South Pacific, 1986 (SPREP Convention)
- International Convention on Biological Diversity, Rio de Janeiro 1992.

III. DESCRIPTION OF THE PROJECT

A. Project Components and Location

The Tranche 2 sub-projects covered in this IEE include (i) provision of a surge chamber along with repairs to damaged penstocks at Yonki Toe of Dam (YTD) Hydropower Project (HP) located in Central Province, (ii) Upgrade (refurbishment) of Lake Hargy HP in West New Britain Province and (iii) Refurbishment of Warangoi HP in East New Britain Province. The location of the subproject components is shown on Figure 1 and a description of the proposed works for each component is described below.

Figure 1 Location of the Sub-projects

1. Yonki Toe of Dam

The Yonki Dam and Yonki TOD are located in the Eastern Highlands Province. The powerhouse as well as the dam is located in the Arona Valley and adjacent of the township of Yonki. The site is approximately 180 kilometres and 3 hours' drive from Lae Town.

8. The Yonki Dam was constructed in 1991 to impound Ramu River and provide water storage for Ramu 1 Hydropower Project, which is located about 2.5 km downstream of the dam. The construction of the Yonki Toe-of-Dam (YTOD) Hydropower Project commenced in 2007 and was completed in 2013. It is located below the Yonki Dam and is the first scheme in Ramu cascade. YTOD has an installed capacity of 18 MW with two vertical-shaft Francis turbines, which utilizes a rated head of 43 m and a rated discharge of 48.8 m^3/s. The project has encountered several problems since April 2011, two years before the commissioning of the YTOD Power Station. The main cause of this is the hydraulic transient.

10. Because of the hydraulic transient issues of the YTOD, several studies and measurements have been carried out to propose the option of having a surge tank to control the pressure rise of the water conveying system during plant trip and accidental closure of the waterways. The YTOD Power Station has also encountered generator cooling system problem.

In addition, to the provision of a surge tank, seven sections of damaged penstock will be replaced along with localised repair work on the exterior and interior walls of the penstock.

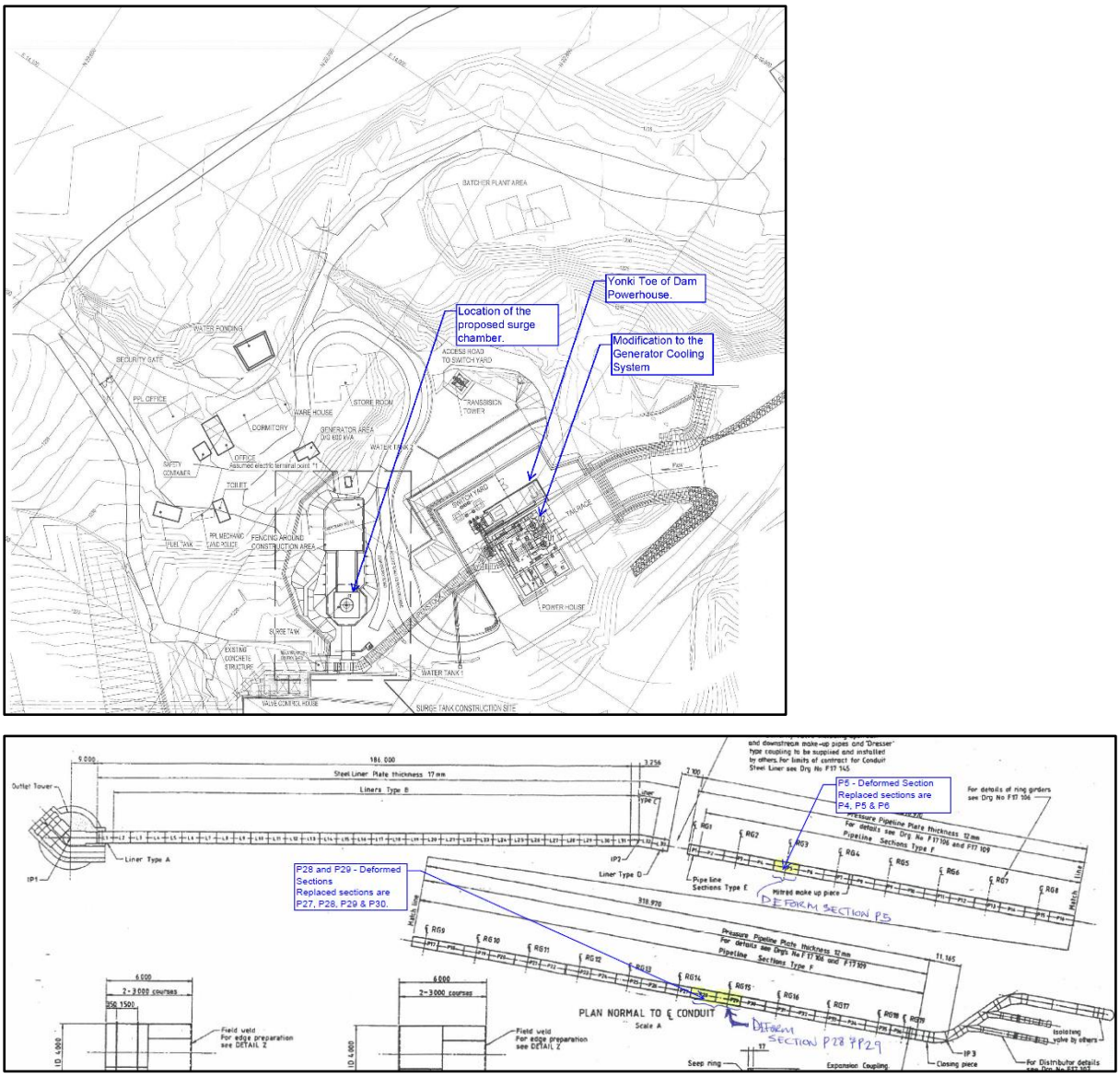


Figure 2 Yonki Toe of Dam Work

The proposed work for the project involves:

- Construction of a Surge Chamber and the associated foundation work to address the transient pressure rise;
- Modification of the cooling sytem of the generator located in the powerhouse to ensure it adequately controls the temperatue rise in the generator;
- Replacement of deformed penstock sections (drawing attached)
- Repair work on the penstock exterior and interior walls

The proposed civil works for the surge tank works will involve excavation and casting concrete foundation supported on piles and structural works, all of which will be done with manual labour and use of powered mechanical equipment including a mobile crane and trucks transporting equipment to site. The penstock replacement work would consist of cutting out damaged sections, transporting them out, transporting in cut pieces for the new section and welding in-situ. The work will be undertaken within the existing cavern of the penstock pipe. No civil works is required. The repair work whilst yet to be fully defined (subject to full inspection) is expected to involve localised application of corrosion protection

painting on the outside and localised repair of penstock interior with filler material where there is visible damage.

All work will be confined to the existing project area.

2. Lake Hargy HP Refurbishment

Lake Hargy Hydropower Project is located in Bialla in West New Britain Province, 21 km east of Bialla.Township. It was constructed in the 80's and commissioned in 1989 and 1990. It has a total installed capacity of 1,500 kW. The intake arrangement consist of a concrete gravity weir across the river with a submerged intake and a sluiceway on the right bank. The flow through the intake is controlled by a sliding gate and discharge is carried to the forebay through a 1.5 km long open channel. The forebay is a single chamber concrete structure with two steel penstock on the downstream end that provides flows to the powerhouse. The powerhouse is on the right bank of the river and consist of two 750 kW turbines. Each unit connects to a 960 kVA generator. The output from the generator at 415 V is stepped up to 22 kV using 415V/22kV transformer for transmission in the switchyard located in the area at the downstream end of powerhouse.

The proposed refurbishment works involves:

- refurbishment of the powerhouse including replacement and installation of new equipment
- installation of a hoisting mechanism to lift the penstock gates
- refurbishment of the intake gate and installation of hoisting mechanism
- grouting of joints in the headrace canal

The layout of the Lake Hargy HP including location of refurbishment works is shown on Figure 3.

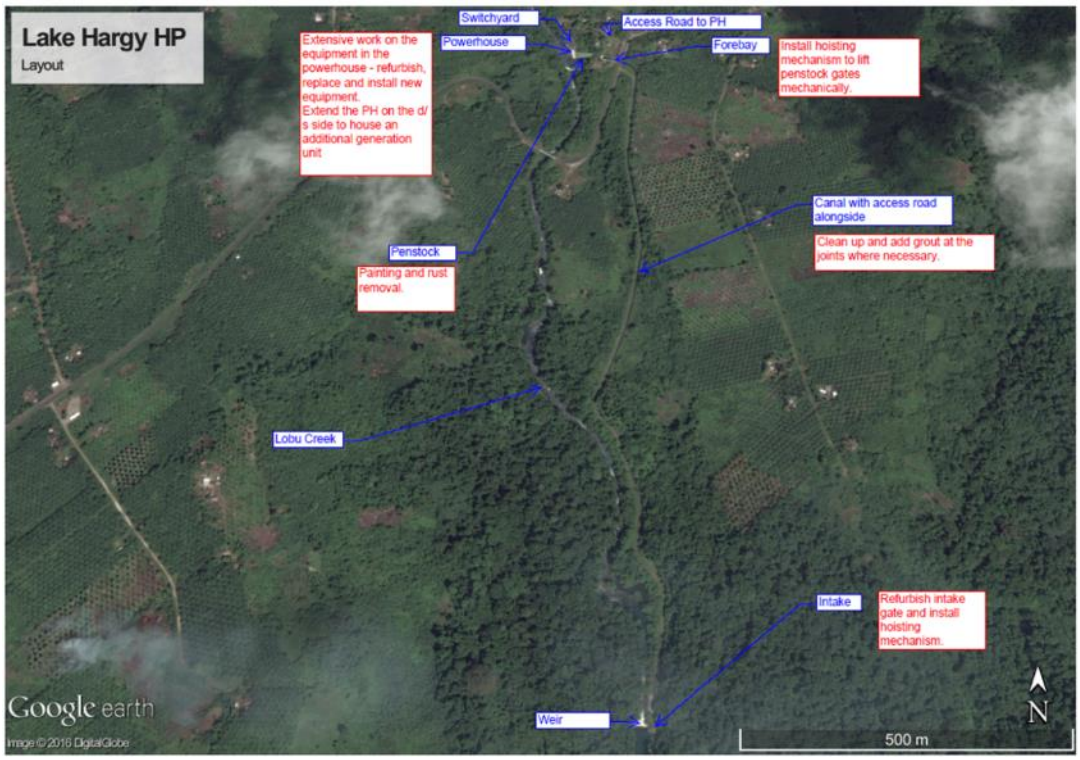


Figure 3 Lake Hargy HP Refurbishment

The proposed refurbishment works will involve small-scale construction activities comprising largely manual labour fitting hydromechanical and electromechanical components. There will be negligible civil works and use of heavy equipment limited to lifting equipment and transport of new equipment to site. The site is easily accessible by access road and transportation of construction material and components is not an issue. It is estimated that temporary employment for up to 5 workers (80% skilled) will be required for the project over the construction period, estimated to be about 12 months.

3. Warangoi HP Refurbishment

Warangoi Hydropower Project is located in East New Britain Province, 30 km south of Kokopo township. Warangoi HP is a run of the river scheme and has an installed capacity of 10 MW. The intake is on the leftt bank of Warangoi River, just downstream of its confluence with Rapmarina River. The arrangement at the intake consists of a concrete weir and a flume across the river. Water from the flume flows into a settling basin through a side intake from where it flows into a tunnel to the powerhouse. The powerhouse is located around 7 km downstream of the intake. It is a surface powerhouse and has two 5 MW turbine units. They are connected to two horizontal shaft air cooled three phase synchronous generators. The switchyard is outdoor and has two station service transformers, two generator step-up transformers and two transmission transformers. It also has an emergency diesel generator.

The proposed refurbishment works involves:

- river training works to reduce river migration and bank erosion: largely consisting of bank protection work upstream and downstream of the intake.
- refurbishment works at the intake area: work consistimg of repairing spillway gates and repairing sediment flushing system and lining the flumeway with abrasion resistant layer to prevent erosion of the concrete section
- refurbishment works in the powerhouse area including: refurbishment and replacement of hydromechanical, mechanical and electrical equipment and components in the powerhouse area.

The layout of the Warangoi HP including location of refurbishment works is shown on Figures 4 and 5.

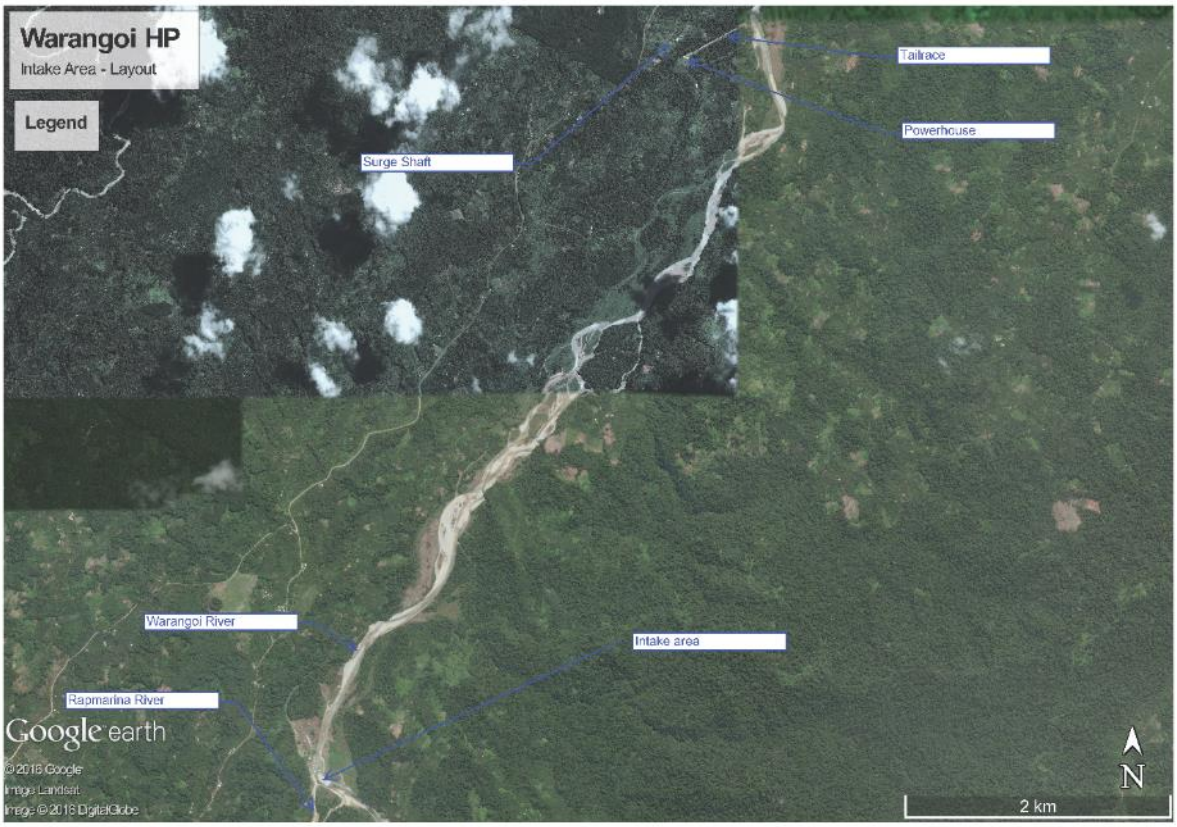


Figure 4 Warangoi HP General Arrangement and location of proposed works

Figure 5 Warangoi HP proposed intake and river protection works

The proposed river protection works will involve the construction of gabion walls which is a small scale civil works activity using largely manual labour with limited use of a mechanical excavator.

Powerhouse works will involve fitting hydromechanical and electromechanical components along with structural modifications as required. The site is easily accessible by access road and transportation of construction material and components is not an issue. It is estimated that temporary employment for up to 20 workers (60% skilled) will be required for the project over the construction period, estimated to be about 12 months.

IV. DESCRIPTION OF ENVIRONMENT (BASELINE DATA)

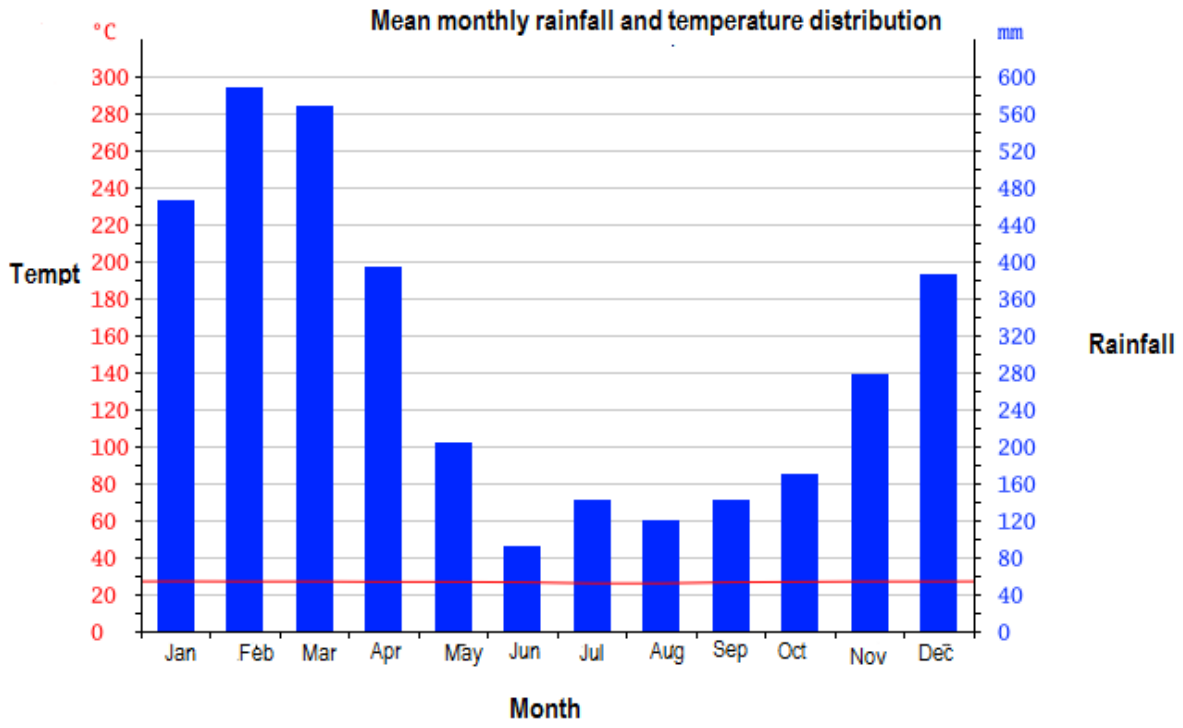
A. Physical Resources

4. Climate, Air Quality and Noise

Overall, PNG has a tropical climate comprising wet and dry seasons. The areas of the Highlands region experience cooler temperatures than areas of the Islands region depending on the altitude. Along the coastal areas of PNG the temperature is higher. Air quality in PNG is generally good especially in the rural areas. Rainfall is highest in the highlands with average annual precipitation varying between 2,000 to 5,000 mm. In Port Moresby the average monthly temperature ranges from 20-26 °C. Noise levels are low and air quality is generally good in rural areas apart from localised areas of smoke from village cooking fires.

West New Britain: West New Britain Province (WNB) has a typical monsoonal climate with alternation of southeast trade winds and northwest monsoons. From May to October the north coast is relatively sheltered from the effects of the southeast trade winds and during this period the north coast does not receive as much rain. The coastal areas are hot and humid. The average temperature in Kimbe (provincial capital) is 26.5 °C. The average annual rainfall is 3,545 mm. Precipitation is lowest in June, with an average of 92 mm. Most of the precipitation in Kimbe falls in February, averaging 587 mm.

Figure 6: Mean Monthly Rainfall and Temperature of Kimbe Town (1982-2012)

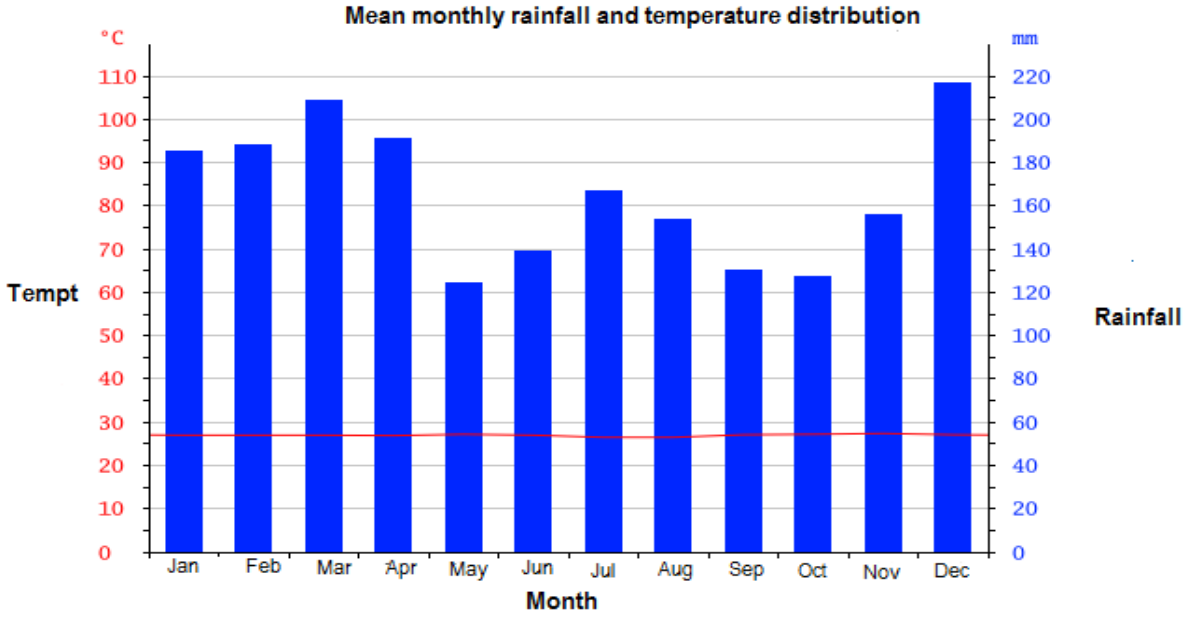


Source: Climate –data.org

East New Britain: East New Britain Province (ENB) has similar climate conditions to WNB although with lower overall rainfall. There are two main seasons: a wet season, influenced by the northwest monsoon, between December and May; and a dry season, influenced by trade-winds from the southeast. Some parts experience a second, brief, dry season during January and February.

The average annual temperature in Kokopo (provincial capital) is 27.0 °C. The average annual rainfall is 1,987 mm. The driest month is May, with an average of 124 mm of rainfall. The wettest month is December, with an average of 217 mm.

Figure 7: Mean Monthly rainfall and temperature at Kokopo Town (1882-2012)

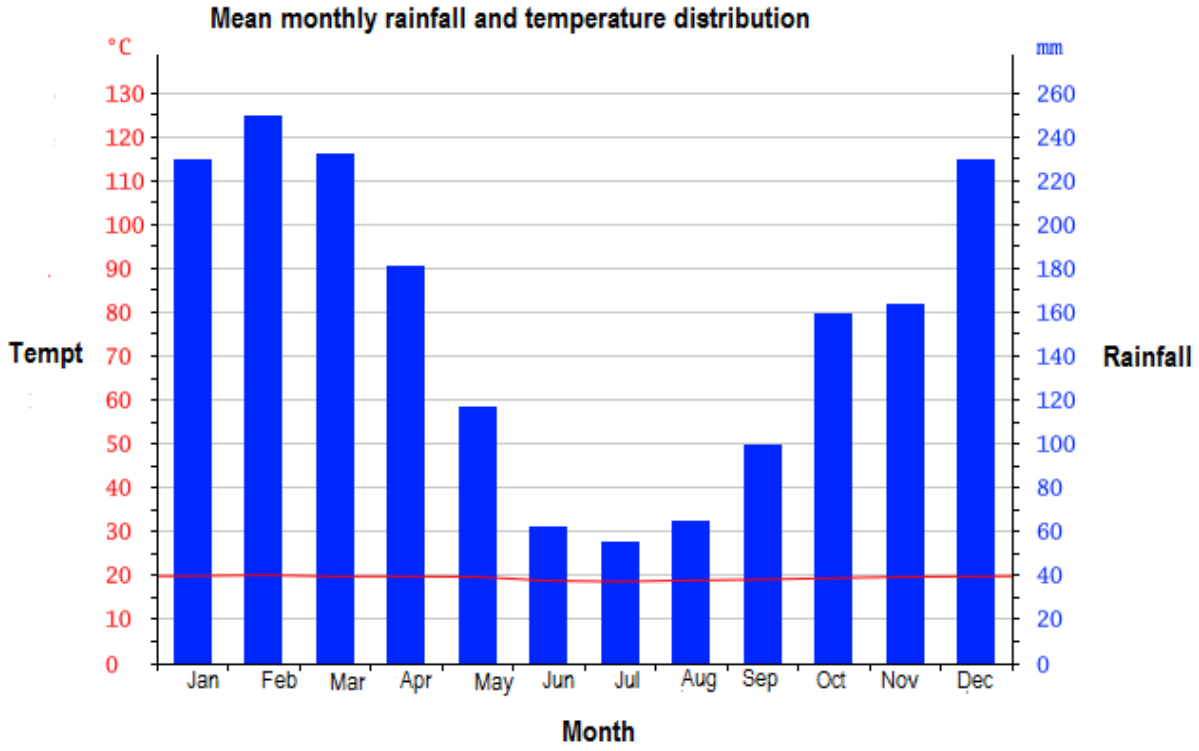


Source: Climate –data.org

Eastern Highlands: Monthly rainfall in the Eastern Highlands Province (EHP) follows a seasonal pattern with a wet season from December to early April having monthly rainfall in the range 203 - 305mm. A dry season follows, with monthly fall in the range 51 - 102mm. The months of April–May and October–November tend to be transitional. Temperature ranges are roughly the samel throughout the year

The average annual temperature in Goroka is 19.5 °C .The average annual rainfall is 1,840 mm. The least amount of rainfall occurs in July averaging 55 mm. The wettest month is February with average rainfall of 249 mm.

Figure 8: Mean Monthly Rainfall and Temperature at Goroka Town (1982-2012)



Source: Climate –data.org

5. Topography and Soils

West New Britain: Lake Hargy HP is situated 50 21''43.7 Ë and 1510 8' 25.81'' S, at an elevation of 319 metres above sea level (asl) downstream of Lake Hargy, a remnant volcanic caldera of the Hargy volcano. Volcanic fans and plains occur at the base of the Lake Hargy volcano and these consist predominantly of volcanic soils.

The Whiteman and Nakanai Ranges form the rugged spine of West New Britain (WNB) in the centre of New Britain Island and consists of numerous volcanoes and intricate drainage systems that descend the volcanic peaks to drain into Kimbe Bay and the Bismarck Sea to the north. Extensive coastal plains have formed along these lower slopes from volcanic outwash which includes alluvium, pumice and tuff.

The ash deposits have weathered to form reasonably stable soils that are predominantly composed of silts and fine sands. Due to their good structure and fertility these soils are the basis for the oil palm industry in PNG and support extensive plantings within WNB.

East New Britain: The Warangoi River and its tributaries drain a large part of south-eastern and central Gazelle Peninsula, and discharge into the sea on the east coast of the peninsula, 38.4km south-east of Rabaul and 33.6km south-east of Kokopo. The project is situated in the Warangoi valley approximately 3.2 kilometers wide which descends from 2100m asl to 150 asl, in a series of dissected gullies and ridges. Relief is moderate but some of the gullies are extremely steep, and deeply incised.

Common soil type found in Warangoi area is Eutropets described as brown forest soil, shallow dark clay and reddish clay.

Eastern Highlands: Yonki Toe of Dam is located adjacent to the Yonki Dam on the upper reaches of Ramu River, EHP. The topography of the eastern highlands comprises a complex system of ranges, upland valleys and volcanos characterized by sheer slopes, sharp ridges and fast-flowing rivers. The relief is generally over 200m asl. The Province's two highest

peaks, Mt Tabletop (3,686 m asl) and Mt Michael (3,750 m asl) are located on the Kratke and Bismarck Ranges respectively.

Asaro and Lamari rivers both flow south into the Purari River, one of PNG's five major river systems, and discharges into the Arafura Sea northwest of Port Moresby. The Yonki Toe of Dam HP is fed by the Ramu River.

The soils found in the project area are characterised as alluvial brown soils with traces of colluvial, humic brown clay soils.

6. Geology, Seismicity, and Natural Hazards

a. Geology

New Britain: Lake Hargy HP is situated on the Lobo River in a subaerial volcanic area comprising basaltic and andesitic rocks. Most rocks are weathered to some degree. The Lobo River flows out of Lake Hargy which is an inundated volcanic caldera with a surface area of 95ha and diameter of 11km.

Warangoi HP is situated on a subarial volcanic area underlain by metamorphic and intrusive rocks. The valley of the Warangoi River downstream of the HP contains exposures of flat-lying silt gravels and conglomerate.

Eastern Highlands: The basement geology of the eastern highlands comprises fault bounded high grade metamorphic rocks including schist, gnesis and quartzite. This is overlain by a thick sequence of greywacke (Omarua Greywacke) comprising folded and weakly metamorphosed interbedded shale, siltstone, sandstone, calc–silicate hornfels and limestone. The Omarua Greywacke has been intruded by dolerite dykes and sills ranging from 5-15m thickness. One of these intrusions includes the dolerite/gabbro Yonki Dome located around 3km north of the damsite.

b. Seismicity and Natural Hazards

PNG is exposed to a range of geological, hydrological and climatic hazards. PNG is located in the 'Pacific ring of fire,' at the collision point of several tectonic plates.The United Nations Development Program (UNDP) notes that PNG is one of the most natural disaster prone countries in the pacific region. PNG accounted for 25% of all the natural disasters that occurred in the Pacific between 1950 and 2008. As such, PNG is ranked within the top 6 countries in Asia-Pacific as having the highest percentage of population exposed to earthquakes, and ranked close behind the Philippines, Indonesia, and Vanuatu in having the highest percentage of population exposed to severe risks of volcanic eruption. Climate change is also likely to exacerbate the risk of natural hazards by causing extreme weather events more frequent. [4]

7. Water Resources and Hydrology

The source of water for the Lake Hargy Hydro Electric Power Project is largely supplied from Lake Hargy described above. The river flows at a steep gradient of up to 3% well contained within incised gorges. The bed and banks are generally of rock with small terraces of large cobbles and weathered gravels, ash and pumice and dense vegetation. The river bed is extremely well armoured with rock outcrops, large to small boulders and mixed cobbles. Gravels and sands are not abundant. Due to the protected nature of the catchment with no human habitation and the dense basalts, there is little to no catchment erosion and consequently low levels of suspended sediment when the river floods. The greater catchment is customary land and has no human habitation. Upstream of the Lake Hargy HP the water and aquatic resources of Lobu River are not significantly used by the local

[4] The information in this paragraph was obtained from UNDP website http://www.pg.undp.org/content/papua_new_guinea/en/home/operations/projects/crisis_prevention_and_recovery/disaster-risk-management.html

population. Whilst there is no water quality data available, water quality in the Lobu River is expected to be good.

The Warangoi River rises in the Mountains of East New Britain south of Kokopo, adopting a northerly flow pattern for some 40km where it meets the Nengmulha River below the Village of Warangoi, then turning east and flowing into the St Georges Channel (between New Britain and New Ireland) to the Ocean. The catchment could be described as a medium to low mountain catchment, falling from the ridge tops through well defined incised channels, concentrating in the mid section to a well defined main channel with only minor tributaries. Directly above the Warangoi HEP intake, it is joined by the Rapmarina Creek, with similar catchment characteristics. The catchment in the upper reaches is densely forested with old growth vegetation with the mid reaches now having some increased land development with logging and incursion and development from the Oil Palm Industry. The lower catchment is dominantly farming and older plantations of coconut and cocoa, in some cases being overtaken by Oil Palm. Whist the upper reaches are well contained within gorges and terraces, the mid to lower sections have large wide flood channels contained within high terraces with substantial sand, gravels and large boulders. Catchment erosion, bed load and sediment transport are ongoing due to the steeper slopes, slope instability and regular rainfalls at the higher altitudes. The river tends to migrate within its flood channels with broad and braided channels.

It has been reported that gold mining activities in the Rapamarina catchment have affected the water quality of the Warangoi River downstream of the confluence, however, no data was available to verify this.

B. Biological Resources

Much of PNG is covered with tropical rain forest, of which only a fraction is primeval forest. The vegetation is similar to that of the Philippines, Malaysia, and Indonesia (Irian Jaya). There are some 40,000 species of flowering plants, including 5,000 species of orchids. There are more than 3,000 tree species, including durian, sandalwood, and illupi nut, valuable timber varieties such as teak and ironwood, and rattans.

More than 6,000 species are exploited for economic purposes, either directly or indirectly. Major timber operations are located throughout PNG, where the trees are not differentiated but are referred to as "broad-leaved species"; they include, for example, meranti, which has a soft, lightweight, pinkish to dark is red wood. Teak, which is also broad-leaved, comes mainly from plantations in PNG.

1. Terrestrial Habitats

The most important vegetation type in PNG is the mixed lowland and hill tropical rainforest, which occurs below 5,000 feet. It is characterised by a large number of species, including high-canopied and buttressed trees and woody, thick stemmed lianas (climbing plants). Epiphytes, such as orchids and ferns, saprophytes, and parasites are well developed. Above 5,000 feet this forest gives way to temperate upland forest dominated by oak, laurel, tea, and magnolia species. Another typical feature of PNG vegetation is the mangrove forest, characterised by the formation of stilt or prop-rooted trees, which grow only in salty or brackish water along muddy shores. Mangrove swamps are extensively developed along the coastline of PNG mainland and the islands.

New Britain: Forests on New Britain have diminished rapidly in recent years, largely due to clearing land for oil palm plantations, coconut, cocoa and balsa plantations. Lowland rainforest has been hardest hit, with nearly a quarter of the forest below 100 m disappearing between 1989 and 2000. If those rates of deforestation continue, it is estimated that all forest below 200 m will be cleared by 2060.

Eastern Highlands:The terrestrial ecology in the Yonki area is mainly grassland and some patches of trees that are mainly associated with human settlement. This is a result of continuous burning and use of the land for subsistence agriculture.

2. Terrestrial Fauna

Terrestrial fauna of West and East New Britain is similar.The Bismarck Archipelago records 60 bird species that are endemic with about 8 species that are endemic to West New Britain. Some bird species found to be common in New Britain include *Myiagra hebetior, Ceyx lepidus, Tanisiptera nigriceps,Dicrurus bracteatus, Ecletus roratus and Rhipidura alblimbata*. Most of these are frugivores, insectivores and nectivores and depend on fruit, flowering plants and insects. The common scrub fowl, *Megapodius eremita* inhabits lowland forests near rivers and creeks and is common in the area. Various species of Kingfishers, Pigeons, Parrots, Lorikeets, Cockatoos and Cassowaries and the Torresian crow are common throughout New Britain. The Eclectus Parrot (*Eclectus roratus solomonensis*), is widespread and common throughout the mountains and foothills.

Marsupial diversity is lower in the island regions than in mainland PNG because they are very poor over-water dispersalists with only three species known to occur in New Britain. Cuscus and gliders are common. *Petaurus breviceps* is a common sugar glider found throughout PNG and is expected to be found in New Britain.

The species diversity of Bats in New Britain is relatively high with 17 species. The Pteropodid fruit-bats have a high degree of endemism on the New Guinea islands including New Britain. Bats are hunted for their meat. There are seven species of rodents on New Britain of which three are endemic and only found in New Britain. The species are *Uromys neobrittanicus, Hydromys neobrittanicus* and Melomys *cf. levipes.*

There is low endemism of snakes and frogs in the Bismarck Archipelago. *Bufo marinus*, the marine toad is an introduced species. Snakes include the Brown Tree Snake, (*Boiga irregularis*) and the Pacific Tree Boa, (*Candoia Carinata*)

Near the project areas the fauna has been significantly disturbed due to human settlements and associated agricultural activities such as oil palm, cocoa and balsa cash crops replacing previously forested land. However, significant stands of intact forest do occur upstream of both the Warangoi HP and Lake Hargy HP sites. Common avifuna often sighted includes Grey Crow (*Corvus tristis*), Blyth's Hornbill (*Rhyticeros plicatus*), and Rainbow Lorikeet (*Trichoglossus haematodus*)

The diversity of fauna around Yonki Toe of Dam is limited to common species that inhabit highly disturbed habitats associated with areas that have been subject to years of slash and burn agriculture.Main species comprise various birds and rodents common to grassland areas.

3. Fish and Aquatic Resources

New Britain: Within New Britain Island, various aquatic habitats occur along the water courses and range from slow moving rivers to fast bouldery sections. Riparian vegetation mainly consists of the tall grass *Saccahrum sponteum, pandanus* and low water tolerant trees. In slower stream sections aquatic larvae of a range of insects and worm like groups typically dominate the streambed ecosystems. Fish which have been sampled in Ru Creek and also in the Lobu River below Lake Hargy have shown that neither fish diversity nor numbers were significant in any of the watercourses. Diversity increased as river size increased and diversity was also greater below the waterfall that is situated on the Lobu River below the Lake Hargy powerhouse.

In the upper sections of the water courses fish mainly consisted of gobies and gudgeons. All of these fish are commonly found throughout PNG in these water systems and grow to <10cm in length. Freshwater prawns *Macrobrachium sp*. and eels (family Anguillidae) also occur in these systems.

Along the Warangoi River common native fish species include the Mullet (*Liza tade sp)* Bluntsnout Goby *(Glossogobius sp),* Mountain rainbow fish *(Melarotaenia monticola),* eels (family *Anguillidae*) and prawns. These species are typically used for food by local communities along the river.

Eastern Highlands: The aquatic environment of the Ramu River around Yonki has been significantly influenced by the Yonki Dam. Aquatic resources are dominated by introduced species such as Talapia (*Orechromis mossambica spp*) and common carp species. These provide a significant food source and income to surrounding communities that were previously resttled following the dam construction around 30 years ago.

4. Protected Areas and Areas of Conservation Value

There are no Protected Areas or areas of conservation value within the area of influence of the subproject areas. Approximately 10km upstream of the Lake Hargy HP intake a conservation area encompassing the riparian area of Lake Hargy has been proposed but has not progressed. There is also one Wildlife Management Area (WMA) Pokili which is situated 60 km south west of the Biala - Kimbe transmission line in Talasea District.

5. Rare and Endangered Species

In New Britain some bat species from the Order Chiroptera are classified as Endangered, Vulnerable and Critically Endangered in accordance to CITES categories of varying threat. The Lesser Bare Back Fruit Bat, *Dobsoni minor,* the Lesser Tube Nosed Bat, *Nyctimene draconill*a the Greater Tube Nosed Bat, *Nyctimene aello* are classified as RARE according to the IUCN threat classifications. Existing threats are clear fell logging of bat habitats and clearing of habitation to make way for new oil palm and cocoa plantations. Bat colonies are located in dense forest areas where fewer disturbances occur. Many travel to garden areas in search for fruit at night.

For YTOD information on vulnerable and/or endangered species is absent from the area but it should be noted that the project are is within already significantly disturbed area.

6. Invasive Alien Species

Biological impacts from introduced species and invasive species can cause damage to naturally adapted ecosystsems. Invasive or introduced species are species that are non-indigenous and can colonise and out-compete local species.

Introduced species such as Tilapia and Mosquito fish are two examples that threaten natural freshwater fauna in PNG. However, Mosquito fish are unlikely to be found in the Lobu River as this fish inhabits slow flowing streams and fast flowing watercourses will restrict its colonization. Tilapia is also not reported to be found in the area.

At Yonki Dam Talapia (*Orechromis mossambica spp*) and other common species such as carp, which were introduced to provide a protein supplement and income for the local communities which were displaced due to the Yonki Dam Construction during the 1980s. As a result Tilapia have vigorously taken over the native speices of Ramu River. However, Tilapia is now considered as an important food resource for the communities near the dam. The Government has introduced cage fishing in the lake to income from fish farming.

No invasive species has been reported in the Warangoi River.

C. Socioeconomic and Cultural Resources

1. Population and Communities

The population of Papua New Guinea has reached 7,275,324 according to the 2011 census. It has increased by 40 per cent and at average annual growth rate 3.1 % since the last census in 2000. About 39 per cent of the population live in the highlands region while the southern and islands regions make up 20 per cent and 15 per cent respectively. The annual

population growth of PNG has increased steadily from 2.2 per cent in 1980 and currently stands at 3.1 per cent.

Lake Hargy HP is within the Bialla Rural LLG of Talasea District which according to the 2011 census has a population of 58,373 with a total household count of 10,283 and average household size of 5.7.

Warangoi HP is located in the Sinivit LLG of Pomio District which according to the 2011 census has a population of 19,103 persons with total household count of 3,294 and average household size of 5.8.

Yonki Toe of Dam is located in the Kainantu Urban District comprising Yonki township which according to the 2011 census has a population 7,287 with a total household count of 1,643 with an average household size of 4.4.

2. Health and Education

According to WHO PNG life expectancy at birth increased from 58.80 years to 60 years. Between 1990 and 2012 the infant and under 5 mortality rates decreased steadily from 65 and 89 per 1000 live births to 48 and 63 per 1000 live births respectively. This decline is however not sufficient for PNG to meet its MDG 4 targets. Very few mothers deliver at health facilities. In 2012 on average only 44% of births occurred at health facilities. The maternal mortality ratio for PNG is estimated to be 230 per 100,000 live births. Whilst PNG has maintained its polio free status since 2000, there have been breakthrough measles outbreaks in 2005 and recently in 2013-2014.

Communicable diseases continue to be the major cause of morbidity and mortality, with malaria, tuberculosis, diarrheal diseases and acute respiratory infections at the top of the list. Studies conducted by the Institute of Medical Research PNG indicate an incidence of malaria is on the decline. Tuberculosis (TB) remains a problem of public health significance with drug resistant strains becoming increasingly common and extremely drug resistant (XDR) TB being reported in some areas. The HIV prevalence amongst pregnant women has stabilized at 0.56% (2013).

Talasea district around Lake Hargy HP has 12 medical officers, 131 nurses, 14 Health Centres and 42 aid posts. There are 156 elementary schools, 25 community schools, one provincial high school and 3 vocational schools. The literacy rate for male is 77 per cent and for female is 71.7 per cent.

Communities around the Warangoi HP comprise mostly people resettled following the volcanic eruption disaster in Rabaul in 1994. Other people from the coastal areas have also moved into the area due to shortage of land and increased population around the coast near Kokopo. Warangoi is located within the Sinivit LLG of Pomio district. The Warangoi area has a small township with a health centre, a primary school, one provincial high school, and three elementary schools. It also caters for the residents of the Warangoi HP staff and other provincial government officers. The literacy rate for the district is 59.6 per cent for male and 51.5 per cent for female.

There is one Aid post in the Yonki Township that is accessible to the people living within the township with 3 nurses available. For the district of Kainantu there are 19 nursing officers, 3 health centres and 11 aid posts. There are 54 elementary schools, 13 community schools, 2 provincial high schools and 2 vocational schools. The literacy rate for male is 60.2% and female is 45.8%.

3. Cultural Heritage

PNG is a country with over 800 languages and diverse culture. The country is divided into four regions including the Highlands, Islands, Momase and Southern Regions. Each province has different customs and beliefs unique to their environment and ancestral history.

Lake Hargy is a sacred site for the customary landowners. The landowners are the only people who are allowed access to the area. There is no human habitatation near the lake. There are nine clans who claim ownership of the lake and are residing at Bialla in Baikakea village. They claim ownership of the side of Lake Hargy that draws water to the Hargy HP, towards West New Britain. They have created a route up to lake from their end and are the only people in West New Britain who go to the lake. The other side of the lake is owned by the Mengen people of Pomio, East New Britain.

Land around the Warangoi River belongs to the ethnic group known as the Baining. They are said to be the first indigenous group of people to live in the area. Over the years they have migrated further inland and sold most of their land to the government, and more recent arrivals from Rabaul and other provinces of PNG. At present there is a mixture of people living in the Warangoi area.

The culture of the Eastern Highlands people living within and around Yonki revolves around vegetable gardening and tending to livestock. Vegetables and livestock are given as contribution during funerals, marriages and other festivities.

4. Land use, Livelihoods and Employment

Land use in WNB is high with the extensive planting of oil palm. Land potential is low to moderate around Lake Hargy area due to high rainfall, steep slopes and cloud cover. A significant amount of land is unoccupied. Income around the area of Lake Hargy is relatively high due to employment in the oil palm industry. Cultivation of staple food crops such as banana, cassava, Chinese taro and sweet potatoes is low. Apart from in the oil palm industry other employment opportunities are low and people are mostly subsistence farmers.

The land area around Warangoi has been converted into plantations of cocoa, balsa and most recently oil palm and settlement. People get their income from the cultivation of cash crops. Coconut plantations are mostly found in the coastal areas of ENB. Employment opportunities are mainly for labour on the plantations and a few find employment in the town. However, most are subsistence farmers. Communities affected by the Tavana volcanic eruption at Rabaul in 1994 have settled near the Warangoi Township. Their livelihood depends on gardening and they obtain income from selling their garden produce. People that have small blocks of cocoa and balsa sell their produce to the well-established local cocoa buyers.

The land use of Yonki and Kainantu District where Yonki is located is agriculturally intense and dominated by sweet potatoes. There are 3 to 5 consecutive plantings until fallow periods that take from 1 to 4 years. Production is maintained with peanut rotation and tillage of small mounds and long beds. The flood plains around Kainantu have high land potential but constrained by poor soils and long dry seasons. Incomes are moderate to high due to sales of coffee, fresh food and tobacco. Most people are subsistence farmers and employment opportunities are low. People live in semi permanent and traditional houses with a few permanent houses.

5. Infrastructure

Water Supply: In PNG the main sources of drinking water supply for households in urban areas are piped water into household (58 per cent), and piped water into neighbourhoods and rain water (12 per cent each). In rural areas, the majority of the households depend on river / stream (43 per cent), springs (24 per cent), and rainwater and piped water into neighbourhood (7 per cent each). There has been no significant improvement in the source of water supply since 1996 as the majority of households (60 per cent) still depend on river/stream and spring water.

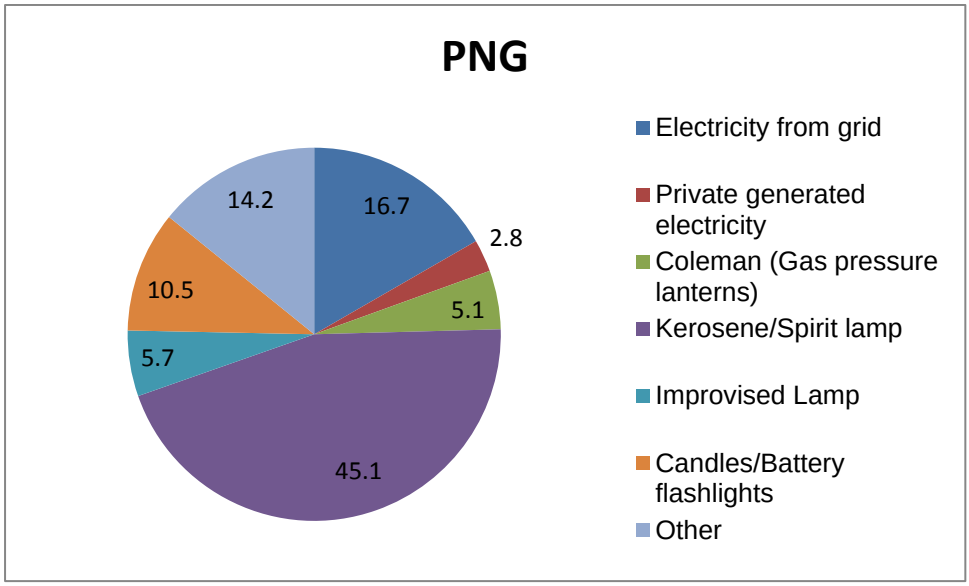
In WNB 75% of the population access water from rivers and small streams, 15% from piped systems 8% from rainwater and 2% from wells. In ENB 60% of the population access water

from rainwater, 25% depend on surface water sources, 10% from piped systems and 5% from wells.

In the Eastern Highlands more than 70 % of the population uses surface water sources, about 15% have access to piped water supply, 10% depend on well water and 5% depend on rainwater.

Energy: Across the country only 16.7% of the population use grid electricity for lighting. The majority (45%) use kerosene lamps and 10% use small generators. (Figure 9).

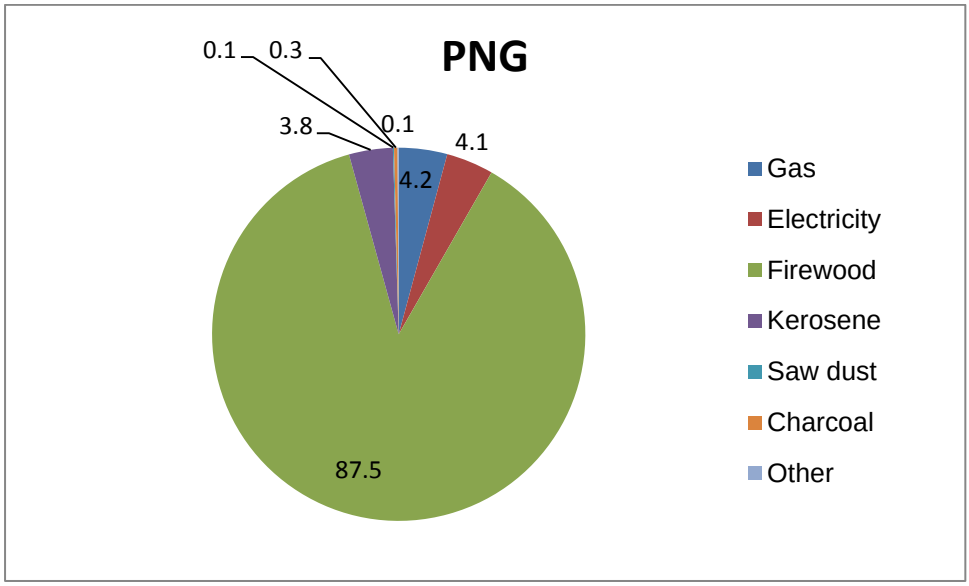
Figure 9 Sources of Energy for Lighting in PNG



Source: National Statistics Office Report on Household Expenditure and Income Survey 2009-10

With regard to sources of energy for cooking the vast majority (87%) of the population use firewood. (Figure 10)

Figure 10 Sources of Energy for Cooking



Source: National Statistics Office Report on Household Expenditure and Income Survey 2009-10

Waste Management: Most of the small towns and rural areas in PNG have their own landfill sites where domestic rubbish such as is tins, bottles and old tyres are often dumped dumped into one site with no separation or recycling. Other rubbish such as wood, dried vegetation and paper are burnt openly. There is no proper waste management system.

Transportation: In WNB road conditions are well maintained along the coastal areas. From Kimbe Town to Bialla town the road is a National Highway and sealed. Communities along the highway make use of regular public transport. The outer islands along the coast are accessed by outboard motor boats.

The Warangoi area is more accessible compared to the other areas within the Pomio district. The road is sealed from Kokopo town to Warangoi. From Warangoi Village to the project site the road is unsealed but maintained regularly. Small PMV buses, trucks and cars travel up and down the road transporting people and goods. It takes less than an hour to travel from Warangoi to the provincial capital, Kokopo.

Road and transportation via the highlands highway from Lae is used regularly by people living in Yonki and Kainantu. Large trucks bring in goods from the highlands along the highlands highway to Lae. These goods typically include fresh vegetables, and commodities such as coffee. PMV buses owned by the locals also transport people from the highlands region down to Lae city. The influx of people into Lae City shows that Morobe province has the highest population. From Lae up to the highlands the highway paves the way for goods to reach Goroka and on to Mount Hagen and other towns of the Highlands region accessible by road. It takes 2 to 4 hours to travel from Lae to Yonki and from Yonki onwards it takes 4 to 6 hours onto other towns in the highlands region.

V. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Screening of Potential Impacts

ADB's rapid environmental appraisal checklist for hydropower projects and climate risk screening checklist were used to screen for potential impacts and to determine ADB's environment categorization for the project. The checklists were prepared and approved by ADB Safeguards staff during February 2016. The project was desigated as Environment Category B. The climate risk screening indicates that the project is at overall high risk of being affected by climate change primarily in respect of changes to and increase in intensity of future rainfall patterns.

The following section provides an assessment of the project's likely impacts on physical, biological, socio-economic and physical cultural resources, and identifies mitigation measures to ensure all such environmental impacts will be avoided or managed/reduced to acceptable levels.

An audit of existing facilities at each of the subproject sites has also been undertaken to identify if existing operations and facilities that are linked with the project comply with the SPS. Through due diligence, review, and supervision ADB ensures that borrowers comply with the SPS requirements during project preparation and implementation. The audit reports for the three subprojects are included in Annex 1 and the findings are included in this section while required actions are integrated into the EMP presented in Section VII.

The mitigation measures identified below along with other environmental management requirements normally associated with international best practice will be implemented in accordance with the EMP presented in Section VII.

B. Audit of Existing Facilities

Due diligence of existing facilities at each subproject site has been undertaken through a review of the available documentation, interviews with staff of PPL and site visits during April 2016 to explore whether or not the facilities are in compliance and/or can be brought into

compliance with SPS, and if so to agree on required corrective actions and a time-line for their implementation as a part of international good practice.

In undertaking the due diligence the consultants have exercised due diligence and studied where PPL's current practices meet ADB SPS requirements and where there are gaps that need to be filled. This section summarizes the results set out in Annex 1 and identifies how any gaps can be addressed so that the Tranche 2 loan procedures can proceed with confidence that the requirements of SPS will be complied with.

1. Yonki Toe of Dam HP

Current status of compliance. The YTD hydropower project commenced construction in 2011 and was commissioned in 2013. It has an installed capacity of 18MW. Prior to construction an environmental impact assessment was undertaken for the project in accordance with the Environment Act 2000 and an Environmental Permit (EP) was obtained for the project on 10 February 2010. The term of the EP is 50 years. The EP includes terms and conditions in relation to the operation of the power station during this period.

An audit checklist was prepared based on the Terms and Conditions of Environment Permit No. WD-L2B (235) with respect to the operation of the Yonki Toe of Dam project. The terms and conditions of the EP are consistent with international best practice including SPS requirements. Thus, the terms and conditions of the EP were used as the basis for due diligence review during the site inspection and discussion with PPL staff. The full Due Diligence Review for Yonki Toe of Dam HP is provided in Annex 1.1.

Based on the findings of the audit of the EP for operations at YTD HP the DDR concluded that the environmental impacts from the existing activities at YTD HP are not significant at the actual site. However, the issue of disposal of used oil from the site represents a significant non-compliance with the EP and international best practice including SPS. The audit also identified the fact that there appears to have been i) no Waste Management Plan or Environmental Monitoring Plan prepared by PPL as required in the EP ii) no implementation of the required environmental monitoring program and iii) no annual Environmental Performance reporting undertaken to date.

Actions required for compliance: The key recommendations and corrective actions identified in the DDR are summarized below:

- It is recommended that PPL make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new or amended EP for YTD HP.
- PPL to immediately cease disposing of used oil to the ground at the Ramu 1 workshop and fuel/oil storage facility and establish a proper used oil storage facility and associated operational procedures for waste oil disposal to comply with the DEC Environment Code of Practice for Vehicle Machinery and Petroleum (Hydrocarbons) Storage/Resale/Usage Site DEC 1997.
- In association with the above, PPL shall remove all dumped waste oil and associated contaminated soil from the site, decontaminate the area, and dispose of the waste oil/ contaminated soil at an appropriate hazardous materials disposal facility
- PPL to prepare a waste management plan and environmental monitoring plan for approval of CEPA in accordance with the current EP (or amended EP if required).
- PPL to commence annual environmental performance monitoring as required under the EP (or amended EP if required)
- PPL to commence environmental performance reporting as required under the EP (or amended EP if required)

With these recommendations and corrective actions implemented, the environmental impacts of YTD HP current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards.

2. Lake Hargy HP

The full Due Diligence Review for Lake Hargy HP is provided in Annex 1.2.

Current status of compliance: The Lake Hargy hydropower project was constructed during the 1980s. The first 750kW unit was commissioned in 1989 and a second 750kW unit was commissioned in 1995. It has a total installed capacity of 1500 MW. At the time of commissioning there was no statutory requirement under PNG law for environmental impact assessment nor any requirement for an environmental permit. However, two water use permits (WUP) under the Water Resources Act 1982 were obtained by PNG Electricity Commission (ELCOM), the entity preceding PPL Ltd. The Water Resources Act was repealed by the Environment Act in 2000, and while all permits approved under Water Resources Act stayed in force, the permits for Lake Hargy HP will expire in 2018.WUP No. 29/290 Item 2 was issued on 7/6/88 and covered the construction of the scheme only. WUP No. 29/90 Item 2(a) was issued on 7/5/93 and provided permission to "Dam and divert Lobu River near Lake Hargy for power generation". The intended rate for the use of water for the permit was set at 1,440,000 litres per hour (4 cumecs), 24 hours per day, 365 days per year for 25 years. This permit expires on 10/6/2018. It appears that no additional WUP or amendment to the existing one, was obtained by ELCOM in respect of the operation of the second unit that was commissioned in 1995 which required an additional 4 cumecs to be diverted from the river for power generation.

Actions required for compliance: The DDR concluded that the environmental impacts from the existing activities at Lake Hargy HP are not significant. However lessons have been learned from the DDR and some matters require attention in order that existing operations comply with the SPS. Potential impacts are manageable if appropriate mitigation measures identified in the DDR are implemented thoroughly. The following recommendations and key actions required to comply with SPS are summarized below:

- PPL to make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Lake Hargy to replace the WUP due to expire in 2018.
- PPL to disclose the scope of the improvements for Lake Hargy refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Lake Hargy HP.
- PPL to introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at an authorized site and prevent burning of waste in line with the DEC environmental codes of practice.
- PPL to minimize impacts from incorrect storage and disposal of hazardous substances in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage.
- PPL to stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kimbe maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use.
- PPL to prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers.
- PPL to prepare and implement a Health and Safety Plan for the operation of Lake Hargy hydropower scheme. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines.

- PPL to ensure that workforce training for all workers will include environment, safety and environmental hygiene.
- PPL to maintain clean toilet facilities by cleaning daily and keeping flush toilets well maintained to allow effective operation.
- PPL to Maintain consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public.
- It is recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works

With these measures in place, the environmental impacts of Lake Hargy HP current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards.

3. Warangoi HP

The full Due Diligence Review for Warangoi HP is provided in Annex 1.3.

Current status of compliance: The Warangoi hydropower project was constructed during the early 1980s and commissioned in 1983. It has an installed capacity of 10MW. At the time of commissioning there was no statutory requirement under PNG law for environmental impact assessment nor any requirement for an environmental permit. However, a water use (WUP) under the Water Resources Act 1982 was obtained by PNG Electricity Commission (ELCOM), the entity preceding PPL Ltd. The Water Resources Act was repealed by the Environment Act in 2000, and all permits approved under Water Resources Act stayed in force. WUP No. 29/77 was issued on 30/12/82 and provided permission to "Divert and use water up to 26 cumecs for the purpose of electricity generation from the Warangoi River" The WUP for Warangoi HP expired in December 2007 and has not been updated such that the scheme has been operating without a permit.

Actions required for compliance: The DDR concluded that the environmental impacts from the existing activities at Warangoi HP are not significant. However lessons have been learned from the DDR and some matters require attention in order that existing operations comply with the SPS. Potential impacts are manageable if appropriate mitigation measures identified in the DDR are implemented thoroughly. The following recommendations and key actions required to comply with SPS are summarized below:

- PPL to make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Warangoi to replace the WUP which expired in December 2007.
- PPL to disclose the scope of the improvements for Warangoi refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Warangoi HP.
- PPL to introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at authorized site and prevent burning of waste in line with the DEC environmental codes of practice.
- PPL to minimize impacts from incorrect storage and disposal of hazardous substances in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage is followed.
- PPL to stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kokopo maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use.

- PPL to prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers.
- PPL to prepare and implement a Health and Safety Plan for the operation of Warangoi hydropower project. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines.
- PPL to ensure that workforce training for all workers will include environment, safety and environmental hygiene.
- PPL to repair toilet facilities and ensure they are well maintained and cleaned daily to allow effective operation.
- PPL to Maintain consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public.
- It is recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works

With these measures in place, the environmental impacts of Warangoi HP current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards.

C. Impacts on the Physical Environment

1. Erosion and Loss of Top Soil

The potential for erosion and loss of top soil would only occur during foundation excavation for the Yonki Toe of Dam (YTD) surge tank adjacent to the penstock and minor excavations required for river bank protection immediately upstream of the Warangoi HP head works. In both cases excavation works will be minor and most likely undertaken by manual labour with little use of mechanical excavators.At YTD, the works will be undertaken within the YTD footprint which itself is located on the existin Yonki dam.

Minor erosion could occur during foundation construction at YTD and during construction of the Warangoi bank protection works. Erosion could result in temporary increased siltation/sedimentation of the Ramu River at YTD and the Warangoi River at the headworks. These impacts can be avoided or minimized through recognized good engineering design and construction practices incorporating the following mitigation measures:

- Minimizing the vegetation clearance at the sites;
- Installing cut-off drains when excavating on steep slopes;
- Ensuring slope cuts are appropriately designed and engineered for the prevailing conditions (geotechnical, climate etc);
- Cleared slopes to be re-vegetated as soon as practicable to minimize the exposure of bare surfaces;
- Re-vegetation of slopes to incorporate appropriate bioengineering practices utilizing local native species as much as possible;
- Scheduling the construction in the dry season (May - Oct).

The limited scale of construction activities associated with bank protection works at Warangoi (Gabion baskets) and surge tank foundation excavation on the Yonki dam means there will be limited direct loss of top soil. However, some indirect loss of topsoil could occur through erosion as described above. Following site clearance top soil will be stockpiled for later use in landscaping.

The relatively small scale nature of the works coupled with local labour intensive approach and implementation of the above mitigation measures will ensure that the potential impact of erosion and loss of topsoil due to the project will be minimized to acceptable levels.

2. Sedimentation and Water Quality

There is potential for localized and short term water contamination from runoff of suspended sediment from exposed surfaces, slope erosion and concrete residues into the Ramu and Warangoi rivers during various construction activities as outlined below:

- Vegetation clearance and stockpiling of excavated materials;
- Excavation works associated with:
  - Foundation excavation for surge tank
  - Excavation along Warangoi river bank in preparation for gabion wall construction
- Spoil disposal from excavation works.

Construction activities will involve some use of powered mechanical equipment however it is envisaged that the majority of the construction activities will be undertaken using manual labour. This should help in minimizing the potential for erosion and sediment runoff at both locations.

A range of proven mitigation measures normally associated with good construction practice will be implemented during construction of the facilities to avoid or minimize sedimentation impacts on the Ramu and Warangoi rivers. As a minimum these mitigation measures will include:

- Minimizing the vegetation clearance of the footprint for all components;
- Re-vegetating and/or stabilizing exposed surfaces and excavated materials
- Implementing effective construction site drainage such that runoff is directed to sediment traps before discharge to water courses (where practical);
- Use of cut-off drains above excavated areas on slopes to reduce erosion;
- Close construction supervision to ensure the above measures are implemented; and
- Scheduling the construction in the drier months (May - Oct).

Effective implementation of the above mitigation measures will ensure that the potential short term impacts on water quality due to construction of the project will be insignificant.

Operation of the project will not give rise to any significant impact on water quality.

3. Dust and Noise

Owing to the limited scope of works, largely manual construction methods and distance away from residential communities, the impact of dust and noise generation will be negligible. The largest impact of dust and noise will likely be from construction site traffic transporting materials and equipment to the sites along existing access roads. This will be temporary and sporadic over a short period (6 months). Implementation of good practice construction methods such as watering of access roads adjacent to residential areas during dry spells and using well maintained powered mechanical equipment equipped with silencers will ensure impacts are minimized and acceptable.

4. Materials and Spoil Management

Moderate amounts of sand and cement and other equipment and materials will be required for construction. It is envisaged that a dedicated borrow pit /quarry will not be required for the project and that aggregates could be obtained from existing sources. Materials sources will be identified by the contractor and will be detailed in a Site Materials and Spoil Management Plan (MSMP). Excavation activities will be limited with a corresponding limited volume of excess spoil needing to be disposed of.

The contractor will be required to prepare and implement a MSMP to minimize the use of non-renewable resources and provide for safe disposal of excess spoil. As a first priority, where surplus materials arise from the removal of the existing surfaces these will be used elsewhere on the project for fill (if suitable) before additional rock, gravel or sand extraction is considered. The MSMP will include as a minimum consideration of the following:

- Required materials, potential sources and estimated quantities available;
- Impacts related to identified sources and availability;
- Excavated material for reuse and recycling methods to be employed;
- Excess spoil to be disposed of and methods proposed for disposal;
- Endorsement from local authority and local landowners for use of sources and disposal of excess spoil; and
- Methods of transportation to minimize interference with normal traffic.

The contractor will be responsible for; i) identifying suitable sources and obtaining all agreements associated with the sources and preparing a MSMP; ii) balancing cut and fill requirements to minimize need for aggregates from other sources; iii) managing topsoil, overburden, and low-quality materials so they are properly removed, stockpiled near the site, and preserved for reuse; and, iv) arranging for the safe disposal of any excess spoil including provision for stabilization, erosion control, drainage and re-vegetation provisions at the disposal site

Effective implementation of the MSMP by the contractor as outlined above will ensure that potential environmental impacts associated with the management and disposal of construction materials will be negligible.

5. Waste Management

Uncontrolled waste disposal during construction (including contractor's camp and work sites/yard) and operation activities can cause significant impacts including water and land pollution and public safety. Mitigation measures for the waste arising from the project will seek to reduce, recycle and reuse waste as far as practicable and dispose of residual waste in an environmentally sustainable way.

As part of the Contractor's EMP (CEMP) waste management measures will be included in a waste management plan (WMP) to cover all matters related to solid and liquid waste disposal arising from construction related activities (including storage, disposal and accidental spills). The WMP will cover the following issues:

- Expected types of waste and volumes of waste arising;
- Waste reduction, reuse and recycling methods to be employed;
- Agreed reuse and recycling options and locations for disposal/endorsement from local authorities;
- Methods for treatment and disposal of all solid and liquid wastes;
- Establishment of regular disposal schedule and constraints for hazardous waste;
- Program for disposal of general waste / chain of custody for hazardous waste;
- Designation of waste disposal areas agreed with local authorities;
- Segregation of wastes to be observed. Organic (biodegradable - such as tree trimmings) shall be collected, stockpiled and given to the local community (no burning is allowed on site);
- Recyclables to be recovered and sold to recyclers;
- Residual waste to be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams;
- Camp, construction offices/facilities and work's yard to be provided with garbage bins;
- Burning of construction and domestic wastes to be prohibited;

- Disposal of solid wastes into drainage ditches, rivers, other watercourses, agricultural fields and public areas shall be prohibited; and
- All solid waste will be collected and removed from work camps and disposed in designated local waste disposal sites.

The contractor's WMP, as part of the CEMP, will need to be approved in writing by PPL prior to start of construction.

Hazardous Materials and Hazardous Waste Disposal. Use of hazardous substances during construction, such as oils,lubricants and corrosion protection paint can cause significant impacts if uncontrolled or if waste is not disposed correctly. Mitigation measures will aim to control access to and the use of hazardous substances such as oils, lubricants and corrosion protection paints and control waste disposal.

The contractor's mitigation measures in the hazardous materials section of the WMP will include but not necessarily be limited to the following measures. The contractor shall ensure implementation of such measures.

- Ensure that safe storage of fuel, other hazardous substances and bulk materials are agreed by PPL and follow internationally recognized good practice;
- Hydrocarbon and toxic material will be stored in adequately protected sites consistent with the Environmental Code of Practice (ECOP) for Vehicle/Machinery Workshops and Petroleum, Storage Resale and Usage Sites (DEC 1997) to prevent soil and water contamination;
- Segregate hazardous wastes (oily wastes, used batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution and shall be undertaken consistent with the ECOP;
- Ensure all storage containers are in good condition with proper labelling;
- Regularly check containers for leakage and undertake necessary repair or replacement;
- Store hazardous materials above possible flood level;
- Discharge of oil contaminated water shall be prohibited;
- Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by PPL;
- Adequate precautions will be taken to prevent oil/lubricant/ hydrocarbon contamination of drainage channel beds;
- Spill clean-up materials will be made available before works commence (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored; and
- Spillage, if any, will be immediately cleared with utmost caution to leave no traces.

All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations complying with all the applicable statutory stipulations.

Provided the WMP is prepared, approved and implemented in accordance with the above recommendations the environmental impacts associated with waste management are expected to be negligible.

D. Impacts on the Biological Environment

1. Impact on Aquatic Ecosystem

Given the limited scale and duration of excavation works associated with construction of river bank protection works at Warangoi HP headworks over a short period in an otherwise highly disturbed aquatic environment due to the existing facilities, the potential impact on the

existing aquatic ecosystem will be insignificant. Furthermore, it is understood that the aquatic ecosystem of the Warangoi River both above and below the headworks has been subject to water quality contamination by sedimentation and tailings from old Gold mining works upstream of the headworks.

There will be no impacts on the aquatic ecosystem at YTD or Lake Hargy due to the fact that the proposed upgrading/rehabilitation works do not involve disturbance of the existing river channel. Any potential indirect impact due to erosion, siltation or waste disposal during construction will be mitigated to acceptable levels through the measures described above.

2. Impacts on Terrestrial Habitat and Biodiversity

The project will involve minor clearance of vegetation for the river bank protection works at Warangoi and for the surge tank footprint on the Yonki Dam. In both cases the vegetation to be cleared comprises grass and scrub which has colonized the site following previous disturbances. At Warangoi the river bank vegetation is typical of a river bank terrace which is periodically affected by flooding and changes of river course and has low ecological value. Similarly, the vegetation to be cleared at Yonki Dam is highly modified habitat of low biodiversity value that has colonised the dam slope. The potential impact on terrestrial habitat and wildlife will be insignificant.

The proposed use of predominantly manual labour over mechanical equipment during construction will reduce the risk of excessive vegetation clearance. However, this will require close construction supervision to ensure vegetation clearance is minimized. Such provisions shall be included in the CEMP.

There will be no impacts on terrestrial habitat and biodiversity at Lake Hargy HP due to the fact that no significant civil works will be undertaken.

Workers will be prohibited from poaching or hunting any birds or wildlife from within the project areas or adjacent catchments.

E. Impacts on the Socio-economic Environment

1. Construction Camp/Site Office Impacts

At each of the three sites it is most likely that the workforce is expected to be in the order of about 20 with 50% being unskilled labour which can be recruited locally from surrounding settlements of Yonki Town, Kokopo and Lake Hargy. Skilled labour will likely come from outside the area and can be accommodated in Yonki Town, Kokopo and Kimbe therefore it is unlikely that there will be need for large-scale accommodation at the site. However, a site office and storage/maintenance area is likely to be established for the duration of the construction period at each site.

The contractors will be required to adopt good management practices to ensure that both physical impacts and social impacts associated with a camp and/or office/yards are minimized. As noted previously fuels and chemicals, raw sewage, wastewater effluent, and construction debris associated with the construction site office and storage maintenance area will be disposed of appropriately. As part of implementation of the WMP waste will be disposed of under controlled conditions to reduce impacts (refer to section B.5).

It is expected that the contractors' camps and/or office/yards will be located within the boundary of the three HP sites.

Social impacts include i) potential for conflict between workers from outside and local residents and communities; ii) risk of spread of communicable diseases including STIs and HIV; and iii) risk of contamination of local water sources.

The proposed measures to mitigate the above risks and impacts include:

- Induction of workers on protocols established for any contact between local communities and contractor/workers;
- Implementation of a communicable disease awareness and prevention program targeting risk of spread of STIs and HIV as outlined in the project's poverty and social assessment and gender action plan;
- The contractors will put up notice boards regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions;
- Locations of site office and facilities to be agreed with local community including land owners) with facilities approved by PPL (if outside site boundary).;
- The facilities (camp and yard) will be fenced and sign-posted and unauthorized access or entry by general public will be prohibited;
- Potable water, clean water for showers, hygienic sanitation facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. Adequate toilet facilities shall be installed and open defecation shall be prohibited and use of toilets encouraged by keeping toilet facilities clean at all times separate toilets shall be provided for male and female workers;
- For unskilled activities and labour, as many local people (including women) as possible will be recruited and trained;
- Standing and open water (including puddles, ponds, drains etc) within the camp or office/yard shall not be permitted to reduce possible disease vectors;
- To reduce risk of contamination of local water sources, wastewater effluent from contractors' workshops (if any) will be passed through gravel/sand beds or an oil separator and all oil/grease contaminants will be removed before discharging it into natural water courses. Oil and grease residues shall be stored, handled and disposed of as per the agreed WMP;
- The contractors facilities area will be cleaned up to the satisfaction of PPL and local community after use; and
- Post-construction the area shall be fully rehabilitated and all waste materials shall be removed and disposed to disposal sites approved by local authorities.

Effective implementation of the above measures will ensure that potential social impacts associated with the contractorss camps and/or site office/yards will be negligible.

2. Occupational Health and Safety

A Health and Safety Plan (HSP) will be submitted by the contractors to establish routine safety measures and reduce risk of accidents during construction/refurbishment of the facilities. The HSP will cover both occupational health and safety (workers) and community health and safety. The HSP will be appropriate to the nature and scope of construction activities and as much as reasonably possible meet the requirements of good engineering practice and World Bank's Environmental Health and Safety Guidelines.

The HSP will include agreement on consultation requirements (workers and communities), establishment and monitoring of acceptable practices to protect safety, links to the complaints management system for duration of the works (in accordance with agreed Grievance Redress Mechanism), and system for reporting of accidents and incidents.

Mitigation measures to be implemented by the contractor to ensure health and safety of workers are as follows:

- Before construction commences the contractors will conduct training for all workers on environmental, safety and environmental hygiene. The contractors will instruct workers in health and safety matters as required by good engineering practice and Environmental Health and Safety Guidelines;
- The camp and/or office/yard will be equipped with first aid facilities including first aid kits in construction vehicles. A suitable vehicle will be available for

transport to the nearest clinic or hospital for medical or emergency treatment if required;

- Regular meetings will be conducted to maintain awareness levels of health and safety issues and requirements;
- Workers shall be provided (before they start work) with appropriate personnel protective equipment (PPE) suitable for civil work such as safety boots, helmets, gloves, protective clothes, goggles, and ear protection at no cost to the workers. Site agents/foremen will follow up to see that the safety equipment is used and not sold on;
- Provision of potable water supply in all work locations;
- The camp and/or office/yard will be securely fenced and warning signs erected. Unathroized people shall not be permitted within the cam and work sites/yards; and,
- Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works.

All measures related to workers' safety and health protection shall be free of charge to workers. The worker occupational HSP to be submitted by the contractor before construction commences and in tandem can be extended to cover public safety and approved by PPL.

3. Community Health and Safety

Community safety can be threatened by works in public areas. General measures and requirements of the HSP which apply equally to community and workers have been discussed above. The HSP will cover measures to minimize risk to community safety including:

- Communication to the public through public/community consultation including notice boards and meetings etc. regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions;
- Barriers (e.g. fence) and signboards shall be installed around the camp and construction areas to deter access to or through the sites;
- The general public/local residents shall not be allowed in the sites which are high-risk areas;
- Provision of warning signs at the periphery of the site warning the public not to enter; and
- Strict imposition of speed limits along access through residential areas and where other sensitive receptors such as schools, hospitals, and other populated areas are located.

Such measures will manage risk to community health and safety to acceptable levels.

4. Physical Cultural Resources

Given that all works will be undertaken within the boundary of existing project sites owned by PPL, no impacts on physical cultural resources due to the upgrading and refurbishment works are expected.

F. Operation Impacts

There will be no significant operational impacts due to the proposed refurbishment and upgrade works at the three subproject sites over and above the existing conditions since the works proposed do not significantly alter the current operational aspects other than to improve efficiency.

However, the Due Diligence Review of the current operations did identify a number of issues related to current operations at the three subproject sites that were considered non compliant with SPS safeguard requirements. Corrective actions and recommendations have been proposed to ensure compliance with SPS requirements The issues including recommendations and corrective actions are summarized in Section VB and described in more detail in Annexes 1.1-1.3.

G. Climate Change Effects and Adaptation Requirements

Climate change is concerned with long term changes in weather patterns often averaged over 30 years. These include things like increases in average temperatures, changes to average rainfall and changes to the intensity and frequency of extreme events, such as cyclones. Climate change risk management approaches focus on predicting how these changes could impact on natural systems including hydrologic, geological processes, agricultural systems, ecological equilibrium and the built environment, and building resilience in these systems through adaptive interventions.

Based on the available information, an assessment of climate risks is presented and recommendations made for resilience building adaptive measures into the project.

1. Review of Relevant information

Fairly clear projections exist which suggest that temperature has been steadily rising and is expected to increase by 0.4-1.0°C by 2030 in PNG. Projections in terms of rainfall changes are less consistent and climate change models are unable to resolve many of the physical processes involved in producing extreme rainfall.[5] However, increases in extreme rainfall days are expected in terms of frequency. For the design of most infrastructure, peak rainfall is more important than annual average rainfall.

Sea level has risen near PNG by about 7 mm per year since 1993 which is larger than the global average of 2.8-3.6 mm per year and is an issue that needs to be considered in long-term infrastructure development. Sea-level is expected to continue to rise in PNG. By 2030 under a high emissions scenario, this rise is expected to be in the range of 4-15cm. This will increase the impact of storm surges and coastal flooding.[6]

Sea-surface temperatures have also gradually risen around PNG since the 1950s and ocean acidification has increased which puts the health of coral reefs at risk. These are important because coral reefs protect the shoreline from impacts from storms and support the tourism and fishing industries, which are important to the country.[7]

2. Exposure of Small Hydropower Infrastructure

Key civil infrastructure components associated with the hydropower projects of the project including intake structure, canal, penstock, powerhouse and access road are located away from the coast in hilly areas.

In the next 50 years PNG has a 40% chance of experiencing at least one severe tropical cyclone which will be destructive enough to cause widespread damage and significant economic losses. There is also a 20% chance that the areas of PNG where the subprojects are located will experience the second highest category of earthquake intensity within the next 50 years.[8]

Climate change is expected to change the patterns for tropical storms. Generally there is a projected decrease in the number of events but an increase in their intensity or severity (i.e.

[5] Government of Vanuatu, Australian Bureau of Meteorology. 2011. Pacific Climate Change Science Program: Current and Future Climate of PNG (2011)
[6] Ibid.
[7] Ibid.
[8] United Nations Office for the Coordination of Humanitarian Affairs. 2011. PNG: Natural Hazard Risks

category 4 and 5 being the highest). Windstorms, including cyclones, tidal surges and storms are already the leading hazard cause of losses of life and assets across the Pacific.[9] Earthquakes are the most important hazard for building damage.

It should be noted that the above assessment does not include risks from sea-level rise and associated storms, increased temperatures and land based flooding. This type of hazard assessment does not exist on a country scale. Sea level rise will increase exposure where elevations are lower and floods may increase in more mountainous areas.

Some of the identified risks posed by climate change and natural hazards in the Pacific, specific to the energy sector are described in Table 5.1. This table is adapted from ADB's Climate Risks and Adaptation in the Power Sector (2012). It includes various adaptation options that could be considered for the risks identified in respect of the small run-of-river type hydropower projects proposed under the project.

Energy production, utilization, conversion and transportation have and will be affected by most natural weather phenomena such as cyclones, floods, droughts and storm surge.

Table 5.1 - Summary of Impacts and Adaptations on Hydroelectricity Infrastructure

Climate change/hazard	Potential Impact	Potential Resilience Measure	Complementary Measures
Sea-level rise	Most hydro is located inland and not directly affected by sea-level rise, possibly increased rate of deterioration of concrete structures due to increased salinity from sea-level penetration upstream	Materials substitution for less corrosive materials	Coastal zone protection to protect estuaries and watersheds
Increase/decrease in rainfall	Energy from hydropower relies on rainfall and reduced river flow over a period of time could reduce or disrupt entirely energy generation.	Where flow is expected to increase, modify the number and type of turbines that are better suited for expected water flow rates, reduce expected turbine lifetime due to higher suspended sediment loads, modify canals to better handle changes in water flows, modify spillway capacities	Develop improved hydrological forecasting techniques and adaptive management operating rules; develop basin-wide management strategies that take into account the full range of downstream environmental and human water uses; restore and better manage upstream land including afforestation to reduce floods, erosion, silting, and mudslides. Improved watershed modelling to inform better management
Cyclones/hurricanes and frequent strong storms	Flooding of riverbanks could adversely affect stream flow particularly where hydropower is generated. Transmission/distribution lines and poles are damaged.	Design more robust infrastructure for heavier flooding and extreme events	
Increased temperatures	Higher evaporation rates, reduced turbine efficiency	Water cooling systems in turbines	

[9] World Bank. 2006. *Not if But When: Adapting to Natural Hazards in the Pacific Islands Region* (Policy Note)

Climate change/hazard	Potential Impact	Potential Resilience Measure	Complementary Measures
Earthquakes	Damage to infrastructure, oil spills and fire hazards.	Use design standards applicable to high earthquake risk areas.	

Source: Asian Development Bank (2012)

1. Integrating Climate Change Adaptation Measures into Project Design

Integrating climate change adaptation measures into the design of the refurbishment components of the subprojects needs to be based on the economic considerations associated with the hydropowser schemes.The expected increase in the frequency of extreme rainfall events is the prime climate change issue in respect to the design of small run-of-river hydro projects in PNG. Therefore design criteria in respect of peak flood size and levels need to take account of the potential effects of climate change.

Critical structures that need to be considered for possibly increased peak floods include: (i) intake weir - suitable erosion protection to prevent scour around the intake weir's training walls; and (ii) powerhouse - level of powerhouse discharge outlet needs to be sufficiently high so as to prevent any flood induced backflow resulting in flooding of the powerhouse and damage to electromechanical equipment.

Appropriate climate change adaptation and resilience needs to be incorporated into the design of refurbishment structures including suitable erosion protection to prevent scour around the Warangoi intake structures. Design criteria need to be established for these structures that take account of future climate change induced peak flood size and levels during the design life of the plant. In practical terms this could mean increasing the maximum design flood level for each of the above structures and/or increasing the level of design flood freeboard. If possible, the establishment of design criteria needs to be based on available climate change modelling data to develop synthetic extreme event data. In the absence of climate change modelling data the design criteria should be demonstrably conservative. Design criteria for the necessary components will be established by the consultant responsible for preparation of the tender documents.

Other measures to mitigate the effect of an increase in intensity of extreme rainfall and consequent floods on the project components centre on enhanced erosion protection. This is particularly relevant for the proposed bank protection works at Warangoi. Such measures could include additional river bank protection / rock armor placed around the intake structures.

The extent to which such climate change adaptive measures are employed for erosion protection needs to be balanced against the marginal economics of small scale hydropower projects. For example, for project components that are repairable and any resulting outage not significant, normal best practice design criteria should apply. Any additional erosion protection measures over and above normal design criteria for such works, can be implemented during project operation if required. On the other hand if there is a plentiful supply of nearby rock material able to be utilized for erosion protection it might be that a small incremental cost for enhanced erosion protection for climate change adaptation purposes during construction may have a significant economic benefit.

In principle, it is suggested that the project only makes climate change design decisions on structures that cannot be practically modified or adapted later during the project's operational life. This includes the critical structures that need to be protected against peak flood size and levels as indicated above. However, if the incremental cost of providing enhanced river bank and/or slope protection as a climate change adaptation measure is low, this should also be incorporated into the project design otherwise such measures can be implemented as needed during the operational life of the project.

VI. INFORMATION DISCLOSURE AND CONSULTATION

Community consultations were undertaken as much as possible in repect of the three subprojects assessed in this IEE during May 2016. Consultations were undertaken in conjunction with the social safeguards team and are reported in detail in the social safeguards due diligence documents.

PPL's TEIP environment officer represented ADB's environmental due diligence team at the consultations and presented the key findings of the Draft IEE to the attendees and asked the attendees to raise any issues of concern regarding the environment. A meeting with community stakehoklders was not possible at YTD. However, from an environment issues perspective this is not considered significant for this subproject given the relatively benign nature of the works associated with construction of the surge chamber adjacent to the penstocks on the YTD itself. A brief summary of the meetings including number and nature of attendees and environmental issues addressed/discussed is provided below.

Lake Hargy HP Upgrade: A meeting was held at Baikekea Village, West New Britain Province on 19 May 2016 with landowners and clan representatives of the area around Lake Hargy. There were 13 participants plus the consultation team comprising PPL's Bialla Centre Manager, the Consultant's social and gender specialist and PPL's social and environment specialists. Following presentation of the key findings of the IEE the participants were asked to raise any issues of concern. No environmental issues were raised by the participants and they were happy for the project to proceed.

Warangoi HP Refurbishment: No meetings with community stakeholders were undertaken however, on 24 May 2016 meetings were held with key informants including the Provincial Lands Advisor at the Division of Lands of the East New Britain Provincial Administration in Kokopo and with the CEO of the Qaqet Stewardship Council Inc in Kokopo. No issues of concern relating to environmental issues associated with the proposed works were raised by the key informants.

VII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

The environmental assessment of the construction, operation, and maintenance of the Tranche 2 project components has determined that the project will have an insignificant impact on the local environment. Environmental mitigation measures have been proposed to avoid or minimize environmental impacts to acceptable levels. The proposed environmental mitigation measures are proven technologies normally associated with internationally recognized good engineering practice.

EMPs for each of the three projects are presented below and comply with government and ADB requirements. The EMPs include the following information:

- Implementation arrangements for the EMP including:
  - institutional roles and responsibilities for EMP implementation throughout all stages of the project (procurement, design, construction, operation)
  - capacity building requirements for executing agency to ensure environmental management requirements are properly understood and fully implemented
  - grievance redress mechanism
- Environmental mitigation and monitoring matrices including:
  - potential environmental impacts that could occur during each stage of the project (pre-construction/design, construction, operation)
  - proposed mitigation measures to address each impact identified
  - agency responsible for implementing each mitigation measure

- monitoring tasks to ensure mitigation measures have been implemented effectively during each stage of the project
- schedule and responsibility for monitoring

- Costs associated with implementation of all aspects of the EMP.

B. Implementation Arrangements

General. The PMU already established in PPL to support the project will be supported by a design and supervision consultant (DSC) including an international environment specialist (IES). The IES will provide on the job training to the PMU's environment officer (EO) to monitor the implementation of the Contractors' EMPs. The IES will also provide training to the EO and other PPL staff as required to address environmental management issues in respect of Tranche 1 project implementation.

The PMU will engage the contractors for construction. The contractors will have an environmental engineer delegated in their health and safety management division to cover the implementation of environmental mitigation measures.existing operations.

C. Institutional Roles and Responsibilities

Table 7.1 presents the responsibilities of the various parties that will apply to all aspects of the project implementation with respect to environmental requirements.

Table 8.1 - Responsibilities for EMP Implementation

Agency	Responsibilities
PNG Power Limited (PPL)	• Implementing agency with overall responsibility for project construction and operation • Ensure that sufficient funds are allocated to properly implement the EMP • Ensure that Project complies with the provisions of the EMP and SPS • Ensure that Project implementation complies with Government environmental policies and regulations. • Ensure that the PPL retain sufficient resources to support EMP related implementation issues. • For project duration ensure that the PMU commit and retain dedicated environment and safety staff. • Provide sufficient resources to PMU and segregate these amounts, specifically to support PMU for proper and timely staffing and monitoring and reporting of required mitigation measures in the EMP and CEMP.
Project Management Unit (PMU)	• Ensure that environmental protection and mitigation measures in the EMP are incorporated in the detailed designs. • Obtain necessary environmental clearances certification under Environment Act from CEPA as necessary prior to award of civil works contracts. • Ensure that Project implementation complies with SPS principles and requirements. • For project duration, commit and retain dedicated staff within the PMU to oversee EMP implementation (assisted by DSC) • Confirm that bidding contract documents include the IEE and EMP. • Check that necessary environmental clearances and approval(s) are obtained from CEPA prior to award of civil works contracts • Establish and implement an environmental grievance redress mechanism, as described in the IEE, to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the Project environmental performance. • Ensure that Contractor's bidding and contract documents include the IEE and updated EMP. • Include the IEE for Project subprojects and EMP and specify in the employers requirements of the contract for preparation and implementation of method statement and Contractor's site-specific EMP (CEMP) as described in the IEE/EMP and that the CEMP includes all mitigation measure specified in the updated EMP. • Prior to Contract being signed seek clarification from the Contractor on the Contractors proposed detailed design and method statements are as proposed in

Agency	Responsibilities
	the tender submitted. • Ensure that the Contractor has provided sufficient funding and human resources for proper and timely implementation of required mitigation measures in the CEMP and that these sums are segregated in the contract documents. • Ensure that updated EMP provisions are strictly implemented during various project phases (design/pre-construction, construction and operation) to mitigate environmental impacts to acceptable levels. • Check that environmental protection and mitigation measures in the updated EMP and CEMP are incorporated in the detailed designs and carried out by the Contractor. • Participate in an environmental grievance redress mechanism, as described in the IEE to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the Project's environmental performance • Undertake monitoring of the implementation of the EMP (mitigation and monitoring measures) with assistance from DSC. • Report to ADB on all aspects of environmental management and monitoring at six month intervals, based on the results of EMP monitoring. • Submit monthly progress reports implementation to PPL and ADB as necessary. • Prepare and submit summary semi-annual monitoring reports on EMP implementation to ADB with support from DSC. • Based on the results of EMP monitoring, identify environmental corrective actions and prepare a corrective action plan, as necessary, for submission to ADB. • Utilize all resources provided to PMU to support PMU and segregate these sums for proper and timely staffing and monitoring and reporting of required mitigation measures in the EMP and CEMP
Design and Supervision Consultant (DSC)	• Engage an IES to ensure proper implementation of EMP provisions. Through IES the DSC shall: (i) ensure proper and timely implementation of DSC 's tasks specified in the EMP, (ii) conduct on the job environmental training for PMU. (iii) conduct Contractor workers' orientation, awareness training and induction on EMP provisions, (iv) undertake regular monitoring of the Contractor's environmental performance, as scheduled in the EMP (v) assist PMU to prepare semi-annual environmental monitoring reports, as specified in the EMP, for submission to ADB. • Prior to Contractor's contract being signed assist PMU to seek clarification from the Contractor on the Contractors proposed detailed design and method statements in the tender submitted. • Review, and if necessary, update the IEE and EMP based on the Contractors proposed detailed design and method statements. • During the pre-construction phase when the Contractor produces detailed designs ensure that the detailed designs of the Contractor incorporate all the environmental protection and mitigation measures identified in the updated EMP. • Assist PMU to ensure that all environmental requirements and mitigation measures from the IEE and EMP are incorporated in the contract documents. • Prior to construction, review and approve in writing the updated CEMP/method statements prepared in consultation with Contractor as per Employers Requirements. • Implement all mitigation and monitoring measures for various project phases specified as DSC 's tasks in the EMP. • Support the PMU prepare and submit any submissions required by CEPA under the Environmental Act 2000 and obtain environmental clearance (EP) prior to project construction as required in the EMP • Assist PMU in obtaining environmental approvals and permits from CEPA prior to award of civil works contracts. • Assist PMU to ensure that the contractor has provided sufficient funding and human resources for proper and timely implementation of required mitigation measures in the CEMP and that these sums are segregated in the contract documents. • Undertake environmental management capacity building activities for PMU and awareness training and induction for contractor as described in the IEE. Monitor compliance with CEMP and other plans. • Support the establishment of monitoring and reporting/recording systems within PMU. • Provide inputs to Quarterly Progress Reports (QPR) to ADB
Contractor	• Recruit qualified environmental and safety agents (environmental specialists and /

Agency	Responsibilities
	or environmental engineers (ESA) to ensure compliance with environmental statutory and contractual obligations and preparation and thorough implementation of the CEMP. • Prior to start of construction, update the EMP and compile draft CEMP based on method statements to include WMP, MMP, ERCP, NDCP, DMP, TMP and HSP for approval by DSC. • Implement WMP, MMP, ERCP, NDCP, DMP, TMP and HSP and other management plans in cooperation with PMU and in close coordination with other relevant authorities. • Provide sufficient funding and human resources for proper and timely implementation of required mitigation measures in the EMP and CEMP and segregate these sums in the contract documents • Implement additional environmental mitigation measures for unexpected impacts, as necessary and as required by the PMU/DSC. • Monitor environmental effect as required by DEC environmental permit and ADB approved updated EIA and EMP.
PPL as operator	• Responsible for operation and maintenance of subproject. • Implement any additional monitoring if required in updated IEE and EMP for operations. • Provide additional resources to PMU to support EO and PMU for proper and timely implementation of operational monitoring if required and mitigation measures in the EMP.
Conservation and Environment Protection Authority	• Determine notice to proceed/EP requirements for each subproject. • Review and approve environmental assessment reports required by the Government. • Undertake monitoring of the project's environmental performance based on the CEPA mandate and environmental assessment.

To facilitate EMP implementation, during construction the contractors must be prepared during the detailed design / pre-contract and pre-construction phase to cooperate with PMU, DSC and the local population in the mitigation of impacts. The contractor will be required (under employers requirements of the contract and with the assistance of the DSC) to compile a CEMP based on their method statements and IEE and EMP or its updates if prepared by the DSC during the detailed design phase. Clearances for payments will include certification from the DSC as to the effective implementation of the CEMP and all other mitigation measures specified in the IEE and updated EMP. The completion of implementation of mitigation measures will therefore be linked to payment milestones.

D. Grievance Redress Mechanism

During the course of the project it is possible that people may have concerns with the project's environmental performance including the implementation of the EMP.[10] Issues may occur during construction and again during operation. Any concerns will need to be addressed quickly and transparently, and without retribution to the AP.

The following process is to be used and commences with an attempt to sort out the problem directly at sub-project level. If this cannot be resolved then the grievance moves to the resolution process outlined in Section 87 of the Environment Act 2000.

During construction: Most complaints (if any) arising during construction are expected to be minor complaints concerning dust or noise that should be able to be resolved easily and acted upon immediately at the sub-project level by the Project Engineer (PE). Where the complaint is of a more serious nature the PE will have up to two days to resolve the complaint.

[10] This procedure is for addressing environmental issues. Any grievances dealing with land and compensation issues are to be directed to the Department of Lands who have established procedures for dealing with these issues.

i. Affected people (AP) are in the first place to discuss their complaint directly with the Ward Councillor in their village. If the Ward Councillor supports the complaint both persons take the complaint to the on-site PE who will review the complaint within 2 days. All complaints arriving at the Site Office are to be entered in a Register that is kept at site by; date, name, contact address and reason for the complaint. A duplicate copy of the entry is given to the AP for their record at the time of registering the complaint. The Register will show who has been directed to deal with the complaint and the date when this was made together with the date when the AP was informed of the decision and how the decision was conveyed to the AP. The Register is then signed off by the person who is responsible for the decision and dated. The Register is to be kept at the front desk of the Site Office and is a public document. The duplicate copy given to the AP will also show the procedure that will be followed in assessing the complaint, together with a statement affirming the rights of the AP to make a complaint. For anybody making a complaint no costs will be charged to the AP.

ii. The (PE) will consider the complaint and within a maximum of two days will convey a decision to the AP. The AP and the Ward Councillor may if so desired discuss the complaint directly with the PE or his representative. If the complaint of the AP is dismissed the AP will be informed of their rights in taking it to the next step. A copy of the decision is to be sent to the PM at the PMU.

iii. Should the AP not be satisfied, then the AP may take the complaint to the Managing Director in the Conservation and Environment Protection Authority. (CEPA) and continue the grievance in accordance with Section 87 of the Environment Act 2000. Procedure for dealing with compensation claims for environmental impacts. The procedure is shown in the following steps.

iv. Affected party (AP) meets with Environment Permit Holder (PH) to formally register concern over impact and seek redress. A copy of the alleged impact is submitted to the Managing Director of CEPA (MD).

v. PH has to determine whether the impact has occurred due to its activities.

vi. If PH accepts responsibility for the impact, it can negotiate a mutually acceptable settlement with AP within 90 days.

vii. If PH rejects responsibility for the impact, AP can request CEPA to carry out a verification investigation.

viii. If MD confirms that the impact has occurred, he/she will advise the PH and AP to negotiate a settlement within 90 days.

ix. If a negotiated settlement is not reached under either Step 3 or 5, the PH or AP can request SDEC to formulate a determination. Once this request is made, MD will have 90 days to reach a determination.

x. If either party is dissatisfied with the determination, it can appeal to the National Court.

xi. The Secretary will have four weeks to consider the complaint. The Secretary will arrange for any complaint to be dealt with under the same procedure i.e. there will be no charge made to the AP for making a complaint.

xii. Should the AP not be satisfied with the ruling of the MD of the CEPA, the AP may at their discretion take the grievance to the PNG judicial system. This will be at the APs cost but if the court shows that the Managing Director, or the administration have been negligent in making their determination the AP will be able to seek costs.

During Operation The same procedure is followed except that the complaint is now directed to the HP manager to rectify. During operation the same conditions apply; i.e. there are no fees attached to the AP for making a complaint, the complainant is free to make the complaint which will be treated in a transparent

E. Environmental Mitigation and Monitoring Matrix

The EMP matrix for each subproject is provided in Annexes 2.1 – 2.3 and identifies the following:

- Potential environmental impacts during each stage of the subproject;
- Proposed mitigation measures to address each impact;
- Agency responsible for implementing mitigation measures;
- Monitoring tasks to ensure mitigation measures have been implemented effectively during each stage of the subproject; and
- Schedule and responsibility for monitoring.

VIII. CONCLUSION AND RECOMMENDATION

The IEE concludes that the potential environmental impacts arising from design, construction, operation and maintenance of the Tranche 2 project components will be minor, localized and acceptable provided that the mitigation measures set out in the EMP are incorporated into the design and implemented properly. Key findings are summarized below:

- The project involves refurbishment of two existing small hydropower projects and upgrading a third hydropower project with the provision of a surge tank along with repairs to the penstocks. All works proposed are within the footprint of the existing schemes' boundaries.
- The only civil works to be undertaken is the construction of river bank protection works at the Warangoi headworks and excavation for the foundations of a surge tank at Yonki Toe of dam. All other works are associated with refurbishment of hydro-mechanical or electro-mechanical components of the three subprojects.
- The potential loss of an insignificant amount of highly modified habitat of low ecological value within the existing hydropower site boundaries of Yonki Toe of Dam and Warangoi HP and impact on terrestrial wildlife due to the project will be insignificant. Loss of habitat can be further minimized by reducing the vegetation clearance for the civil works components.
- Following completion of refurbishment works there will be no change to the existing operations of the three subprojects other than improved operational efficiency and improved environmental health and safety facilities and processes.
- Nearby communities consulted are happy for the project to be implemented. and
- Appropriate climate change adaptation and resilience needs to be incorporated into the design of refurbishment structures including suitable erosion protection to prevent scour around the Warangoi intake structures and enhancement armouring to the proposed river bank protection works at Warangoi.

An audit of the existing facilities and operations at each of the subprojects identified a number of key areas where environmental improvements are required to bring operations in line with ADB SPS and international and standards. These and associated corrective actions recommended for PPL to implement to bring operations in line with SPS and interneational standards are as follows:

All subprojects

- PPL to make a formal request to CEPA using prescribed forms to obtain clarification regarding requirements for obtaining new or amended Environment Permits for the subprojects in light of refurbishment and upgrading works and taking account of any new EP requirements and procedures under the CEPA Act 2014

Yonki Toe of Dam HP

- PPL to cease disposing of used oil to the ground at the Ramu 1 workshop and fuel/oil storage facility and establish a proper used oil storage facility and associated operational procedures for waste oil disposal to comply with the DEC Environment Code of Practice for Vehicle Machinery and Petroleum (Hydrocarbons) Storage/Resale/Usage Site DEC 1997.
- PPL to remove all dumped waste oil and associated contaminated soil from the site, decontaminate the area and dispose of the waste oil/ contaminated soil at an appropriate hazardous materials disposal facility
- PPL to prepare a waste management plan and environmental monitoring plan for approval of CEPA in accordance with the current EP (or amended EP if required).
- PPL to commence annual environmental performance monitoring as required under the EP (or amended EP if required)
- PPL to commence environmental performance reporting as required under the EP (or amended EP if required)

Lake Hargy HP and Warangoi HPs

- PPL to introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at an authorized site and prevent burning of waste in line with the DEC environmental codes of practice.
- PPL to minimize impacts from incorrect storage and disposal of hazardous substances in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage.
- PPL to stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kimbe maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use.
- PPL to prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers.
- PPL to prepare and implement a Health and Safety Plan for the operation of Lake Hargy hydropower scheme. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines.
- PPL to ensure that workforce training for all workers will include environment, safety and environmental hygiene.
- PPL to maintain clean toilet facilities by cleaning daily and keeping flush toilets well maintained to allow effective operation.
- PPL to Maintain consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public.
- It is recommended that upgrading of the existing transformer bays to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works

With these recommendations and corrective actions implemented the environmental impacts of the Tranche 2 subprojects current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards

EMPs for each subproject have been prepared which will be updated based on detailed design and implemented during all phases of the Tranche 2 project. The EMPs identify potential environmental impacts arising from the project along with a corresponding schedule of mitigation measures to ensure potential impacts are maintained at insignificant levels and that international best practice is applied. They also include recommendations and corrective actions in respect of the due diligence audit.

This IEE, including the subproject EMPs is considered sufficient to meet ADB's and government environmental safeguard requirements in respect of the Tranche 2 subprojects for TEIP. No further or additional impact assessment is considered necessary.

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ANNEX 1 - AUDIT OF EXISTING FACILITIES AND OPERATIONS

ANNEX 1.1 YONKI TOE OF DAM HYDROPOWER PROJECT

1 INTRODUCTION

The project preparatory technical assistance for Tranche 2 of the TEIP has completed feasibility studies of three subprojects including Yonki Toe of Dam HP Surge Chamber, ii) Warangoi HP refurbishment and iii) Lake Hargy HP Refurbishment. The feasibility studies include an initial environmental examination (IEE) report covering all three project components which includes appendices with separate EMPs for each project component. This report documents the audit of existing facilities and operations at Yonki Toe of Dam (YTD) hydropower project (HP) operated by PPL Ltd. for which the provision of a surge chamber is proposed under the project.

Environmental impacts of the YTD subproject have been assessed in the IEE in line with the ADB Safeguards Policy Statement (SPS) 2009. The focus of the audit is on the environment in the existing facility in which the subproject will operate and if the facility's environmental management is generally consistent with ADB's safeguard objectives and requirements as defined in SPS. The audit also identifies any mitigation measures that are needed (corrective actions) to bring the facility's environmental management into line with ADB's safeguard objectives and requirements.

Through due diligence, review, and supervision ADB ensures that borrowers comply with the SPS requirements during project preparation and implementation. The process outlined in the SPS notes that, over time, ADB's safeguards may require updating of existing operations to enhance environmental effectiveness, respond to changing needs, and reflect evolving best practices. Due diligence has been undertaken through a review of the available documentation, interviews with operational staff of PPL Ltd and a site visit on 1 April 2016 in order to explore whether the facility is in compliance and/or can be brought into compliance with SPS, and if so to agree on required corrective actions and a time-line for their implementation as a part of international good practice.

In preparing the audit report the consultants have exercised due diligence and studied where PPL's current practices meet ADB SPS requirements and where there are gaps that need to be filled. This report summarizes the results of that study and identification of how any gaps can be addressed so that the loan procedures can proceed with confidence that the requirements of SPS will be complied with.

2 CURRENT STATUS OF ENVIRONMENTAL COMPLIANCE

The YTD hydropower project commenced construction in 2011 and was commissioned in 2013. It has an installed capacity of 18MW. Prior to construction an environmental impact assessment was undertaken for the project in accordance with the Environment Act 2000 and an Environmental Permit (EP) was obtained for the project on 10 February 2010. The term of the EP is 50 years. The EP includes terms and conditions in relation to the operation of the power station during this period.

The provision of a surge tank comprising a concrete cylinder of approximately 8 m diameter and 10 m high immediately adjacent to the penstock within the site will have an insignificant environmental impact and not fundamentally alter the existing operation of the project. Nevertheless, PPL needs to seek formal clarification from CEPA regarding the need for any additional permit requirements for the proposed works. An EMP in accordance with PNG guidelines has been prepared as part of the IEE.

A. ACTIONS REQUIRED FOR YONKI TOE OF DAM OPERATIONS TO COMPLY WITH SPS

The recommended course of action for PPL in order to achieve environmental compliance with SPS is for PPL to make a formal request to CEPA, using prescribed formsm, to obtain clarification regarding requirments for a new or amended EP for YTD HP in light of the proposed construction of a surge tank on the site and new procedures under the CEPA Act 2014. As part of this

application PPL needs to disclose the scope of works associated with construction and operation of the surge tank.

B. OPERATIONAL AND MAINTENANCE IMPACTS

An audit checklist was prepared based on the Terms and Conditions of Environment Permit No. WD-L2B (235) with respect to the operation of the Yonki Toe of Dam project. The terms and conditions of the EP are consistent with international best practice including SPS requirements. Thus, the terms and conditions of the EP were used as the basis for due diligence review during the site inspection and discussion with PPL staff. The results of the audit are presented in Table 1.

Table 1 – YTD HP Environmental Permit Audit Checklist for Operations

Environmental Issue	Permit No. WD-L2B Terms and Conditions for Operation of YTD HP	Compliance Status[1]	Comment / Recommendation/Corrective action
Erosion Control	Take all reasonable measures to minimize soil erosion and discharge of sediments into surface waters within premises	complies	
Waste Treatment Facilities	Carry out routine inspection of septic tank and landfill in order to maintain the efficiency of these waste treatment facilities	complies	Septic tank remains in good working order although toilet facilities need to be cleaned daily to ensure effective and sanitary operation.
	Ensure all solid wastes are collected and stored in bins for storage before disposal at appropriate landfill site	complies	
Storage of Hazardous Substances	All hazardous substances that are used on the premises shall be safely stored	complies	
Workshop and fuel	Manage workshop and fuel storage areas in accordance with the requirements of DEC Environment Code of practice for Vehicle/machinery and Petroleum (Hydrocarbons) Storage/Resale/Usage Site, DEC 1997	Does not comply	There is no workshop or fuel storage area on the YTD HP site. All workshop areas used for YTD are associated with Ramu 1 hydropower station. An inspection of the Ramu 1 workshop and fuel/oil storage facility showed that waste oil (some of which would likely have originated from YTD HP) was being disposed directly to the ground surface. This is non compliant with the Environment Code of Practice and international best practice. **Corrective Action Required** – PPL to immediately cease disposing of used oil to the ground and establish a proper used oil storage facility and associated operational procedures to comply with the DEC Environment Code of Practice for Vehicle Machinery and Petroleum (Hydrocarbons) Storage/Resale/Usage Site DEC 1997. In addition PPL shall remove all dumoed waste oil and associated contaminated soil from the site, decontaminate the area, and dispose of the waste oil/ contaminated soil at an appropriate hazardous materials disposal facility.
Rehabilitation	Undertake progressive landform rehabilitation within the premises including soil conservation and rehabilitation of dispersed soil and other	complies	

[1] Based on site observations, discussions with PPL staff and available information

Environmental Issue	Permit No. WD-L2B Terms and Conditions for Operation of YTD HP	Compliance Status[1]	Comment / Recommendation/Corrective action
	stockpiles		
Waste Management Plan	Submit a waste management plan for the premises to the Director for approval within 3 months from date of commencement of this permit	No waste management plan submitted to date	PPL to comply with conditions of EP and submit a WMP for approval of Director of Environment (CEPA)
Air Emissions	Employ appropriate control measures to minimize any form of emissions produced from premises. Dust should be controlled using dust suppressants including water sprays	complies	Dust and other air emissions arising from the site are insignificant
	Shall not generate offensive odour from the premises	complies	
Noise	Ensure that noise levels within the premises are minimized through the use of appropriate noise control measures.	complies	Office areas are shielded from turbine noise
Solid Waste	Ensure that all domestic and industrial wastes generated from the premises are disposed at the domestic and industrial landfill site	complies	Some evidence of burning of rubbish on site. This should be discouraged.
	Not place any solid or liquid waste in a manner where it could easily enter surface water through rainfall run-off.	complies	
Rainfall runoff	Segregate rainfall runoff from workshop and fuel storage areas by diverting clean runoff from those areas in order to avoid cross contamination with hydrocarbon waste	complies	
	Ensure only clean rainfall runoff from the premises is discharged into the Ramu River	complies	
Water & Waste Discharge	Discharge of rainfall runoff to comply with following water criteria; Dissolved Oxygen - > 6.0mg/L Total Suspended Solids < 10% change from background mean seasonal values Oil & Grease – None noticeable as visible film or detectable by odour	unknown	No monitoring has been undertaken to confirm compliance however, site observations suggest that compliance is likely
	Discharge of sewage effluent at discharge point shall occur at the rate specified	N/A	Plant is served by a septic tank and soak away pit. Therefore there is no direct discharge of sewage waste.
	The discharge of wastewater shall not cause water quality of the Ramu River to exceed the specified water quality criteria	N/A	As above
Monitoring	Permit Holder shall submit an Environmental Monitoring Plan to the Director for approval within 3 months from the date of amendment of this permit. The monitoring plan shall contain a detail outline of the monitoring programs for the premises, including monitoring requirements under this permit	No record of plan submitted	PPL to comply with conditions of EP.
	Permit Holder shall monitor its environmental performance in accordance with approved Environmental Monitoring Plan	No monitoring undertaken to date	PPL to comply with conditions of EP.
Reporting	Permit Holder shall submit an Environmental Performance Report to the Director at the end of each calendar year reporting on monitoring undertaken including interpretation of results, incidence of noncompliance and reasons and status of compliance with the Waste	No EPR submitted to date	PPL to comply with conditions of EP

Environmental Issue	Permit No. WD-L2B Terms and Conditions for Operation of YTD HP	Compliance Status[1]	Comment / Recommendation/Corrective action
	Management Plan and other conditions of the permit.		
	Permit Holder shall notify Director of any significant environmental incident that occurs in relation to carrying out of works or the discharge of wastes from the premises	No significant environmental incidents have occurred to date	

C. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the audit of the EP for operations at YTD HP the DDR concludes that the environmental impacts from the existing activities at YTD HP are not significant at the actual site. However, the issue of disposal of used oil from the site represents a significant non-compliance with the EP and international best practice including SPS. The audit also identified the fact that there appears to have been i) no Waste Management Plan or Environmental Monitoring Plan prepared by PPL as required in the EP ii) no implementation of the required environmental monitoring program and iii) no annual Environmental Performance reporting undertaken to date.

The EMP in the IEE presents a more detailed analysis of the environmental impacts and the required mitigation measures based on the type, extent and duration of the identified environmental impacts. The EMP has been prepared through close reference to best practices and compliance with PNG laws and the SPS. The key actions identified in this DDR are summarized below:

- Make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new or amended EP for YTD HP.
- PPL to immediately cease disposing of used oil to the ground at the Ramu 1 workshop and fuel/oil storage facility and establish a proper used oil storage facility and associated operational procedures for waste oil disposal to comply with the DEC Environment Code of Practice for Vehicle Machinery and Petroleum (Hydrocarbons) Storage/Resale/Usage Site DEC 1997.
- In association with the above, PPL shall remove all dumped waste oil and associated contaminated soil from the site, decontaminate the area, and dispose of the waste oil/ contaminated soil at an appropriate hazardous materials disposal facility
- PPL to prepare a waste management plan and environmental monitoring plan for approval of CEPA in accordance with the current EP (or amended EP if required).
- PPL to commence annual environmental performance monitoring as required under the EP (or amended EP if required)
- PPL to commence environmental performance reporting as required under the EP (or amended EP if required)

With these measures and corrective actions implemented, the environmental impacts of ETD HP current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards

ANNEX 1.2 LAKE HARGY HYDROPOWER PROJECT

1 INTRODUCTION

The project preparatory technical assistance for Tranche 2 of the TEIP has completed feasibility studies of three subprojects including Yonki Toe of Dam hydropower project (HP) Surge Chamber, ii) Warangoi HP refurbishment and iii) Lake Hargy HP Refurbishment. The feasibility studies include an initial environmental examination (IEE) report covering all three project components which includes appendices with separate EMPs for each project component. This report documents the audit of existing facilities and operations at Lake Hargy hydropower project operated by PPL Ltd. which will be upgraded as part of the Lake Hargy HP upgrade component of the project.

Environmental impacts of the Lake Hargy subproject have been assessed in the IEE in line with the ADB Safeguards Policy Statement (SPS) 2009. The focus of the audit is on the environment in the existing facility in which the subproject will operate and if the facility's environmental management is generally consistent with ADB's safeguard objectives and requirements as defined in SPS. The audit also identifies any mitigation measures that are needed (corrective actions) to bring the facility's environmental management into line with ADB's safeguard objectives and requirements.

Through due diligence, review, and supervision ADB ensures that borrowers comply with the SPS requirements during project preparation and implementation. The process outlined in the SPS notes that, over time, ADB's safeguards may require updating of existing operations to enhance environmental effectiveness, respond to changing needs, and reflect evolving best practices. Due diligence has been undertaken through a review of the available documentation, interviews with operational staff of PPL Ltd and a site visit on 5 April 2016 in order to explore whether the facility is in compliance and/or can be brought into compliance with SPS, and if so to agree on required corrective actions and a time-line for their implementation as a part of international good practice.

In preparing the audit report the consultants have exercised due diligence and studied where PPL's current practices meet ADB SPS requirements and where there are gaps that need to be filled. This report summarizes the results of that study and identification of how any gaps can be addressed so that the loan procedures can proceed with confidence that the requirements of SPS will be complied with.

2 CURRENT STATUS OF ENVIRONMENTAL COMPLIANCE

The Lake Hargy hydropower project was constructed during the 1980s. The first 750kW unit was commissioned in 1989 and a second 750kW unit was commissioned in 1995. It has a total installed capacity of 1500 MW. At the time of commissioning there was no statutory requirement under PNG law for environmental impact assessment nor any requirement for an environmental permit. However, two water use permits (WUP) under the Water Resources Act 1982 were obtained by PNG Electricity Commission (ELCOM), the entity preceding PPL Ltd. The Water Resources Act was repealed by the Environment Act in 2000, and while all permits approved under Water Resources Act stayed in force, the permits for Lake Hargy HP will expire in 2018.WUP No. 29/290 Item 2 was issued on 7/6/88 and covered the construction of the scheme only. WUP No. 29/90 Item 2(a) was issued on 7/5/93 and provided permission to "Dam and divert Lobu River near Lake Hargy for power generation". The intended rate for the use of water for the permit was set at 1,440,000 litres per hour (4 cumecs), 24 hours per day, 365 days per year for 25 years. This permit expires on 10/6/2018. It appears that no additional WUP or amendment to the existing one, was obtained by ELCOM in respect of the operation of the second unit that was commissioned in 1995 which required an additional 4 cumecs to be diverted from the river for power generation.

Under the Environment Act, PPL will be required to obtain a new permit for the Lake Hargy System in 2018. A meeting was held with the Senior Permitting Officer of the Conservation and Environment Protection Authority (CEPA) to clarify the permitting requirements for Lake Hargy HP in respect of the EAct 2000 and the CEPA Act 2014. It was advised that CEPA has developed some new requirements around granting of EPs to replace expired WUPs. CEPA advised PPL to

send a letter of request for clarification using prescribed forms. Given that no new activities are proposed for Lake Hargy other than refurbishment of existing components and the project remains a Level 1 activity, it is understood that CEPA will require at most an Environmental Management Plan (in accordance with the PNG Guideline). PPL is in the process of obtaining formal clarification from CEPA using the prescribed forms as required. An EMP in accordance with PNG guidelines has been prepared as part of the IEE.

A. ACTIONS REQUIRED FOR LAKE HARGY OPERATIONS TO COMPLY WITH SPS

There are several immediate recommended actions for PPL in order to achieve environmental compliance with SPS: The recommended course of action is for PPL to:

- Make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Lake Hargy HP to replace the WUP due to expire in 2018.
- Disclose the scope of the improvements for Lake Hargy refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Lake Hargy HP.

B. OPERATIONAL AND MAINTENANCE IMPACTS

There are occasional small scale impacts arising at Lake Hargy HP from routine operations and maintenance. They include (i) waste disposal, (ii) clearing drainage and access roads near buildings (iii) service road maintenance and drainage, (iv) maintenance of header pond, intake, headrace canal and penstock, (v) delivery and installation of spare parts and equipment, (vi) disposal of waste oil (vii) maintaining toilets and washrooms, and (vi) managing safety of various worker activities in and around the site. These impacts are minor in scale and do not constitute non-compliance with SPS.

For purposes of this DDR existing facilities or aspects of operations and control measures that do not meet SPS requirements have been identified.

General Waste Management

There is no waste collection from Lake Hargy HP. Small amounts of general refuse are dumped in an open earth pit adjacent to the perimeter fence on the site boundary approximately 50m from the powerhouse. The pit does not appear to be managed in any systematic way. The mitigation measures for waste will seek to reduce, recycle and reuse waste as far as practicable. The mitigation measures are not repeated here in full but the Waste Management Plan (WMP) will also be sufficient to control other waste from Lake Hargy HP. The key actions for general waste disposal are to:

- Introduce waste reduction, reuse and recycling methods
- Segregation wastes at source
- Prohibit burning of operational and general wastes.
- Establish regular disposal schedule for general waste off site at local waste disposal areas. Such areas should be approved by local authorities and be operated in line with the DEC environmental code of practice for Sanitary Landfill Sites and rehabilitated, monitored, catalogued, and marked
- Organic (biodegradable - such as tree trimmings) shall be collected, stockpiled and given to the local community (NO BURNING is allowed on site)
- Lake Hargy yard shall be provided with garbage bins
- Disposal of solid wastes into drainage ditches, rivers, other watercourses, agricultural fields and public areas shall be prohibited

Hazardous Materials and Hazardous Waste Disposal

Transformer oil and other oils and lubricants are hazardous substances used at Lake Hargy HP. The use of hazardous substances such as oils and lubricants is not controlled by spill prevention procedures or containment facilities. Oil drums are transported to the site on an as needed basis, usually one or two drums at a time. The oil drums are stored in a partially covered area on the ground surface next to a storm water drainage channel adjacent to the powerhouse. There is no hard standing covered area and associated bunds that would prevent contamination of storm water runoff or allow for containment of oil spills or leakage from storage or use of the oil drums. According to operational staff, waste oil is mainly given away to the local community with the remainder dumped in the on-site domestic waste pit noted above. Empty oil drums are given to the local community for their use. There is no monitoring of waste oils and lubricants disposal.

In order to minimize impacts from incorrect storage and disposal of hazardous substances in the construction stage several mitigation measures have been proposed for the Contractors to implement. These will be covered in the Hazardous Materials section of the Waste Management Plan. Several of the mitigation measures are also relevant to routine operations at Lake Hargy to bring the operations in line with SPS. The contractors shall ensure implementation of such measures.

- Ensure safe storage of fuel, other hazardous substances and bulk materials in line with DEC environmental code of practice for Vehicle/Machinery Workshops and Petroleum Storage / Resale / Usage is followed
- Ensure that transformer oil drums are stored drums on side with outlet at 9 o'clock or 3 o'clock to keep bung moist and avoid penetration of water vapour
- Ensure all storage containers are in good condition with proper labeling
- Regularly check containers for leakage and undertake necessary repair or replacement.
- Store hazardous materials above possible flood level
- Discharge of oil contaminated water shall be prohibited
- Used waste oil and other toxic and hazardous materials shall be disposed of off-site at the PPL Kimbe maintenance area stockpile or given to the local community for there use.
- Adequate precautions will be taken to prevent oil/lubricant/ hydrocarbon contamination of drainage channel beds
- Make spill clean-up materials available (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored
- Immediately clear up spillage, if any, with utmost caution to leave no traces.

It was noted during a visual inspection of the switchyard at Lake Hargy HP that the transformer bay does not have adequate oil containment facilities that would normally be expected in accordance with international best practice. No evidence of oil leakage from existing transformers was noted and the risks of leakage are considered low. Furthermore, the size of the transformers is not much larger than distribution level which does not normally require such containment.

Nevertheless, international best practice requires switchyard transformers to be housed on platforms with sufficient oil containment facilities to prevent release of oil to the surrounding environment in the unlikely event of release of oil due to catastrophic failure of a transformer. It is therefore recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works.

Polychlorinated Biphenyls (PCBs)

PCBs were widely used as dielectric fluids in transformers and capacitors up to the 1980s. Since that time and since the 1990s new equipment has generally been supplied free of PCBs. It has not been possible for the maintenance section of PPL to identify any records of PCB content of the

PPL equipment; much of which was inherited earlier from the PNG Electricity Commission. Previous discussions with the maintenance section at PPL have indicated that many of the transformers and capacitors still in commission by PPL date from the 1980s to 1990s period and therefore they may contain or may have contained PCB.

Transformers and capacitors do not generally require frequent maintenance but the transformer oil is checked regularly and topped up as necessary. PCBs have not been used in transformer oils for many years.

Due to the gradual replacement of the transformer oil as the topping up proceeds over many cycles over several years PCBs in old transformers will be gradually flushed out but residual PCBs can remain trapped and leach out only slowly into fresh transformer oil. Thus the replacement transformer oil can become contaminated.

PPL have also been accustomed to reconditioning the transformer oil for reuse and therefore there remains a third possibility that reconditioned transformer oil can become contaminated if it is mixed with oil from PCB containing equipment. If this oil is reused in an otherwise uncontaminated or newer transformer this may lead to contamination of equipment that originally did not containing any PCBs.

PPL have not been accustomed to keeping detailed records of the sources of oil used to top-up transformers and therefore there is a low possibility that some of the PPL transformers in service may have been contaminated with PCB or may still contain oil that may be leaching residual PCBs. The only way to check this would be to analyze the transformer oils for PCB. However there is no accredited laboratory in PNG that can make this analysis and samples would need to be transferred overseas.

Options for treatment of PCB contaminated transformers have been developed by specialist companies and include:

- Collection of PCB-contaminated transformers and equipment
- Pumping-out and rinsing of this equipment (suing solvents)
- Disassembly and cleaning of these objects for purposes of removing PCBs
- Sorting and processing into scrap of the cleaned metal parts
- Distillation of the solvents

End disposal of waste PCBs can include high temperature incineration. Co-disposal in secure landfills has also been used.

If oil in transformers or waste transformer oil is subsequently discovered to contain PCBs there is no disposal facility in PPL or PNG and therefore treatment by specialist company overseas would seem to be the only an option at this stage. However these types of facilities are not available in PNG.

For this subproject, new equipment and transformer oil will be supplied without PCB and for purposes of the subproject a way forward would be to ring fence any new subproject transformers and other equipment needing dielectric oil and make sure that new equipment is only serviced with new PCB free transformer oil. In future the subproject transformers and capacitors will only receive PCB free transformer oil so that they do not become contaminated and remain PCB free. A rule can be made that no new equipment supplied under the subproject can be serviced with reconditioned dielectric oil.

In order to minimize impacts from unknown status of PCBs at Lake Hargy switchyard the following measures are proposed to be included in the Hazardous Materials section of the WMP and implemented to bring the subproject in line with SPS.

- Enforce a rule in line with ADB guidelines on environmentally responsible procurement that new equipment is supplied free of PCB and certified to be PCB free. No new equipment shall be supplied with PCB contamination.
- Ring fence the new subproject transformers and other equipment needing dielectric oil.

- Enforce a rule that no new equipment supplied under the subproject can be serviced with reconditioned dielectric oil.
- Ensure that the new equipment is only serviced with new PCB free transformer oil.
- Ensure that in future the new subproject transformers and capacitors will only receive PCB free transformer oil so that they do not become contaminated and remain PCB free.

The following mitigation measures are also relevant to routine operations to bring them in line with SPS. PPL shall ensure the contractors implement these measures.

- Isolate and stockpile waste dielectric oil from transformers and stockpile at Kimbe maintenance depot.
- Store waste dielectric oil from transformers in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage.
- In the medium term identify a safe disposal option for PCB waste dielectric oil from transformers in line with SPS and ADB guidelines on environmentally responsible procurement and DEC environmental code of practice.

Drainage

There is a need to maintain local existing drainage ditches and culverts to prevent damage to the site from heavy rainfall. Maintenance of drainage should focus on:

- Prevention of flooding and ponding around Lake Hargy and adjacent channels;
- Protection of work crews from hazards associated with heavy rainfall draining towards the site;
- Maintenance of access to adjoining properties; and
- In areas close to the PPL residential compound, the existing drains would be maintained so that the outfalls of the surface run-off are diverted away from the sensitive receptor.

Occupational Health and Safety

Routine health and safety measures are not in place at Lake Hargy HP. There is no dedicated health and safety manager for Lake Hargy HP and there is no systematic induction and training of workers on health and safety matters for workers and visiting contractors. There are no signs for safety awareness, little evidence of availability of PPE for staff and visitors and no staff were observed wearing PPE during the site inspection.

There is provision of potable water in the work locations. Fencing is installed on areas next to walkways and deep pits into which workers could fall. Some of the fencing is in disrepair and needs maintenance. The power station is provided with toilets/sanitation facilities including a septic tank. The toilet facilities are not maintained and need to be cleaned daily to allow effective and sanitary operation.

A health and safety plan (HSP) will be submitted along with the CEMP by the Contractor. In addition it is recommended that PPL prepare and implement a Health and Safety Plan for the operation of Lake Hargy HP. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines. Workforce training for all workers will include environment, safety and environmental hygiene.

River protection

The existing flow regime of the river and tributaries will not be affected by the project. Waste materials are not being disposed to the rivers. The Lobu River supports subsistence fisheries in the area that will not be affected during the works. Provisions in the EMP will protect the river.

Water Resources

The water abstraction for Lake Hargy HP is permitted under an existing Water Use Permit under the Water Resources Act (see above). Action is being taken by PPL with CEPA to regularize the environmental permit required for Lake Hargy HP.

C. CONCLUSIONS AND RECOMMENDATIONS

This DDR concludes that the environmental impacts from the existing activities at Lake Hargy HP are not significant. However lessons have been learned from the DDR and some matters require attention in order that existing operations comply with the SPS. Potential impacts are manageable if the mitigation measures mentioned above are implemented thoroughly. The EMP in the IEE presents a more detailed analysis of the environmental impacts and the required mitigation measures based on the type, extent and duration of the identified environmental impacts. The EMP has been prepared through close reference to best practices and compliance with PNG laws and the SPS. The key actions are summarized below:

- Make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Lake Hargy to replace the WUP due to expire in 2018.
- Disclose the scope of the improvements for Lake Hargy refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Lake Hargy HP.
- Introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at authorized site and prevent burning of waste in line with the DEC environmental codes of practice.
- Minimize impacts from incorrect storage and disposal of hazardous substances in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage.
- Stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kimbe maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use.
- Prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers.
- PPL to prepare and implement a Health and Safety Plan for the operation of Lake Hargy hydropower scheme. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines.
- Workforce training for all workers will include environment, safety and environmental hygiene.
- Maintain clean toilet facilities by cleaning daily and keeping flush toilets well maintained to allow effective operation.
- Maintaining consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public.
- It is recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works

With these measures in place, the environmental impacts of Lake Hargy HP current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards.

ANNEX 1.3 LAKE HARGY HYDROPOWER PROJECT

1 INTRODUCTION

The project preparatory technical assistance for Tranche 2 of the TEIP has completed feasibility studies of three subprojects including Yonki Toe of Dam hydropower project (HP) Surge Chamber, ii) Warangoi HP refurbishment and iii) Lake Hargy HP Refurbishment. The feasibility studies include an initial environmental examination (IEE) report covering all three project components which includes appendices with separate EMPs for each project component. This report documents the audit of existing facilities and operations at Warangoi HP operated by PPL Ltd. which will be upgraded as part of the Warangoi HP refurbishment component of the project.

Environmental impacts of the Warangoi subproject have been assessed in the IEE in line with the ADB Safeguards Policy Statement (SPS) 2009. The focus of the audit is on the environment in the existing facility in which the subproject will operate and if the facility's environmental management is generally consistent with ADB's safeguard objectives and requirements as defined in SPS. The audit also identifies any mitigation measures that are needed (corrective actions) to bring the facility's environmental management into line with ADB's safeguard objectives and requirements.

Through due diligence, review, and supervision ADB ensures that borrowers comply with the SPS requirements during project preparation and implementation. The process outlined in the SPS notes that, over time, ADB's safeguards may require updating of existing operations to enhance environmental effectiveness, respond to changing needs, and reflect evolving best practices. Due diligence has been undertaken through a review of the available documentation, interviews with operational staff of PPL Ltd and a site visit on 7 April 2016 in order to explore whether the facility is in compliance and/or can be brought into compliance with SPS, and if so to agree on required corrective actions and a time-line for their implementation as a part of international good practice.

In preparing the audit report the consultants have exercised due diligence and studied where PPL's current practices meet ADB SPS requirements and where there are gaps that need to be filled. This report summarizes the results of that study and identification of how any gaps can be addressed so that the loan procedures can proceed with confidence that the requirements of SPS will be complied with.

2 CURRENT STATUS OF ENVIRONMENTAL COMPLIANCE

The Warangoi hydropower project was constructed during the early 1980s and commissioned in 1983. It has an installed capacity of 10MW. At the time of commissioning there was no statutory requirement under PNG law for environmental impact assessment nor any requirement for an environmental permit. However, a water use (WUP) under the Water Resources Act 1982 was obtained by PNG Electricity Commission (ELCOM), the entity preceding PPL Ltd. The Water Resources Act was repealed by the Environment Act in 2000, and all permits approved under Water Resources Act stayed in force. WUP No. 29/77 was issued on 30/12/82 and provided permission to "Divert and use water up to 26 cumecs for the purpose of electricity generation from the Warangoi River" The WUP for Warangoi HP expired in December 2007 and has not been updated such that the scheme has been operating without a permit.

A meeting was held with the Senior Permitting Officer of the Conservation and Environment Protection Authority (CEPA) to clarify the permitting requirements for Warangoi HP in respect of the EAct 2000 and the CEPA Act 2014. It was advised that CEPA has developed some new requirements around granting of EPs to replace expired WUPs. CEPA advised PPL to send a letter of request for clarification using prescribed forms. Given that no new activities other than bank protection works are proposed for Warangoi other than refurbishment of existing components, it is understood that CEPA will require only an Environmental Management Plan (in accordance with the PNG Guideline). PPL is in the process of obtaining formal clarification from CEPA using the prescribed forms as required. An EMP in accordance with PNG guidelines has been prepared as part of the IEE.

A. ACTIONS REQUIRED FOR WARANGOI OPERATIONS TO COMPLY WITH SPS

There are several immediate recommended actions for PPL in order to achieve environmental compliance with SPS: The recommended course of action is for PPL to:

- Make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Warangoi HP to replace the expired WUP.
- Disclose the scope of the improvements for Warangoi HP refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Warangoi HP.

B. OPERATIONAL AND MAINTENANCE IMPACTS

There are occasional small scale impacts arising at Warangoi HP from routine operations and maintenance. They include (i) waste disposal, (ii) clearing drainage and access roads near buildings (iii) service road maintenance and drainage, (iv) maintenance of settling basin, sediment flushing gates, main radial gate, intake, headrace tunnel and penstock, (v) delivery and installation of spare parts and equipment, (vi) disposal of waste oil (vii) maintaining toilets and washrooms, and (vi) managing safety of various worker activities in and around the site. These impacts are relatively minor in scale and do not constitute non-compliance with SPS.

For purposes of this DDR existing facilities or aspects of operations and control measures that do not meet SPS requirements have been identified.

General Waste Management

There is no waste collection from Warangoi HP. Small amounts of general refuse are dumped in an open earth pit within the powerhouse site and buried when the pit is full. Following burial a new pit is dug adjacent to the previous one and the process is repeated. The mitigation measures for waste will seek to reduce, recycle and reuse waste as far as practicable. The mitigation measures are not repeated here in full but the Waste Management Plan (WMP) will also be sufficient to control other waste from Warangoi HP. The key actions for general waste disposal are to:

- Introduce waste reduction, reuse and recycling methods
- Segregation wastes at source
- Prohibit burning of operational and general wastes.
- Establish regular disposal schedule for general waste off site at local waste disposal areas. Such areas should be approved by local authorities and be operated in line with the DEC environmental code of practice for Sanitary Landfill Sites and rehabilitated, monitored, catalogued, and marked
- Organic (biodegradable - such as tree trimmings) shall be collected, stockpiled and given to the local community (NO BURNING is allowed on site)
- Warangoi yard shall be provided with garbage bins
- Disposal of solid wastes into drainage ditches, rivers, other watercourses, agricultural fields and public areas shall be prohibited

Hazardous Materials and Hazardous Waste Disposal

Transformer oil and other oils and lubricants are hazardous substances used at Warangoi HP. The use of hazardous substances such as oils and lubricants is not controlled by spill prevention procedures or containment facilities. Oil drums are transported to the site on an as needed basis, usually one or two drums at a time. The oil drums are stored outside the power house, uncovered, on the ground surface. There is no hard standing covered area and associated bunds that would prevent contamination of storm water runoff or allow for containment of oil spills or leakage from storage or use of the oil drums. While there is no evidence of significant oil spills to the ground around the drums, the likelihood of at least occasional minor spill and leakage to the ground surface is high. According to operational staff, all waste oil is sold locally. Empty oil drums are

given to the local community for their use. There is no monitoring of waste oils and lubricants disposal.

In order to minimize impacts from incorrect storage and disposal of hazardous substances in the construction stage several mitigation measures have been proposed for the Contractors to implement. These will be covered in the Hazardous Materials section of the Waste Management Plan. Several of the mitigation measures are also relevant to routine operations at Warangoi HP to bring the operations in line with SPS. The contractors shall ensure implementation of such measures.

- Ensure safe storage of fuel, other hazardous substances and bulk materials in line with DEC environmental code of practice for Vehicle/Machinery Workshops and Petroleum Storage / Resale / Usage is followed
- Ensure that transformer oil drums are stored drums on side with outlet at 9 o'clock or 3 o'clock to keep bung moist and avoid penetration of water vapour
- Ensure all storage containers are in good condition with proper labeling
- Regularly check containers for leakage and undertake necessary repair or replacement.
- Store hazardous materials above possible flood level
- Discharge of oil contaminated water shall be prohibited
- Used waste oil and other toxic and hazardous materials shall be disposed of off-site at the PPL Kokopo maintenance area stockpile or given to the local community for there use.
- Adequate precautions will be taken to prevent oil/lubricant/ hydrocarbon contamination of drainage channel beds
- Make spill clean-up materials available (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored
- Immediately clear up spillage, if any, with utmost caution to leave no traces.

It was noted during a visual inspection of the switchyard at Warangoi HP that the transformer bay does not have adequate oil containment facilities that would normally be expected in accordance with international best practice. No evidence of oil leakage from existing transformers was noted and the risks of leakage are considered low.

International best practice requires switchyard transformers to be housed on platforms with sufficient oil containment facilities to prevent release of oil to the surrounding environment in the unlikely event of release of oil due to catastrophic failure of a transformer. It is therefore recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works.

Polychlorinated Biphenyls (PCBs)

PCBs were widely used as dielectric fluids in transformers and capacitors up to the 1980s. Since that time and since the 1990s new equipment has generally been supplied free of PCBs. It has not been possible for the maintenance section of PPL to identify any records of PCB content of the PPL equipment; much of which was inherited earlier from the PNG Electricity Commission. Previous discussions with the maintenance section at PPL have indicated that many of the transformers and capacitors still in commission by PPL date from the 1980s to 1990s period and therefore they may contain or may have contained PCB.

Transformers and capacitors do not generally require frequent maintenance but the transformer oil is checked regularly and topped up as necessary. PCBs have not been used in transformer oils for many years.

Due to the gradual replacement of the transformer oil as the topping up proceeds over many cycles over several years PCBs in old transformers will be gradually flushed out but residual PCBs can

remain trapped and leach out only slowly into fresh transformer oil. Thus the replacement transformer oil can become contaminated.

PPL have also been accustomed to reconditioning the transformer oil for reuse and therefore there remains a third possibility that reconditioned transformer oil can become contaminated if it is mixed with oil from PCB containing equipment. If this oil is reused in an otherwise uncontaminated or newer transformer this may lead to contamination of equipment that originally did not containing any PCBs.

PPL have not been accustomed to keeping detailed records of the sources of oil used to top-up transformers and therefore there is a low possibility that some of the PPL transformers in service may have been contaminated with PCB or may still contain oil that may be leaching residual PCBs. The only way to check this would be to analyze the transformer oils for PCB. However there is no accredited laboratory in PNG that can make this analysis and samples would need to be transferred overseas.

Options for treatment of PCB contaminated transformers have been developed by specialist companies and include:

- Collection of PCB-contaminated transformers and equipment
- Pumping-out and rinsing of this equipment (using solvents)
- Disassembly and cleaning of these objects for purposes of removing PCBs
- Sorting and processing into scrap of the cleaned metal parts
- Distillation of the solvents

End disposal of waste PCBs can include high temperature incineration. Co-disposal in secure landfills has also been used.

If oil in transformers or waste transformer oil is subsequently discovered to contain PCBs there is no disposal facility in PPL or PNG and therefore treatment by specialist company overseas would seem to be the only an option at this stage. However these types of facilities are not available in PNG.

For this subproject, new equipment and transformer oil will be supplied without PCB and for purposes of the subproject a way forward would be to ring fence any new subproject transformers and other equipment needing dielectric oil and make sure that new equipment is only serviced with new PCB free transformer oil. In future the subproject transformers and capacitors will only receive PCB free transformer oil so that they do not become contaminated and remain PCB free. A rule can be made that no new equipment supplied under the subproject can be serviced with reconditioned dielectric oil.

In order to minimize impacts from unknown status of PCBs at Warangoi HP switchyard the following measures are proposed to be included in the Hazardous Materials section of the WMP and implemented to bring the subproject in line with SPS.

- Enforce a rule in line with ADB guidelines on environmentally responsible procurement that new equipment is supplied free of PCB and certified to be PCB free. No new equipment shall be supplied with PCB contamination.
- Ring fence new subproject transformers (if any) and other equipment needing dielectric oil.
- Enforce a rule that no new equipment supplied under the subproject can be serviced with reconditioned dielectric oil.
- Ensure that the new equipment is only serviced with new PCB free transformer oil.
- Ensure that in future any new subproject transformers and capacitors will only receive PCB free transformer oil so that they do not become contaminated and remain PCB free.

The following mitigation measures are also relevant to routine operations to bring them in line with SPS. PPL shall ensure the contractors implement these measures.

- Isolate and stockpile waste dielectric oil from transformers and stockpile at Kokopu maintenance depot.
- Store waste dielectric oil from transformers in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage.
- In the medium term identify a safe disposal option for PCB waste dielectric oil from transformers in line with SPS and ADB guidelines on environmentally responsible procurement and DEC environmental code of practice.

Drainage

There is a need to maintain local existing drainage ditches and culverts to prevent damage to the site from heavy rainfall. Maintenance of drainage should focus on:

- Prevention of flooding and ponding around the headworks and powerhouse areas and adjacent channels;
- Protection of work crews from hazards associated with heavy rainfall draining towards the site; and
- Maintenance of access to adjoining properties.

Occupational Health and Safety

Routine health and safety measures are not in place at Warangoi HP. There is no dedicated health and safety manager for Warangoi HP and there is no systematic induction and training of workers on health and safety matters for workers and visiting contractors. There are no signs for safety awareness, little evidence of availability of PPE for staff and visitors and no staff were observed wearing PPE during the site inspection.

There is provision of potable water in the work locations. Fencing is installed on areas next to walkways and deep pits into which workers could fall. Some of the fencing is in disrepair and needs maintenance. The power station is provided with toilets/sanitation facilities including a septic tank. However, the toilet facilities are currently non-functional and need to be repaired. Furthermore, regular maintenance and daily cleaning of toilet facilities is required to ensure effective and sanitary operation.

A health and safety plan (HSP) will be submitted along with the CEMP by the Contractor. In addition it is recommended that PPL prepare and implement a Health and Safety Plan for the operation of Warangoi HP. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines. Workforce training for all workers will include environment, safety and environmental hygiene.

River protection

The existing flow regime of the river and tributaries will not be affected by the project. Waste materials are not being disposed to the rivers.. Provisions in the EMP will protect the river.

Water Resources

The water abstraction for Warangoi HP was permitted under a Water Use Permit under the Water Resources Act until December 2007 when the permit it expired (see above). The WUP has not yet been renewed. Action is being taken by PPL with CEPA to regularize the environmental permit required for Warangoi HP.

C. CONCLUSIONS AND RECOMMENDATIONS

This DDR concludes that the environmental impacts from the existing activities at Warangoi HP are not significant. However lessons have been learned from the DDR and some matters require attention in order that existing operations comply with the SPS. Potential impacts are manageable if the mitigation measures mentioned above are implemented thoroughly. The EMP in the IEE presents a more detailed analysis of the environmental impacts and the required mitigation measures based on the type, extent and duration of the identified environmental impacts. The EMP

has been prepared through close reference to best practices and compliance with PNG laws and the SPS. The key actions are summarized below:

- Make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Warangoi to replace the WUP which expired in December 2007.
- Disclose the scope of the improvements for Warangoi refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Warangoi HP.
- Introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at authorized site and prevent burning of waste in line with the DEC environmental codes of practice.
- Minimize impacts from incorrect storage and disposal of hazardous substances in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage is followed.
- Stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kokopu maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use.
- Prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers.
- PPL to prepare and implement a Health and Safety Plan for the operation of Warangoi hydropower project. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines.
- Workforce training for all workers will include environment, safety and environmental hygiene.
- Repair toilet facilities and ensure they are well maintained and cleaned daily to allow effective operation.
- Maintaining consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public.
- It is recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works

With these measures in place, the environmental impacts of Warangoi HP current operations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards.

ANNEX 2- ENVIRONMENTAL MITIGATION AND MONITORING PLANS

Annex 2.1–EMP Matrix: Environmental Mitigation and Monitoring Plan For Yonki Toe of Dam Surge Tank and Repairs to Penstocks

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
DESIGN / PRE CONSTRUCTION								
Project disclosure	1. Submit ADB-approved IEE including EMP to CEPA for approval using applicable form and obtain a Development Consent as per the Environment Act. 2. Ensure CEPA approved EMP and any conditions of Development Consent are included in tender documents including i) requirement for contractor to seek CEPA approval and update EMP in the case of significant changes to FS design ii) requirement for contractor to prepare a CEMP for approval of PMU/DSC before commencement of construction. The CEMP will demonstrate the manner (location, responsibilities, schedule/ timeframe, budget, etc.) in which the contractor will implement the mitigation measures specified in the EMP approved under CEPA Development Consent. 3. Implement plan for Grievance Redress Mechanism as described in the IEE 4. Contractor's project design to adhere to all design related mitigation measures in FS EMP or in updated EMP as approved under CEPA Development Consent.	1 to 3: PMU/DSC 4 Contractor	1 and 2 Immediate. 3: During tender preparation 4:Detailed design phase	1 to 3: Cost included in PMU/DSC staffing 4: Cost included in Contract	Environmental approval for the project obtained from CEPA. Complete check of items 1 to 4.	Prior to signing of EPC contract and start of site works. Once.	PMU	Cost included in PMU budget for EO to support the project procurement and impl..
Environmental capacity development	1. PMU to commit to provide sufficient resources for project duration to oversee EMP implementation. 2. DSC to train PMU/EO in implementation of EMP as well as general training in ADB safeguards requirements to raise awareness and build capacity of environmental	1: PMU 2: DSC 3: Ccontractor	Initiate during procurement period and continue throughout project construction	1: & 2: IES (project) costs 3:Included in contract cost	1.ADB loan covenants 2.IES TOR, DSC progress reports to PMU/ADB 3.Tender	Prior to start of site works and throughout construction phase.	PMU	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	**Responsible to Implement**	**Timing to Implement**	**Cost**	**Parameter to monitor**	**Frequency & Verification**	**Responsible to Monitor**	**Cost**
	management in PMU. A mix of workshops and on-the-job training to be used. 3. Conduct contractor / workers' orientation on EMP provisions.				documents and check during construction.			
Environmentally responsible procurement	1. EMP is included in tender documents to ensure that mitigation measures are budgeted and to prepare the contractor for environmental responsibilities. 2. Specify in tender document that contractor shall engage appropriately qualified and experienced staff to take responsibility for the environmental management and safety issues and monitor the effectiveness and review mitigation measures as the project proceeds. 3. Contractor to submit construction environmental management plan (CEMP) based on contractual EMP for approval by DSC (i.e., site clearance, site drainage, waste and materials management, traffic, noise and dust management etc.). 4. Contractor recruit qualified and experienced staff to oversee implementation of environmental and safety measures specified in the EMP.	1 & 2: DSC for PMU 3: Preparation of CEMP - Contractor, Approval of CEMP-DSC 4: Contractor	1 & 2: Bid preparation 3 & 4: Before start of civil works	Included in bid cost	1 & 2: Inclusion in bid docs 3 & 4: Check compliance	Bid preparation stage. Before start of site works	PMU/IES	PMU – as above. IES – included in DSC staffing
Disclosure of CPP and GRM and establishment of procedures	1: Project documents disclosed to public and communities in an appropriate form and manner and accessible place 2: Inclusion of appropriate measures from CPP and GRM in tender documents	PMU	Before Contractor mobilization	Included in bid cost	Tender document; Grievance registry, monthly reports	Monthly Grievance registry, monthly reports	Contractor, PMU	Included in project cost PMU - as above.
Workers and public safety	CEMP to include measures covering workers and public safety and to identify interfaces between the works and the public, formulate measures to ensure safety of workers and the public, and prevent accidents due to the construction works.	Contractor in preconstruction	Before start of civil works	Cost included in contract.	Tender document. Check at preconstruction.	During tender preparation and again before start of works	PMU/IES	PMU – as above. IES - included in DSC staffing

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	**Responsible to Implement**	**Timing to Implement**	**Cost**	**Parameter to monitor**	**Frequency & Verification**	**Responsible to Monitor**	**Cost**
Grievance Redress Mechanism established	Establishment and implementation of GRM confirmed by PMU.	PMU	Before start of civil works	Met by PMU/ project	GRM confirmed and agreed with community.	Before start of civil works	PMU	Incl. in PMU budget for EO
Raise awareness of Contractor on environmental management matters	Induction safeguards training for Contractor	DSC	Before submission of CEMP	Cost included in project and contract	Approved CEMP	Before submission of CEMP	PMU	Included in PMU budget for EO
Audit of Yonki Toe of Dam hydropower project – corrective actions required	1. PPL to make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new or amended EP for YTD HP. 2. PPL to immediately cease disposing of used oil to the ground at the Ramu 1 workshop and fuel/oil storage facility and establish a proper used oil storage facility and associated operational procedures for waste oil disposal to comply with the DEC Environment Code of Practice for Vehicle Machinery and Petroleum (Hydrocarbons) Storage/Resale/Usage Site DEC 1997. 3 .In association with the above, PPL shall remove all dumped waste oil and associated contaminated soil from the site, decontaminate the area, and dispose of the waste oil/ contaminated soil at an appropriate hazardous materials disposal facility 4. PPL to prepare a waste management plan and environmental monitoring plan for approval of CEPA in accordance with the current EP (or amended EP if required). 5. PPL to commence annual environmental performance monitoring as required under the EP (or amended EP if required) 6. PPL to commence environmental performance reporting as required under the EP (or amended EP if required)	PPL	All items to be implemented as soon as possible and prior to award of construction contract	PPL to estimate	Conditions of existing EP	Prior to signing contract for proposed works	PMU (EO) DSC (IES)	PMU – as above. IES – included in DSC staffing

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
CONSTRUCTION STAGE								
Physical Impacts								
Noise and dust nuisances	1. Construction equipment and vehicles will be maintained to a good standard and provided with muffler silencers. 2. Watering of access road during dry periods as required 3. Monitor and investigate complaints; propose alternative mitigation measures.	Contractor	Throughout construction phase	Cost included in contract	Check implementation	Once a month as part of routine construction monitoring	EO/IES	As above
Erosion and loss of topsoil	1. Schedule excavation activities in the drier months (Jun - Oct) 2. Minimize vegetation clearance of surge tank footprint 3. Ensure slope cuts (if any) are properly engineered and re-vegetated immediately after cutting 4. Install cut-off drains above excavated areas on steep slopes 5. Stockpile topsoil for later use in landscaping or made available to local community for their use 6. As far as possible ensure cut to fill balance	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Once a month as part of routine construction monitoring	EO/IES	Included in DSC staffing
Sedimentation and water quality impact	1. Schedule excavation activities in the drier months (Jun - Oct); 2. Minimize vegetation clearance; 3 Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles of excavated material; 4. Effective construction supervision to ensure above measures implemented	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Once a month as part of routine construction monitoring	EO/IES	As above.
Materials and Spoil Management	1. Identify and implement measures for spoil management as part of CEMP. and fill requirements to minimize need for aggregates from other sources 2. Topsoil, overburden, and low quality	1:Contractor to prepare CEMP and submit to PMU/DSC for approval	1: One month before start of site works 2 to 7: Throughout	Cost included in contracts	Check implementation of items 1-7 and CEMP provisions	1: Before construction 2 - 7 Implementation of CEMP	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	materials shall be properly removed, stockpiled near the site, and stored for reuse. 3.Areas for disposal to be agreed with land owner and local authority and recorded by the PMU/DSC and monitored 4. Spoil will not be disposed of in rivers and streams or other natural drainage path. 5. Surplus spoil will be used where practicable for local repair works to fill eroded gullies and depression areas and degraded land in consultation with local community. 6.Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas. 7. Spoil disposal sites shall be located at least 50 m from surface water courses and shall be protected from erosion by avoiding formation of steep slopes and grassing.	2 to 7: Contractor	construction phase			provisions: Monthly		
Waste Management	1. Prepare and implement waste management plan (WMP) of CEMP to cover all aspects of waste storage disposal and accidental spills. 2. Areas for disposal to be agreed with land owner and local authorities and checked, recorded and monitored by the PMU/DSC. 3. Segregation of wastes shall be observed. 4. Recyclables shall be recovered and sold to recyclers. 5. Residual wastes shall be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams. 6 Site offices and yard shall be provided with garbage bins 7. Burning of construction and domestic wastes shall be prohibited. 8. Disposal of solid wastes into drainage	1: Contractor to prepare WMP, PMU/DSC IES to assist and approve 2 to 9: Contractor	1: One month before start of site works 2 to 9: Throughout construction phase	Cost included in contracts	Check implementation of items 1-9 and WMP provisions	1: Before construction 2 to 9: Implementation of WMP provisions: Monthly	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	ditches and public areas shall be prohibited. 9. All general solid waste will be collected and removed from the work areas and disposed in local waste disposal sites as identified by the local authorities..							
Use of hazardous substances and hazardous waste disposal	1. Hydrocarbon, toxic material including corrosion protection paint will be stored in adequately protected sites consistent with international best practices to prevent soil and water contamination. 2. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations. 3. Segregate hazardous wastes (oily wastes, used batteries, fuel drums, paint) and ensure that storage, transport and disposal shall not cause pollution and shall be undertaken consistent with international best practice. 4. Ensure all storage containers are in good condition with proper labeling. 5. Regularly check containers for leakage and undertake necessary repair or replacement. 6 Store hazardous materials above possible flood level 7. Discharge of oil contaminated water shall be prohibited. 8. Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by the PMU/DSC. 9. Ensure availability of spill cleanup materials (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored. 10. Spillage, if any, will be immediately cleared	Contractor	Throughout construction phase	Cost included in contracts	Check implementation of all items	Monthly	EO/ IES	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	with utmost caution to leave no traces.							
Biological Impacts								
Loss of Forest Habitat and impacts on fauna	1. Minimize vegetation clearance area 2. Mark boundary of clearance footprint with high visibility tape to ensure construction workers are aware of clearance boundaries; 3. Workers prohibited from poaching, hunting or fishing (sanctions to be imposed);	Contractor	Site surveying and vegetation clearance.	Cost included in contract	1 & 2 Visual observation Sanctions imposed on workers not adhering to item 3	1 & 2: Before start of site works	IES & EO	As above
Socioeconomic Impacts								
Operation of contractor camp / Site offices	1. Location of site office and facilities to be agreed with local community with facilities approved by PMU/DSC and managed to minimize impacts; Protocols established as per CPP and GRM 2. Potable water, clean water for showers, hygienic sanitation facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. 3. Separate toilets shall be provided for male and female workers. 4. As many local workers as possible will be hired and trained. 5. Adequate toilet facilities shall be installed and open defecation shall be prohibited and use of toilets encouraged by keeping toilet facilities clean at all times. 6. Wastewater effluent from contractors' workshops (if any) will be passed through gravel/sand beds and all oil/grease contaminants will be removed before discharging it into natural water courses. Oil and grease residues shall be stored in drums awaiting disposal in line with an agreed WMP.	1:Ccontractor with PMU/DSC approval 2-8: Contractor	1: One month before start of site works 2 to 8: Throughout construction phase	Cost included in contracts	Check implementation of items 1-8	1: Before construction 2 - 8: Monthly	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	7. The Contractors facilities area will be cleaned up to the satisfaction of PMU and local community after use. 8 All waste materials shall be removed and disposed to disposal sites approved by local authorities							
Occupational Health and Safety	1. Contractor to include health and safety provisions in the CEMP and insuct workers in health and safety matters. Plan to be approved in writing by PMU/DSC one month prior to starting works. Contractor to implementall provisions. 2. Before construction commences the contractor will conduct of training for all workers on environmental, safety and environmental hygiene. The contractor will instruct workers in health and safety matters as required by good engineering practice and provide first aid facilities. 3. Workers shall be provided (before they start work) with appropriate PPE. 4. Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works. . 5. Provision of potable water supply in all work locations.	1:Contractor with PMU/DSC approval 2-5: Contractor	1: One month before start of site works 2 to 5: Throughout construction phase	Cost included in contracts	Check implementation of items 1-5	1: Before construction 2 - 5: Monthly	EO/ IES	As above.
Community Health and Safety	1. Include in CEMP for barriers (e.g., temporary fence), shall be installed at construction areas to deter pedestrian access except at designated crossing points. 2. The general public/local residents shall not be allowed in high-risk areas, 3. Provide warning signs at periphery of site warning public not to enter 4. Strict imposition of speed limits along access through residential areas and where other	Contractor	At all times throughout construction phase	Cost included in contracts Cost for item 6 included in PSA	Check implementation of items 1-6	Monthly	EO/ IES	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	sensitive receptors such as schools, hospitals and other populated area are located 5. Communication to the public through public consultation, local authority and notice boards regarding the scope and schedule of construction as well as certain construction activities causing disruptions and access restrictions. 6. Implementation of communicable diseases (incl. STIs and HIV) awareness and prevention measures							
OPERATION STAGE								
Implementation of Corrective Actions identified in Environmental Due Diligence Review (see pre-construction issues above)	See above	PPL	All items to be implemented as soon as possible and prior to award of construction contract	PPL to estimate	Conditions of existing EP	Prior to signing contract for proposed works	PMU (EO) DSC (IES)	PMU – as above. IES – included in DSC staffing

Annex 2.2–EMP Matrix: Environmental Mitigation and Monitoring Plan For Lake Hargy HP Refurbishment

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
DESIGN / PRE CONSTRUCTION								
Project disclosure	1. Submit ADB-approved IEE including EMP to CEPA for approval using applicable form and obtain a Development Consent as per the Environment Act. 2. Ensure CEPA approved EMP and any conditions of Development Consent are included in tender documents including i) requirement for contractor to seek CEPA approval and update EMP in the case of significant changes to FS design ii) requirement for contractor to prepare a CEMP for approval of PMU/DSC before commencement of construction. The CEMP will demonstrate the manner (location, responsibilities, schedule/ timeframe, budget, etc.) in which the contractor will implement the mitigation measures specified in the EMP approved under CEPA Development Consent. 3.Tender document to include upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet. 4. Implement plan for Grievance Redress Mechanism as described in the IEE 5. Contractor's project design to adhere to all design related mitigation measures in FS EMP or in updated EMP as approved under CEPA Development Consent.	1 to 4: PMU/DSC 5 Contractor	1 and 2 Immediate. 3: During tender preparation 4:Before start of civil works 5:Detailed design phase	1 to 4: Cost included in PMU/DSC staffing 5: Cost included in Contract	Environmental approval for the project obtained from CEPA. Complete check of items 1 to 5.	Prior to signing of EPC contract and start of site works. Once.	PMU	Cost included in PMU budget for EO to support the project procurement and impl..
Environmental capacity development	1. PMU to commit to provide sufficient resources for project duration to oversee EMP implementation. 2. DSC to train PMU/EO in implementation of	1: PMU 2: DSC 3: Ccontractor	Initiate during procurement period and continue	1: & 2: IES (project) costs 3:Included in	1.ADB loan covenants 2.IES TOR, DSC progress	Prior to start of site works and throughout construction	PMU	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	EMP as well as general training in ADB safeguards requirements to raise awareness and build capacity of environmental management in PMU. A mix of workshops and on-the-job training to be used. 3. Conduct contractor / workers' orientation on EMP provisions.		throughout project construction	contract cost	reports to PMU/ADB 3.Tender documents and check during construction.	phase.		
Environmentally responsible procurement	1. EMP is included in tender documents to ensure that mitigation measures are budgeted and to prepare the contractor for environmental responsibilities. 2. Specify in tender document that contractor shall engage appropriately qualified and experienced staff to take responsibility for the environmental management and safety issues and monitor the effectiveness and review mitigation measures as the project proceeds. 3. Contractor to submit construction environmental management plan (CEMP) based on contractual EMP for approval by DSC (i.e., site clearance, site drainage, waste and materials management, traffic, noise and dust management etc.). 4. Contractor recruit qualified and experienced staff to oversee implementation of environmental and safety measures specified in the EMP.	1 & 2: DSC for PMU 3: Preparation of CEMP - Contractor, Approval of CEMP-DSC 4: Contractor	1 & 2: Bid preparation 3 & 4: Before start of civil works	Included in bid cost	1 & 2: Inclusion in bid docs 3 & 4: Check compliance	Bid preparation stage. Before start of site works	PMU/IES	PMU – as above. IES – included in DSC staffing
Disclosure of CPP and GRM and establishment of procedures	1: Project documents disclosed to public and communities in an appropriate form and manner and accessible place 2: Inclusion of appropriate measures from CPP and GRM in tender documents	PMU	Before Contractor mobilization	Included in bid cost	Tender document; Grievance registry, monthly reports	Monthly Grievance registry, monthly reports	Contractor, PMU	Included in project cost PMU - as above.
Workers and public safety	CEMP to include measures covering workers and public safety and to identify interfaces between the works and the public, formulate measures to ensure safety of workers and the	Contractor in preconstruction	Before start of civil works	Cost included in contract.	Tender document. Check at preconstruction.	During tender preparation and again before start of works	PMU/IES	PMU – as above. IES - included in DSC staffing

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	public, and prevent accidents due to the construction works.							
Climate change adaptation measures to be properly considered and incorporated into design as necessary	Design criteria in respect of peak flood size and levels need to take account of the potential effects of climate change. Appropriate design criteria to be established based on available climate change modelling data to develop extreme event data. In the absence of such data, design criteria to be demonstrably conservative.	PMU/DSC	Tender document preparation	Included in overall project cost	Civil design specifications in tender document Contractor's detailed civil design	Prior to signing of contract and start of site works. Once.	PMU/DSC (IES)	PMU – as above. IES – included in DSC staffing
Grievance Redress Mechanism established	Establishment and implementation of GRM confirmed by PMU.	PMU	Before start of civil works	Met by PMU/ project	GRM confirmed and agreed with community.	Before start of civil works	PMU	Incl. in PMU budget for EO
Raise awareness of Contractor on environmental management matters	Induction safeguards training for Contractor	DSC	Before submission of CEMP	Cost included in project and contract	Approved CEMP	Before submission of CEMP	PMU	Included in PMU budget for EO
Audit of Lake Hargy hydropower project – corrective actions required	1.PPL to make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Lake Hargy to replace the WUP due to expire in 2018. 2. PPL to disclose the scope of the improvements for Lake Hargy refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Lake Hargy HP. 3. PPL to introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at an authorized site and prevent burning of waste in line with the DEC environmental codes of practice. 4. PPL to minimize impacts from incorrect storage and disposal of hazardous substances	PPL	1 and 2 Immediate 3 -10 as soon as possible and needs to be specified as part of post-refurbishment O&M procedures. 11 During implementation of refurbishment works.	Costs included in contract	1 and 2 Documents 3 -10 O&M documentation included in bid documents for refurbishment works 11 Included in design specifications of bid documents	1,2 Prior to signing contract. Once 3 -11 Once bid preparation stage	PMU (EO) DSC (IES)	PMU – as above. IES – included in DSC staffing

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage. 5 PPL to stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kimbe maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use. 6. PPL to prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers. 7. PPL to prepare and implement a Health and Safety Plan for the operation of Lake Hargy hydropower scheme. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines. 8. PPL to ensure that workforce training for all workers will include environment, safety and environmental hygiene. 9. PPL to maintain clean toilet facilities by cleaning daily and keeping flush toilets well maintained to allow effective operation. 10 PPL to Maintain consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public. 11.It is recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the							

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	refurbishment works							
CONSTRUCTION STAGE								
Physical Impacts								
Noise and dust nuisances	1. Construction equipment and vehicles will be maintained to a good standard and provided with muffler silencers. 2. Watering of access road during dry periods as required 3. Monitor and investigate complaints; propose alternative mitigation measures.	Contractor	Throughout construction phase	Cost included in contract	Check implementation	Once a month as part of routine construction monitoring	EO/IES	As above
Erosion and loss of topsoil	1. Schedule excavation activities in the drier months (Jun - Oct) 2. Minimize vegetation clearance corridor or footprint of components 3. Ensure slope cuts (if any) are properly engineered and re-vegetated immediately after cutting 4. Install cut-off drains above excavated areas on steep slopes 5. Stockpile topsoil for later use in landscaping or made available to local community for their use 6. As far as possible ensure cut to fill balance	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Once a month as part of routine construction monitoring	EO/IES	Included in DSC staffing
Sedimentation and water quality impact	1. Schedule excavation activities in the drier months (Jun - Oct); 2. Minimize vegetation clearance; 3 Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles of excavated material; 4. Effective construction supervision to ensure above measures implemented	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Once a month as part of routine construction monitoring	EO/IES	As above.
Materials and Spoil Management	1. Identify and implement measures for spoil management as part of CEMP. and fill requirements to minimize need for	1:Contractor to prepare CEMP and submit to	1: One month before start of site works	Cost included in contracts	Check implementation of items 1-7 and	1: Before construction 2 - 7	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	aggregates from other sources 2. Topsoil, overburden, and low quality materials shall be properly removed, stockpiled near the site, and stored for reuse. 3.Areas for disposal to be agreed with land owner and local authorities and recorded by the PMU/DSC and monitored 4. Spoil will not be disposed of in rivers and streams or other natural drainage path. 5. Surplus spoil will be used where practicable for local repair works to fill eroded gullies and depression areas and degraded land in consultation with local community. 6.Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas. 7. Spoil disposal sites shall be located at least 50 m from surface water courses and shall be protected from erosion by avoiding formation of steep slopes and grassing.	PMU/DSC for approval 2 to 7: Contractor	2 to 7: Throughout construction phase		CEMP provisions	Implementation of CEMP provisions: Monthly		
Waste Management	1. Prepare and implement waste management plan (WMP) of CEMP to cover all aspects of waste storage disposal and accidental spills. 2. Areas for disposal to be agreed with land owner and local authorities and checked, recorded and monitored by the PMU/DSC. 3. Segregation of wastes shall be observed. 4. Recyclables shall be recovered and sold to recyclers. 5. Residual wastes shall be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams. 6 Site offices and yard shall be provided with garbage bins 7. Burning of construction and domestic wastes	1: Contractor to prepare WMP, PMU/DSC IES to assist and approve 2 to 9: Contractor	1: One month before start of site works 2 to 9: Throughout construction phase	Cost included in contracts	Check implementation of items 1-9 and WMP provisions	1: Before construction 2 to 9: Implementation of WMP provisions: Monthly	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	shall be prohibited. 8. Disposal of solid wastes into drainage ditches and public areas shall be prohibited. 9. All general solid waste will be collected and removed from the work areas and disposed in local waste disposal sites as identified by the local authorities..							
Use of hazardous substances and hazardous waste disposal	1. Hydrocarbon, toxic material will be stored in adequately protected sites consistent with international best practices to prevent soil and water contamination. 2. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations. 3. Segregate hazardous wastes (oily wastes, used batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution and shall be undertaken consistent with international best practice. 4. Ensure all storage containers are in good condition with proper labeling. 5. Regularly check containers for leakage and undertake necessary repair or replacement. 6 Store hazardous materials above possible flood level 7. Discharge of oil contaminated water shall be prohibited. 8. Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by the VPMU/DSC. 9. Ensure availability of spill cleanup materials (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored.	Contractor	Throughout construction phase	Cost included in contracts	Check implementation of all items	Monthly	EO/ IES	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	10. Spillage, if any, will be immediately cleared with utmost caution to leave no traces.							
Biological Impacts								
Loss of Forest Habitat and impacts on fauna	1. Minimize vegetation clearance area 2. Mark boundary of clearance footprint with high visibility tape to ensure construction workers are aware of clearance boundaries; 3. Workers prohibited from poaching, hunting or fishing (sanctions to be imposed);	Contractor	Site surveying and vegetation clearance.	Cost included in contract	1 & 2 Visual observation Sanctions imposed on workers not adhering to item 3	1 & 2: Before start of site works	IES & EO	As above
Socioeconomic Impacts								
Operation of contractor camp / Site offices	1. Location of site office and facilities to be agreed with local community with facilities approved by PMU/DSC and managed to minimize impacts; Protocols established as per CPP and GRM 2. Potable water, clean water for showers, hygienic sanitation facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. 3. Separate toilets shall be provided for male and female workers. 4. As many local workers as possible will be hired and trained. 5. Adequate toilet facilities shall be installed and open defecation shall be prohibited and use of toilets encouraged by keeping toilet facilities clean at all times. 6. Wastewater effluent from contractors' workshops (if any) will be passed through gravel/sand beds and all oil/grease contaminants will be removed before discharging it into natural water courses. Oil and grease residues shall be stored in drums	1:Ccontractor with PMU/DSC approval 2-8: Contractor	1: One month before start of site works 2 to 8: Throughout construction phase	Cost included in contracts	Check implementation of items 1-8	1: Before construction 2 - 8: Monthly	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	awaiting disposal in line with an agreed WMP. 7. The Contractors facilities area will be cleaned up to the satisfaction of PMU and local community after use. 8 All waste materials shall be removed and disposed to disposal sites approved by local authorities							
Occupational Health and Safety	1. Contractor to include health and safety provisions in the CEMP and insuct workers in health and safety matters. Plan to be approved in writing by PMU/DSC one month prior to starting works. Contractor to implementall provisions. 2. Before construction commences the contractor will conduct of training for all workers on environmental, safety and environmental hygiene. The contractor will instruct workers in health and safety matters as required by good engineering practice and provide first aid facilities. 3. Workers shall be provided (before they start work) with appropriate PPE. 4. Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works. . 5. Provision of potable water supply in all work locations.	1:Contractor with PMU/DSC approval 2-5: Contractor	1: One month before start of site works 2 to 5: Throughout construction phase	Cost included in contracts	Check implementation of items 1-5	1: Before construction 2 - 5: Monthly	EO/ IES	As above.
Community Health and Safety	1. Include in CEMP for barriers (e.g., temporary fence), shall be installed at construction areas to deter pedestrian access except at designated crossing points. 2. The general public/local residents shall not be allowed in high-risk areas, 3. Provide warning signs at periphery of site warning public not to enter 4. Strict imposition of speed limits along access	Contractor	At all times throughout construction phase	Cost included in contracts Cost for item 6 included in PSA	Check implementation of items 1-6	Monthly	EO/ IES	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	through residential areas and where other sensitive receptors such as schools, hospitals and other populated area are located 5. Communication to the public through public consultation, local authority and notice boards regarding the scope and schedule of construction as well as certain construction activities causing disruptions and access restrictions. 6. Implementation of communicable diseases (incl. STIs and HIV) awareness and prevention measures							
OPERATION STAGE								
Implementation of Corrective Actions identified in Environmental Due Diligence Review (see pre-construction issues above)	See above	PPLr	Operation phase	Included in overall project cost	Implementation of all corrective actions as identified in DDR (see pre-construction issues above)	Periodically during routine maintenance activities	PPL EO	Included in PPL Operation and maintenance costs

Annex 2.3–EMP Matrix: Environmental Mitigation and Monitoring Plan For Warangoi HP Refurbishment

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
DESIGN / PRE CONSTRUCTION								
Project disclosure	1. Submit ADB-approved IEE including EMP to CEPA for approval using applicable form and obtain a Development Consent as per the Environment Act. 2. Ensure CEPA approved EMP and any conditions of Development Consent are included in tender documents including i) requirement for contractor to seek CEPA approval and update EMP in the case of significant changes to FS design ii) requirement for contractor to prepare a CEMP for approval of PMU/DSC before commencement of construction. The CEMP will demonstrate the manner (location, responsibilities, schedule/ timeframe, budget, etc.) in which the contractor will implement the mitigation measures specified in the EMP approved under CEPA Development Consent. 3.Tender document to include upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet. 4. Implement plan for Grievance Redress Mechanism as described in the IEE 5. Contractor's project design to adhere to all design related mitigation measures in FS EMP or in updated EMP as approved under CEPA Development Consent.	1 to 4: PMU/DSC 5 Contractor	1 and 2 Immediate. 3: During tender preparation 4:Before start of civil works 5:Detailed design phase	1 to 4: Cost included in PMU/DSC staffing 5: Cost included in Contract	Environmental approval for the project obtained from CEPA. Complete check of items 1 to 5.	Prior to signing of EPC contract and start of site works. Once.	PMU	Cost included in PMU budget for EO to support the project procurement and impl..
Environmental capacity development	1. PMU to commit to provide sufficient resources for project duration to oversee EMP implementation. 2. DSC to train PMU/EO in implementation of	1: PMU 2: DSC 3: Contractor	Initiate during procurement period and continue	1: & 2: IES (project) costs 3:Included in	1.ADB loan covenants 2.IES TOR, DSC progress	Prior to start of site works and throughout construction	PMU	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	EMP as well as general training in ADB safeguards requirements to raise awareness and build capacity of environmental management in PMU. A mix of workshops and on-the-job training to be used. 3. Conduct contractor / workers' orientation on EMP provisions.		throughout project construction	contract cost	reports to PMU/ADB 3.Tender documents and check during construction.	phase.		
Environmentally responsible procurement	1. EMP is included in tender documents to ensure that mitigation measures are budgeted and to prepare the contractor for environmental responsibilities. 2. Specify in tender document that contractor shall engage appropriately qualified and experienced staff to take responsibility for the environmental management and safety issues and monitor the effectiveness and review mitigation measures as the project proceeds. 3. Contractor to submit construction environmental management plan (CEMP) based on contractual EMP for approval by DSC (i.e., site clearance, site drainage, waste and materials management, traffic, noise and dust management etc.). 4. Contractor recruit qualified and experienced staff to oversee implementation of environmental and safety measures specified in the EMP.	1 & 2: DSC for PMU 3: Preparation of CEMP - Contractor, Approval of CEMP-DSC 4: Contractor	1 & 2: Bid preparation 3 & 4: Before start of civil works	Included in bid cost	1 & 2: Inclusion in bid docs 3 & 4: Check compliance	Bid preparation stage. Before start of site works	PMU/IES	PMU – as above. IES – included in DSC staffing
Disclosure of CPP and GRM and establishment of procedures	1: Project documents disclosed to public and communities in an appropriate form and manner and accessible place 2: Inclusion of appropriate measures from CPP and GRM in tender documents	PMU	Before Contractor mobilization	Included in bid cost	Tender document; Grievance registry, monthly reports	Monthly Grievance registry, monthly reports	Contractor, PMU	Included in project cost PMU - as above.
Workers and public safety	CEMP to include measures covering workers and public safety and to identify interfaces between the works and the public, formulate measures to ensure safety of workers and the	Contractor in preconstruction	Before start of civil works	Cost included in contract.	Tender document. Check at preconstruction.	During tender preparation and again before start of works	PMU/IES	PMU – as above. IES - included in DSC staffing

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	public, and prevent accidents due to the construction works.							
Climate change adaptation measures to be properly considered and incorporated into design as necessary	Design criteria in respect of peak flood size and levels need to take account of the potential effects of climate change. Appropriate design criteria to be established based on available climate change modelling data to develop extreme event data. In the absence of such data, design criteria to be demonstrably conservative.	PMU/DSC	Tender document preparation	Included in overall project cost	Civil design specifications in tender document Contractor's detailed civil design	Prior to signing of contract and start of site works. Once.	PMU/DSC (IES)	PMU – as above. IES – included in DSC staffing
Grievance Redress Mechanism established	Establishment and implementation of GRM confirmed by PMU.	PMU	Before start of civil works	Met by PMU/ project	GRM confirmed and agreed with community.	Before start of civil works	PMU	Incl. in PMU budget for EO
Raise awareness of Contractor on environmental management matters	Induction safeguards training for Contractor	DSC	Before submission of CEMP	Cost included in project and contract	Approved CEMP	Before submission of CEMP	PMU	Included in PMU budget for EO
Audit of Warangoi hydropower project – corrective actions required	1 .PPL to make a formal request to CEPA using prescribed forms in order to obtain clarification regarding requirments for obtaining a new EP for Warangoi to replace the WUP which expired in December 2007. 2. PPL to disclose the scope of the improvements for Warangoi refurbishment and seek guidance from CEPA on the actions needed to establish regularization of environmental compliance of Warangoi HP. 3. PPL to introduce waste management planning, reduction, reuse and recycling methods and off-site disposal at authorized site and prevent burning of waste in line with the DEC environmental codes of practice. 4. PPL to minimize impacts from incorrect storage and disposal of hazardous substances	PPL	1 and 2 Immediate 3 -10 as soon as possible and needs to be specified as part of post-refurbishment O&M procedures. 11 During implementation of refurbishment works.	Costs included in contract	1 and 2 Documents 3 -10 O&M documentation included in bid documents for refurbishment works 11 Included in design specifications of bid documents	1,2 Prior to signing contract. Once 3 -11 Once bid preparation stage	PMU (EO) DSC (IES)	PMU – as above. IES – included in DSC staffing

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	in line with DEC environmental code of practice for Vehicle / Machinery Workshops and Petroleum Storage / Resale / Usage is followed. 5. PPL to stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Kokopo maintenance area stockpile, awaiting bulk disposal by PPL or give to the local community for their use. 6. PPL to prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers. 7. PPL to prepare and implement a Health and Safety Plan for the operation of Warangoi hydropower project. The HSP shall conform to the requirements of the PNG Employment Act 1978 and meet the provisions of the IFC/World Bank Environmental, Health, and Safety General Guidelines. 8. PPL to ensure that workforce training for all workers will include environment, safety and environmental hygiene. 9. PPL to repair toilet facilities and ensure they are well maintained and cleaned daily to allow effective operation. 10. PPL to maintain consultation and grievance redress mechanism for routine operations to enable focus on continuing good public relations and maintaining an open door policy for complaints and concerns from the public. 11. It is recommended that upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at							

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	drainage outlet be included as part of the refurbishment works							
CONSTRUCTION STAGE								
Physical Impacts								
Noise and dust nuisances	1. Construction equipment and vehicles will be maintained to a good standard and provided with muffler silencers. 2. Watering of access road during dry periods as required 3. Monitor and investigate complaints; propose alternative mitigation measures.	Contractor	Throughout construction phase	Cost included in contract	Check implementation	Once a month as part of routine construction monitoring	EO/IES	As above
Erosion and loss of topsoil	1. Schedule excavation activities in the drier months (Jun - Oct) 2. Minimize vegetation clearance corridor or footprint of components 3. Ensure slope cuts (if any) are properly engineered and re-vegetated immediately after cutting 4. Install cut-off drains above excavated areas on steep slopes 5 Install river bank protection measures (Masonry, gabion baskets etc) in river channel adjacent to headworks structures 6. Stockpile topsoil for later use in landscaping or made available to local community for their use 7. As far as possible ensure cut to fill balance	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Once a month as part of routine construction monitoring	EO/IES	Included in DSC staffing
Sedimentation and water quality impact	1. Schedule excavation activities in the drier months (Jun - Oct); 2. Minimize vegetation clearance; 3 Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles of excavated material; 4. Effective construction supervision to ensure	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Once a month as part of routine construction monitoring	EO/IES	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	above measures implemented							
Materials and Spoil Management	1. Identify and implement measures for spoil management as part of CEMP. and fill requirements to minimize need for aggregates from other sources 2. Topsoil, overburden, and low quality materials shall be properly removed, stockpiled near the site, and stored for reuse. 3.Areas for disposal to be agreed with land owner and local authorities and recorded by the PMU/DSC and monitored 4. Spoil will not be disposed of in rivers and streams or other natural drainage path. 5. Surplus spoil will be used where practicable for local repair works to fill eroded gullies and depression areas and degraded land in consultation with local community. 6.Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas. 7. Spoil disposal sites shall be located at least 50 m from surface water courses and shall be protected from erosion by avoiding formation of steep slopes and grassing.	1:Contractor to prepare CEMP and submit to PMU/DSC for approval 2 to 7: Contractor	1: One month before start of site works 2 to 7: Throughout construction phase	Cost included in contracts	Check implementation of items 1-7 and CEMP provisions	1: Before construction 2 - 7 Implementation of CEMP provisions: Monthly	EO/ IES	As above
Waste Management	1. Prepare and implement waste management plan (WMP) of CEMP to cover all aspects of waste storage disposal and accidental spills. 2. Areas for disposal to be agreed with land owner and local authorities and checked, recorded and monitored by the PMU/DSC. 3. Segregation of wastes shall be observed. 4. Recyclables shall be recovered and sold to recyclers. 5. Residual wastes shall be disposed of in disposal sites approved by local authorities and	1: Contractor to prepare WMP, PMU/DSC IES to assist and approve 2 to 9: Contractor	1: One month before start of site works 2 to 9: Throughout construction phase	Cost included in contracts	Check implementation of items 1-9 and WMP provisions	1: Before construction 2 to 9: Implementation of WMP provisions: Monthly	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	not located within 500m of rivers or streams. 6 Site offices and yard shall be provided with garbage bins 7. Burning of construction and domestic wastes shall be prohibited. 8. Disposal of solid wastes into drainage ditches and public areas shall be prohibited. 9. All general solid waste will be collected and removed from the work areas and disposed in local waste disposal sites as identified by the local authorities..							
Use of hazardous substances and hazardous waste disposal	1. Hydrocarbon, toxic material will be stored in adequately protected sites consistent with international best practices to prevent soil and water contamination. 2. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations. 3. Segregate hazardous wastes (oily wastes, used batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution and shall be undertaken consistent with international best practice. 4. Ensure all storage containers are in good condition with proper labeling. 5. Regularly check containers for leakage and undertake necessary repair or replacement. 6 Store hazardous materials above possible flood level 7. Discharge of oil contaminated water shall be prohibited. 8. Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by the VPMU/DSC. 9. Ensure availability of spill cleanup materials	Contractor	Throughout construction phase	Cost included in contracts	Check implementation of all items	Monthly	EO/ IES	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	(e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored. 10. Spillage, if any, will be immediately cleared with utmost caution to leave no traces.							
Biological Impacts								
Loss of Forest Habitat and impacts on fauna	1. Minimize vegetation clearance area 2. Mark boundary of clearance footprint with high visibility tape to ensure construction workers are aware of clearance boundaries; 3. Workers prohibited from poaching, hunting or fishing (sanctions to be imposed);	Contractor	Site surveying and vegetation clearance.	Cost included in contract	1 & 2 Visual observation Sanctions imposed on workers not adhering to item 3	1 & 2: Before start of site works	IES & EO	As above
Socioeconomic Impacts								
Operation of contractor camp / Site offices	1. Location of site office and facilities to be agreed with local community with facilities approved by PMU/DSC and managed to minimize impacts; Protocols established as per CPP and GRM 2. Potable water, clean water for showers, hygienic sanitation facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. 3. Separate toilets shall be provided for male and female workers. 4. As many local workers as possible will be hired and trained. 5. Adequate toilet facilities shall be installed and open defecation shall be prohibited and use of toilets encouraged by keeping toilet facilities clean at all times. 6. Wastewater effluent from contractors' workshops (if any) will be passed through	1:Ccontractor with PMU/DSC approval 2-8: Contractor	1: One month before start of site works 2 to 8: Throughout construction phase	Cost included in contracts	Check implementation of items 1-8	1: Before construction 2 - 8: Monthly	EO/ IES	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	gravel/sand beds and all oil/grease contaminants will be removed before discharging it into natural water courses. Oil and grease residues shall be stored in drums awaiting disposal in line with an agreed WMP. 7. The Contractors facilities area will be cleaned up to the satisfaction of PMU and local community after use. 8 All waste materials shall be removed and disposed to disposal sites approved by local authorities							
Occupational Health and Safety	1. Contractor to include health and safety provisions in the CEMP and insuct workers in health and safety matters. Plan to be approved in writing by PMU/DSC one month prior to starting works. Contractor to implementall provisions. 2. Before construction commences the contractor will conduct of training for all workers on environmental, safety and environmental hygiene. The contractor will instruct workers in health and safety matters as required by good engineering practice and provide first aid facilities. 3. Workers shall be provided (before they start work) with appropriate PPE. 4. Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works. . 5. Provision of potable water supply in all work locations.	1:Contractor with PMU/DSC approval 2-5: Contractor	1: One month before start of site works 2 to 5: Throughout construction phase	Cost included in contracts	Check implementation of items 1-5	1: Before construction 2 - 5: Monthly	EO/ IES	As above.
Community Health and Safety	1. Include in CEMP for barriers (e.g., temporary fence), shall be installed at construction areas to deter pedestrian access except at designated crossing points. 2. The general public/local residents shall not	Contractor	At all times throughout construction phase	Cost included in contracts Cost for item 6 included in	Check implementation of items 1-6	Monthly	EO/ IES	As above.

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	**Responsible to Implement**	**Timing to Implement**	**Cost**	**Parameter to monitor**	**Frequency & Verification**	**Responsible to Monitor**	**Cost**
	be allowed in high-risk areas, 3. Provide warning signs at periphery of site warning public not to enter 4. Strict imposition of speed limits along access through residential areas and where other sensitive receptors such as schools, hospitals and other populated area are located 5. Communication to the public through public consultation, local authority and notice boards regarding the scope and schedule of construction as well as certain construction activities causing disruptions and access restrictions. 6. Implementation of communicable diseases (incl. STIs and HIV) awareness and prevention measures			PSA				
OPERATION STAGE								
Implementation of Corrective Actions identified in Environmental Due Diligence Review (see pre-construction issues above)	See above	PPLr	Operation phase	Included in overall project cost	Implementation of all corrective actions as identified in DDR (see pre-construction issues above)	Periodically during routine maintenance activities	PPL EO	Included in PPL Operation and maintenance costs