Initial Environmental Examination

April 2011

PNG: Bridge Replacement for Improved Rural Access Sector Project

Prepared by the borrower for the Asian Development Bank.

PNG Department of Works

Bridge Replacement For Improved Rural Access Project

Initial Environmental Examination

Ramu Highway

ADB TA-7594 (PNG)

April 2011

ACRONYMS

ADB	Asian Development Bank
AP	Affected person/s
B&C	Bid and Contract Document
CAP	Community Awareness Program
CEMP	Contractor's Environmental Plan (prepared by contractor)
CLO	Community Liaison Officer
DE	Design Engineer (attached to PIU, responsible for pre-construction design supervision)
DEC	Department of Environment and Conservation
DoW	Department of Works
EA	Executing Agency
EARF	Environmental and Review Framework
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EO	Environmental Specialist
EHS	Environmental Health and Safety Officer
ERP	Emergency Response Procedure
ESS	Environmental Safeguards Specialist
GoPNG	Government of Papua New Guinea
IA	Implementing Agency
IEE	Initial Environmental Examination
LLG	Local Government
MSDS	Material safety Data Sheet
NTU	Nephelometric Turbidity Unit
PAM	Project Administration Memorandum
PE	Project Supervising Engineer (employed by SC, responsible for construction supervision)
PM	Project Manager (PIU)
PIU	Project Implementation Unit
PPTA	Project Preparation Technical Assistance
QMP	Quarry Management Plan
RP	Resettlement Plan
RoW	Right of Way
SC	Supervising Consultant
SCD	Social and Community Development Specialist
SE	Site Engineer (Contractor's representative)
SEHSO	Site Environmental Health and Safety Officer (Contractor's representative)
WS	Work Statement

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I. EXECUTIVE SUMMARY

The purpose of the project is to replace ageing Bailey bridges with two lane bridges and following rehabilitation of the Bailey bridges re-erect them in new locations to improve rural access. Bridges to be replaced were selected according to technical and social criteria. An IEE study of the replacement of bridges along the 171km length of the Ramu Highway in Central Province was carried out which identified four Bailey bridges and a river crossing that met the project selection criteria. Replacement of the bridges along the Ramu highway is included as a sub-project with four other national highways within PNG that will replace ageing and undersized bridges.

Replacement of the bridge will enhance the connectivity of rural communities living along the Ramu Highway as well as improving road safety by the provision of a double lane bridge with a separate footpath. The new bridges will be constructed alongside the existing bridge which will provide access during construction. New bridge foundations will be required and fill will need to be brought in to raise and extend the road pavement on either side of the bridge to extend the road to a double lane.

The IEE that has been prepared is compliant with the ADB Safeguard Policy Statement. Bridge replacement is not a prescribed activity under the PNG Environmental (Prescribed Activities) Regulation 2002 and accordingly the IEE will be reviewed by the DoW Environmental Management Branch to meet their Code of Practice. A copy of the IEE will be forwarded to DEC for their information.

The IEE reviews the environmental impacts associated with the replacement of the bridges and the crossing and is based on field inspections and secondary data. Public consultation was also undertaken at central, provincial, district and community level. The corridor in which the bridges will be reconstructed is already highly disturbed and no significant vegetation, primary forest or conservation areas will be affected. There are 98,200 persons living along the highway who will benefit from the replacement of the bridges. No cultural or heritage sites will be affected.

The main environmental issues are construction related impacts all of which can be satisfactorily managed through the application of the EMP by the contractor. Temporary access requirements will need to be arranged for the construction sites and small areas of customary land will need to be acquired at the bridge site. Land acquisition is addressed by the Resettlement Plan which will be implemented by the PNG Department of Lands.

Pre-construction requirements mainly concern the preparation of the EMP as a contractual document. Construction of bridges on the Ramu Highway will be let as one combined contract. The contract will cover both bridge replacement and re-erection of Bailey bridges in new locations that will be selected by the DoW. Construction activities will be localised at the bridge site and construction of the bridge and the re-erection of the old Bailey bridge is expected to be completed within the contract period of 2-3 years. The main issue that has been identified in the IEE is increased turbidity that will arise from vehicles using any temporary crossings and to a lesser extent work within and alongside the stream channel to construct the bridge foundations. Turbidity will be increased for a short period, though this is of little consequence as there are few communities living immediately downstream of the bridge who will be affected. All other construction impacts are of a routine nature and can be effectively addressed by the EMP. Before commencing work the contractor will prepare a Contractors Environmental Management Plan (CEMP). The contract will specify that unskilled labour are to be hired from the local community during construction.

During operation the replacement of the bridges will have a beneficial impact on maintaining the connectivity of communities living along the road. The re-erected Bailey bridges will have a large beneficial impact on allowing services and goods to move in and out of areas that were previously access deficient. The DoW will arrange to carry out maintenance of the bridges.

The project will be funded as a single loan made to the GoPNG which will cover bridge replacement for five national highways as well as re-erecting the deconstructed Bailey bridges in remote rural locations. The project will be implemented and executed by the DoW who will engage a Supervising Consultant for construction. The Supervising Consultant will recruit an international Environmental Safeguards Specialist (ESS) during detailed design and implementation who will train and supervise a nationally recruited Environmental Officer (EO). The ESS will initially be responsible for the implementation of the EMP program and will be assisted by the EO who over time will gradually assume responsibility for the program. Specific duties for the ESS and EO during detailed design include the incorporation of the EMP within the Bid and Contract documents while during implementation the ESS and EO will assist the Project Engineer (PE) in supervising and monitoring the contractor's work. The cost of establishing the environmental program is $0.64 million.

The IEE concludes that the project has few adverse impacts. All can be satisfactorily managed and that an EIA is not required.

II. INTRODUCTION

The Government of Papua New Guinea (GoPNG) has requested the Asian Development Bank (ADB) to provide a loan to replace bridges along five major highways. The bridges are mainly Bailey bridges and after removal the bridges will be rehabilitated and re-erected on rural roads where they can provide safe and reliable access for previously inaccessible rural communities. The project is prepared under the Project Preparation Technical Assistance (PPTA) No. 7594-PNG. The Executing Agency (EA) and the Implementing Agency (IA) for the PPTA is the PNG Department of Works (DoW).

The Project will enhance social and economic development in rural areas by providing safer access to markets and social services for rural population along selected road corridors. The outputs will be (i) reduced bottlenecks on the national roads, (ii) safer journey and reduced travel time, (iii) improved capacity of the road agencies (DOW and NRA[1]) to manage bridge assets, and (iv) maintenance of rural bridges by beneficiary communities.

This Initial Environmental Examination presents the environmental assessment of replacing the Sivitatano bridge along the Ramu Highway. The IEE has been submitted to the ADB by the PNG Department of Works and has been carried out to comply with the *Asian Development Bank Safeguard Policy Statement, June 2009.* Bridge replacement does not trigger the PNG Environment (Prescribed Activities) Regulation of 2000 and instead the DoW will review the IEE with regard to their Code of Practice for Environmental Assessment of Roads and Bridges.

The main purpose of the IEE is to environmentally assess the location, construction and operation of replacing four bridges and one open crossing along the Ramu Highway[2]. The Ramu Highway (Figure 1) is 174 km long and starts at Madang and terminates at its junction with the Highlands Highway at Watarais, 160km inland from Lae. The Highway is classified as a National Route Road (NR13) and is a narrow two lane road. Apart from the unstable

[1] National Roads Authority. Sections of the priority national road corridors have been transferred to NRA for maintenance.

[2] Unlike the other four highways in the study only one bridge has been selected for the Ramu Highway as none of the other bridges made the selection. This was mainly due to the low traffic volumes on this highway.

mountainous section where the road crosses the Finisterre Range the road is sealed for most of its length.

The selection of the bridge sites has been somewhat protracted due to the criteria being continuously amended and while five sites have been reviewed in the IEE it is quite possible that these sites will be further reviewed before any contract is awarded. Accordingly the IEE has two objectives (i) to review the bridges that have been selected and are included in the DFR and (ii) for the EMP to be sufficiently robust so that it may be applied to additional bridges that may be added at a later stage.

A. Overview

Transport plays a vital role in creating and supporting economic growth by providing linkages from production areas to markets and for ensuring the efficient delivery of services between centres. Well maintained transport infrastructure is essential for the efficient flow of consumer goods and services to village communities.

Approximately 85% of the population of PNG live in highly dispersed and culturally diverse rural settlements that are isolated from each other by rugged topography or sea. The rugged topography and swamps has hindered the development of a national road transport system which consequently is highly fragmented. PNG has 8,738 km of national roads[3] of which 5,590 km (64%) are unsealed and 3,148 km are sealed (36%). Roads connect the highlands with ports at Lae and Madang while many other centres including Port Moresby and to a lesser extent Rabaul have limited road systems.

The PPTA will support the replacement of bridges - mainly Bailey bridges that are now becoming unserviceable through age and poor maintenance in five National Highways (NR) throughout PNG.[4] The Project supports the Government's Development Strategic Plan (DSP, 2010-2030) and the country's National Transport Development Plan which identifies a Bridge Replacement Program[5] for the replacement of single lane bridges on National Highways as a priority which will be selected based on load capacity, width and height clearance, reliability and risk.

As 85% of the population live in rural areas, improving service delivery and income opportunities for the rural population is a key priority. Improving accessibility of rural road networks will open up markets, improve agricultural profitability, facilitate market chain linkage with downstream processing and export markets and expand health services. These initiatives are expected to result in a significant rise in employment and income over the DSP period.

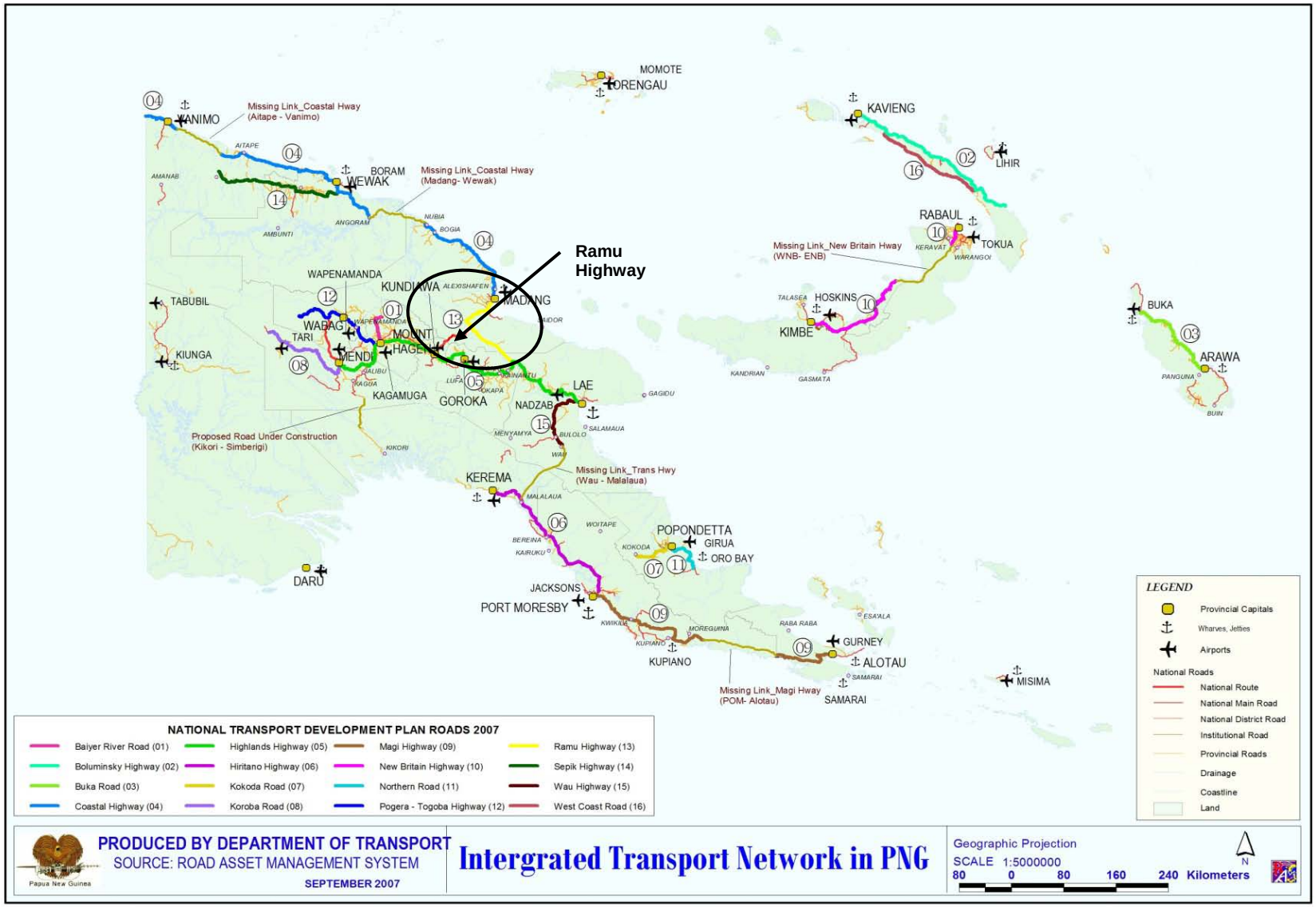
The ADB will arrange a loan to the DoW who will be the Executing Agency (EA) to cover the cost of the bridge replacement program. The first phase of the Project is estimated to cost about $100 million. ADB plans to finance up to $90 million comprising $50 million ADF loan and $40 million OCR loan. The Government will provide counterpart financing of $10 million.

[3] *PNG Road Statistics 2010, Department of Works*

[4] The other NR highways which are planned for bridge replacement include: (i) the West New Britain Highway; (ii) the Sepik Highway; (iii) the Ramu Highway and (iv) the Ramu Highway. As part of this PPTA a representative bridge for each of these highways has been reviewed as an IEE.

[5] *National Transport Development Plan 2006-2010, p. 22.*

Figure 1: Location of Ramu Highway within PNG National Highway System



B. Objectives and Scope of the IEE

The objectives of the IEE are to:

(i) Assess the existing environmental conditions in the project area including the identification of environmentally sensitive areas;
(ii) Assess the proposed location, design, construction and operation activities to identify and evaluate their potential impacts, and determine their significance; and
(iii) Propose appropriate mitigation and monitoring measures that can be incorporated into an Environmental Management Plan that will avoid or minimize adverse impacts so that residual impacts are reduced to acceptable levels.
(iv) Provide an IEE that is sufficiently robust that will allow it to be adopted for construction of other bridges that may be identified at a later date.

The IEE studies were based on secondary sources of information derived from desk studies and supplemented by field studies. A field survey sheet was used to record observations on the bridge site including vegetation, the morphology of the water course and details provided by local communities on wildlife, aquatic and avi-fauna. During the field study all of the bridges were inspected and their locations recorded by GPS. Socio-economic and population was carried into the study from the sociological study that was undertaken at the same time. Catchment areas were determined from the 1:100,000 topographic series of maps. Public consultation was undertaken as part of the IEE process to determine stakeholder and community attitudes to the possible developments.

C. Report Structure

The report structure follows the format outlined in Annex to Appendix 1 of the *Asian Development Bank Safeguard Policy Statement, June 2009.* The IEE consists of eleven sections: (A) Executive Summary, B Introduction; C Policy, Legal and Administrative Framework; D Description of the sub-project; E Description of the Environment; F Anticipated Environmental Impacts and Mitigation Measures; G Analysis of Alternatives; H Information Disclosure, Consultation, and Participation; I Grievance Redress Mechanism; J Environmental Management Plan; K Conclusions and Recommendations.

The Environmental Management Plan (EMP) is presented as a matrix in Annex 1, together with budget details in Annex 2, and the monitoring plan matrix in Annex 3.

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. ADB Policies

The IEE has been carried out to ensure that potential adverse environmental impacts are addressed according to the *Asian Development Bank Safeguard Policy Statement, June 2009.* The ADB's *Safeguard Policy Statement, June 2009* has been used to classify the sub-project as a **Category "B"** project which requires an IEE.

B. PNG Requirements

Environmental impact assessment and management in PNG is addressed by the **Environment Act of 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 are administered by the Department of Environment and Conservation (DEC).

The Environment Act 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 DEC 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 12 addressing Infrastructure Development. Item 12.5 includes *Construction of new national roads.* There is no activity covering bridge replacement and accordingly there is no requirement for environmental approval from DEC for this item. Accordingly no Environmental Permit (EP) is required to be issued by DEC for this work to proceed. The DEC advise that while approval of new road construction is part of their responsibility, road and bridge maintenance and monitoring is within DoWs authority. The IEE will be submitted to the Environment Branch of the DoW for review and a copy sent to DEC.

The **Department of Environment and Conservation** is responsible for the administration and enforcement of the Environment Act 2000 and its regulations. As the governments environmental management agency, the mission statement of DEC is: *To ensure PNG's natural resources are managed to sustain environmental quality, human well-being and support improved standards of living*[6]*.* 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.

The DEC have also issued several guidelines including:

- Guideline for submission of an application for an environmental permit to discharge waste. *GL-Env/03/2004*. These include:
    - Noise discharges. *IB-ENV/03/2004*
    - Air discharges. *IB-ENV/02/2004*
    - Water and Land Discharges. *IB-ENV/04/2004*

DEC operates at the national level from its office based in Port Moresby. It does not have offices and personnel in the provinces. All environmental approval is done in the central office in Port Moresby. As part of the national government's decentralisation policy, DEC 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.

C. The Department of Works (DoW)

Under a World Bank road project the DoW were required to form an Environmental Branch which is located within the Contract's Management Division. The branch is headed by a Manager Environment who is to be supported by two monitoring staff. The DoW have two documents related to environmental assessment these are:

- *Environmental Impact Assessment Guidelines for Roads and Bridges* (also referred to as the Code of Practice) which establishes the need for assessment, the methodology for

[6] DEC Corporate Plan 2009 - 2012.

preparing environmental assessment reports and the EMP. The COP is extensive and among other EMP requirements requires the contractor to prepare a CEMP, arrange HIV/AIDS awareness programs and prepare Quarry Management Plans.

- The second document is the *Environmental Appraisal Report - Suggested Outline* which establishes criteria for verifying the reports contents.

D. Other PNG Legislation

The following legislation will also apply to the project:

(i) 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. This is administered by the Department of Labour and Employment. Conditions of the Act are relevant to the health and safety of workers employed during construction and are reflected in the IEE.

(ii) The National Cultural Property (Preservation) Act 1965. An Act relating to the preservation and protection of objects of cultural or historical importance to PNG. This is administered by the National Museum and Art Gallery. Should any chance finds be made during construction this Act will be triggered.

(iii) The Public Health Act (1978) Chapter 368 protects the general public by regulating and controlling the unplanned disposal of any environmental contaminants such as domestic or industrial waste and/or refuse that will have some kind of impact on the lives of people. The Act regulates the proper and planned establishment of waste disposal points such as rubbish dumps and landfills so that such establishments are seen to be causing minimal inconvenience to people's lives. The Act also covers the areas of general health, sanitation, cleaning, scavenging and disposal of wastes. It covers all the activities that pose risks and potential risks, and inconveniences by their output to the usage of the environment surrounding the area of activity. As the Project will affect the lives of people, especially the local community downstream, this Act is applicable to this project and has been taken into consideration while undertaking the IEE.

(iv) Drinking water quality standards for raw (untreated) water are contained in the Public Health Drinking Water Quality Standards of 1984 while the standards for aquatic life protection are listed in the Environment (Water Quality Criteria) Regulation 2002 and are shown in Table 1 of Act. Sec. 133(2); Reg. Sec. Ranges of criteria are given for several parameters including turbidity which shows that turbidity should not exceed 25 NTU[7].

E. Relevant PNG Planning Documents

1. Papua New Guinea Development Strategy Plan (DSP) 2010-2030

The DSP establishes goals for the various economic sectors including transport which is identified as constraining PNG's economic growth due to the lack of an effective modern transport system. The main issues identified by the plan include lack of maintenance and connectivity and a future issue with regard to inability of the network to cope with enhanced economic growth. This is to be addressed by a tripling of the national road network to 25,000km

[7] Since many of the water courses in PNG are naturally quite turbid this standard appears to be unrealistic as it is close to clean water. It is suggested that the actual pre-project turbidity in the water course be used as the standard for assessing turbidity during construction.

by 2010 by the identification of 16 priority highways. These are identified in the National Transport Development Plan.

2. The National Transport Development Plan (NTDP)

The NTPD covers the period 2006-2010 and outlines a strategy for the development of land water and air transport. The plan identifies 16 national highways of importance. Page 3 of the NTDP also includes a section on Environmental Protection:

The developments proposed in the NTDP 2006-2010 will be undertaken with care to minimise any degradation of the environment and enforce procedures and regulations guarding against pollution from transport services.

F. International Agreements

Papua New Guinea is a signatory to the following international agreements with environment-conservation implications:

(i) International Plant Protection Convention, Rome 1951.
(ii) International Convention for the Prevention of Pollution of the Sea by Oil, London 1954.
(iii) Plant Protection Agreement for the South East Asia and Pacific Region, Rome 1956.
(iv) International Convention on Civil Liability for Oil Pollution Damage, Brussels 1969.
(v) RAMSAR Convention on Wetlands of International Importance, especially waterfowl habitat. 1971.
(vi) International Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, London, Mexico City, Moscow 1972.
(vii) Convention on the World Cultural Heritage and Natural Heritage, 1972.
(viii) International Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington 1973 (CITES Treaty).
(ix) Convention on the Conservation of Migratory Species of Wild fauna and Flora, 1973.
(x) International Convention on the Conservation of Nature in the South Pacific, Apia 1976.
(xi) International Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques, New York 1976.
(xii) 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).
(xiii) International Convention on Biological Diversity, Rio de Janeiro 1992.

Since the bridge replacement project will not affect biodiversity, or any endangered, migratory of other significant species, areas with high conservation values such as wetlands, world heritage areas or conservation reserves to which these treaties apply, the project will not trigger any of these treaties.

IV. DESCRIPTION OF THE SUB-PROJECT

A. Technical Description

Details of the bridges to be replaced are shown in Table 1, while the location of each of the bridges are shown in Figures 2 - 4.

Table 1: Bridges to be replaced along Ramu Highway

Bridge	Location (km)	Coordinates	Elevation (m)	Bridge type	Bridge length (m)	Est. cost US$m)	Ranking
Gusap River	17.2	S6 01.745 E145 56.995	463	Bailey	40.0	3.4	30
Bora River	20.6	S6 01.387 E145 55.606	423	Bailey	45.0	3.8	13
Dry Wara	58.2	S5 50.881 E145 41.635	254	Bailey	40.0	3.4	9
Wasigo	154.2	S5 24.194 E145 36.337	104	Bailey	40.0	3.4	11
Tapo Riv. crossing	159.5	S5 24.335 E145 38.220	147	Open crossing	40.0	3.4	4

Location: is distance along road from start of highway.
Ranking: is place out of a total 152 bridges that were assessed in the five national highways for the PPTA.

The bridges[8] consist of four Bailey bridges and one open crossing. Three of the bridges (Gusap, Bora and Dry Wara) are located within the Ramu Valley while the other bridge and the open crossing (Wasigo and Tapo) are located on the Madang section of the highway. Bailey bridges are designed as a strong unitary system that can be easily erected and disassembled and have been widely employed as a simple and effective first option in providing road access. They are provided as single lane bridges and in the PNG situation, traffic growth and increasing age now makes it imperative that in most situations the bridges be replaced with two lane bridges.

In all cases a new 40m or 45m long single span two lane bridge will be a constructed alongside the existing bridge which will remain to provide access past the site during construction. The bridge design is likely to incorporate steel beams with a concrete deck. New abutments will be required to support the bridge. The bridge will be designed to allow for the 1:100 year flood plus 1.0 m additional clearance. Additional work includes widening the bridge approach embankment for about 100m to accommodate the second lane. Following completion of the new bridge the Bailey bridge will be delaunched, dismantled, rehabilitated and re-erected at a new site.

Construction work includes:

(i) Transport of bridge construction materials and machinery to site.
(ii) Preparation of contractor's campsite.
(iii) Using fill broaden and raise the side of the existing road to provide access to the abutments for pile driving and concrete mixing machinery.
(iv) Drive piles into the channel for the bridge support foundations and into side of the river to form the bridge abutments.
(v) Prepare reinforcing steel, formwork and pour concrete for abutments.
(vi) Place steel girders.
(vii) Lay deck slabs and erect safety railings.
(viii) Finish by painting bridge steelwork.
(ix) Construct bridge approach roads and lay asphalt.
(x) Erection of guardrails and road signs.
(xi) Install abutment and river bank protection as required.
(xii) Dismantling any Bailey bridge for re-erection in another location.

[8] Throughout the PPTA one of the issues that the affected the IEE was that the number of bridges for replacement and their location was being continuously amended. It was necessary to rule a line on it and this is the list of bridges that had been selected at the time that the field work was undertaken towards the end of the PPTA. Should the list be further amended the EMP has been written as a sufficiently robust document to deal with this situation.

The project may employ about 230 people of which about 50 people may be employed from the local community. A summary is provided in Table 2 while actual details of numbers employed is given in Annex 5.

Table 2: Employment of Staff and Workers for Bridge Construction

Staff	Contract	Replacement Bridge	Reuse Bridge
Professionals	20	6	1
Skilled	96	48	21
Unskilled	115	47	15
Total	**231**	**101**	**37**

Contract: workers that may be employed to complete all bridges within the contract package. Replacement or Re-use bridge: is actual number of workers who may be employed on a particular bridge site.

Machinery that may be used on the site is shown in Annex 6 and includes a range of heavy machinery and light machinery. The major item that will have environmental consequences will be the pile driver that will create both noise and vibration impacts during pile driving and the vibratory roller that will be used for settling the road abutments. A fuel truck will be required for refuelling equipment and vehicles.

Materials that may be brought to site that will have environmental implications include: fuel, concrete, asphalt and paint thinners. A list of materials is provided in Annex 7.

The sub-project will have several benefits including:

(i) Improved traffic flow from having a two lane bridge rather than one lane.
(ii) More reliable all weather access.
(iii) Release of a Bailey bridge for re-erection in a rural situation.
(iv) Employment of possibly 50 unskilled workers from local communities during bridge construction.

V. DESCRIPTION OF THE ENVIRONMENT

The project area includes; the area of the bridges and their immediate surrounds where construction facilities including the contractor's facilities (office, storage areas for materials and fuel and vehicle parking areas) will be sited.

A. Physical Environment

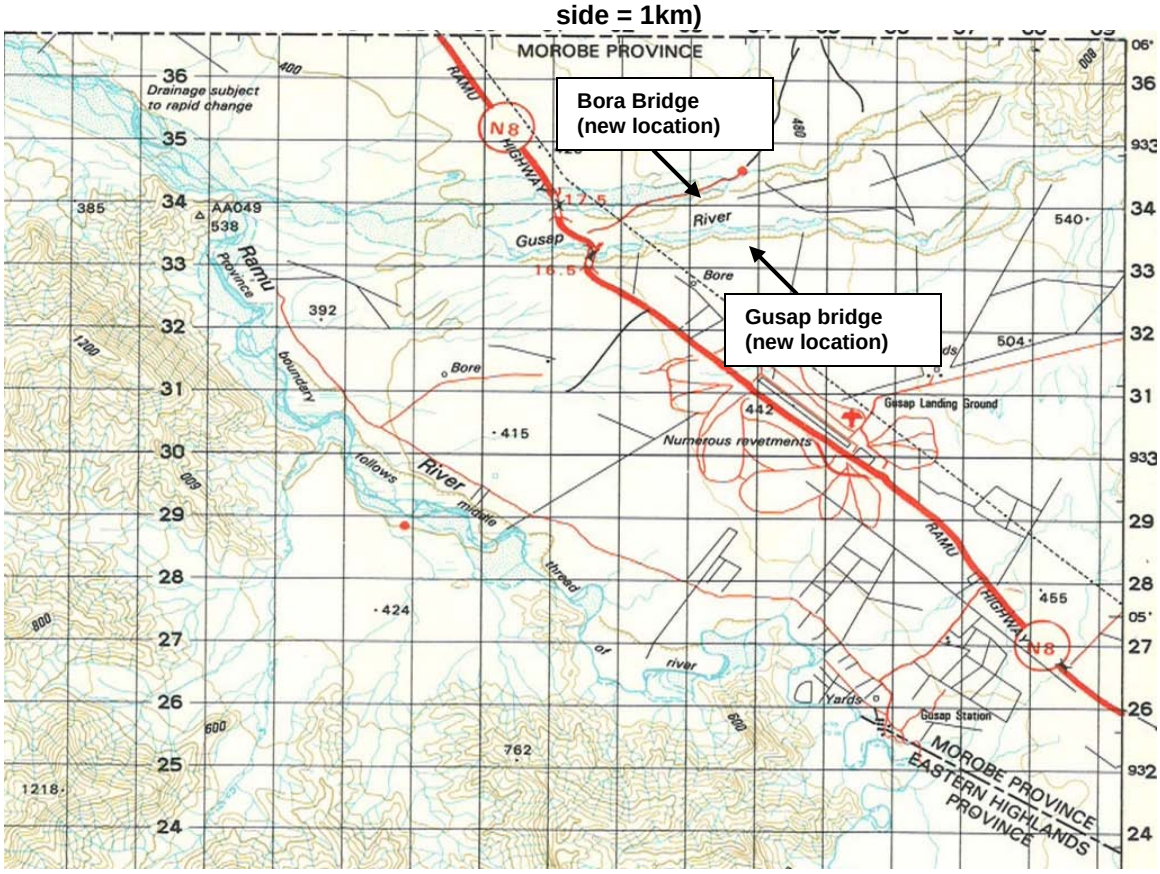
1. Topography Geology and Soils

The Ramu Highway (NR 13) is 174km long and comprises part of the national road network which links Madang with the highlands and Morobe provinces. After following the coast for 20km the road turns inland to pass through a saddle at 475 m between the Finisterre and Adelbert Mountains. From here it descends to the Ramu River valley which is an extension of the Markham valley tectonic depression. Where the highway meets the Ramu Valley the highway turns to the south east to follow the valley to the Morobe border. Before the border the highway passes through the commercial Ramu sugar and oil palm producing situated around Gusap and Dumpu. The highway meets the Highlands Highway at Watarais where it is 160 km to the port of Lae and 120 km to Goroka in the central highlands.

The section through the mountains is unstable and is frequently blocked by landslides which isolates Madang from the rest of the network. In the Ramu valley streams entering the northern

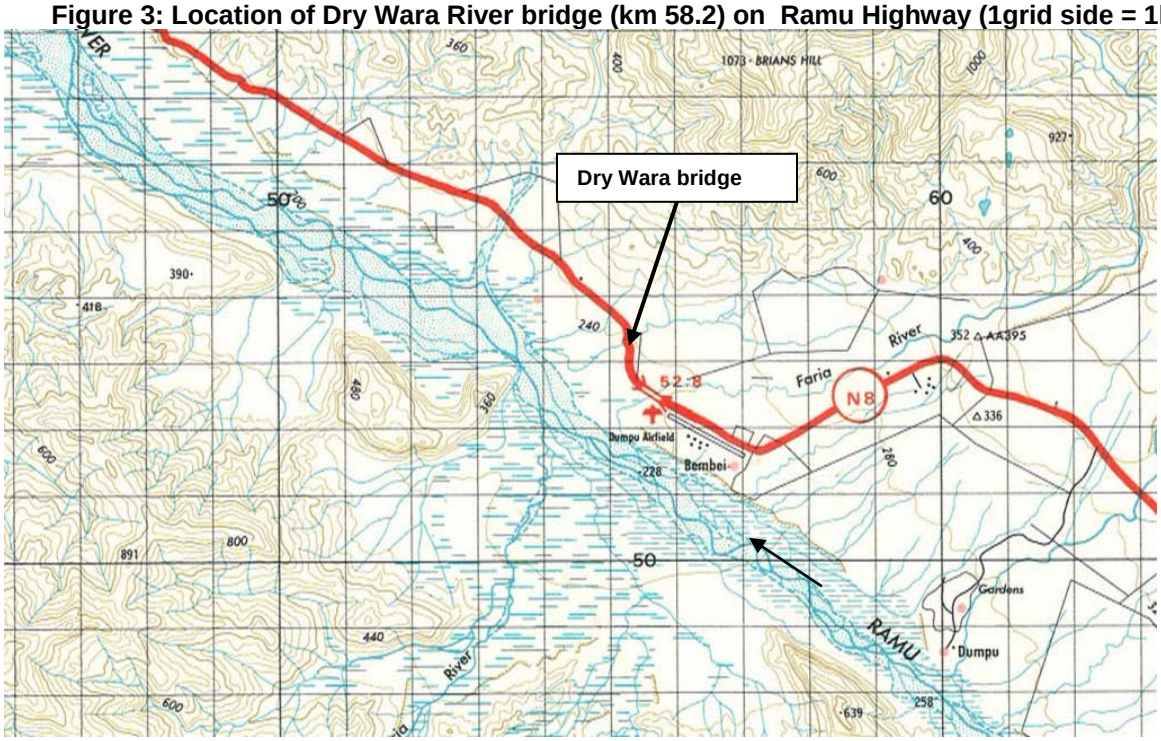
side of the valley frequently wash out bridges during heavy rain events. The high voltage transmission line from Yonki Hydropower Station in the highlands follows the road through to Madang as does the pipeline for the Ramu Nickel project that treats the slurry at Madang. There are 29 bridges and one open crossing located along the highway of which 14 are Bailey bridges varying in length from 22m to 80m. The road serves a population of 210,000 people. The location of the bridges are shown in detail in Figures 2-5.

Figure 2: Location of Gusap (17.2 km) and Bora (20.6 km) River Bridges on Ramu Highway (1grid side = 1km)



The Ramu valley is a prominent north west faulted wide level grassland valley that continues without a break from the Markham valley. Drainage is separated at Watarais (the start of the Ramu Highway) with the Markham valley draining to Lae while the Ramu valley drains to the north coast. The valley consists of lowland plains and dissected alluvial fans that extend northeast to the Ramu River. Various levels of terraces occur along the Ramu valley especially on the Finisterre Range side of the valley where large alluvial deposits remain. The Ramu plains are mapped as Quaternary deposits of sand, boulder gravel and alluvial fan deposits that have emanated from the surrounding basal hills of the Finisterre Range which are situated between Madang and the Ramu valley. These are described as Pliocene deposits of soft mudstone, sandstone, conglomerate and limestone. The Finisterre Ranges consist of rugged terrain rising to 4000m with steep slopes and deeply incised rivers. Landslides are common. The area has extensive northwest trending faults and contains unstable landforms.

Figure 3: Location of Dry Wara River bridge (km 58.2) on Ramu Highway (1grid side = 1km)



PNG is seismically affected by the collision of the Pacific plate with the Indo-Australian plate, that is moving northwards at the rate of approximately 10cm/yr. The DoW have identified four levels of earthquake risk based on a linear scale that ranges from 1 (high risk) to 4 (low risk). Using this scale Madang is ranked as level 2 (intermediate to high) while the Ramu Valley is classified as level 3 (low to intermediate). There have been no serious earthquakes in the area within recent memory and while no bridges have been affected by earthquakes within the area, wharves have been affected in Madang. PNG has well developed design procedures for seismic design of bridges which have been employed by the DoW for over 25 years[9].

The soils that have developed on the Ramu valley are young and mainly consist of coarse sandy loams. These soils are well drained and being developed under grassland are moderately high in organic matter. Depending on their location many of the soils are shallow and overlie deep deposits of alluvially washed gravels and boulders. The valley soils mainly remain under grassland and due to heir low slope angle are relatively stable. However with the removal of vegetative cover these soils will be prone to rainfall erosivity.

The hill soils within the Finisterre ranges and the low hills that flank the Ramu valley are older and depending on the underlying parent material and stability of the landscape in which the soil has formed show greater clay formation and profile development. Many of the soils are shallow and have been affected by surface wash and denudational mass movement of the hill slopes. Otherwise deeper soils with limited clay and profile development occur in more stable situations. The majority of the mountain and hill soils have moderately well drained profiles and may have inclusions of rock fragments within their profiles. Under this high rainfall situation soils that are situated on soft rocks with critical slopes are frequently prone to naturally occurring landslides. Landslides can be easily triggered when these slopes have been cleared for roadworks and the Ramu road formation exhibits significant areas of subsidence and slips.

[9] Beca Gure (PNG) Pty Ltd in association with Beca Carter Hollings and Ferner, 1985. *Earthquake Engineering for Bridges in PNG.* Prepared for Department of Works.

Figure 4: Location of Wasigo (km 154.2) and Tapo Crossing (km 159.5) on Ramu Highway (1grid side = 1km)

2. Climate

The area has a wet humid tropical climate. Mean annual rainfall varies from 1872 mm at Gusap in the upper Ramu valley to 3,594mm at Madang. The wet season is uniform throughout the area and occurs between November and April followed by a dry season from May to October. The lower rainfall in the Ramu valley results from the general alignment of the valley with the SW winds and the lack of any orographic features within the valley while the presence of higher mountains on either side of the valley with their associated orographic effect results in a high rainfall gradient between the centre of the Ramu valley and the surrounding mountains[10]. Rainfall for two stations in the Ramu Valley and Madang is shown in Table 3. Dumpu is beside the Dry Wara River. The area can experience heavy rainfall and occasional intense tropical storms during the wet season. Unexpected flash floods can be experienced in the Ramu Valley resulting from heavy rainfalls occurring in the upper Finisterre Ranges while the Ramu valley has received no rain.

[10] Lands of the Ramu-Madang Area, PNG. Land Research Series No 37, CSIRO, Australian 1976.

Table 3: Rainfall Data: Madang. Gusap and Dumpu

Rainfall	unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Madang	mm	361	335	375	452	377	209	166	128	138	255	403	394	3594
Gusap	mm	214	261	282	193	104	57	27	68	134	147	189	196	1872
Dumpu	mm	227	285	211	141	128	97	41	71	115	121	181	274	1891

Data from CSIRO, 1976. Lands of the Ramu-Madang Area.
Rainfall for Madang, Gusap and Dumpu based on 20, 10 and 5 years of record respectively.

Temperatures are reasonably uniform throughout the year and are slightly higher inland. Climate data is shown in Table 4. Seasonal and diurnal temperatures range from 18 to 33°C.

Table 4: Climate Data: Madang

Station Name: Madang W O
Latitude: 05.22 South Longitude: 145.78 East
Elevation: 4 Metres
Years of record: 37 Years (1973 -10

Parameter	unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Av monthly Rainfall	mm	335.2	314.7	347.5	400.4	357.9	219.6	159.1	109.0	123.0	253.0	301.0	379.2	3299.6
Max monthly rainfall	mm	678.0	501.6	699.6	787.6	566.0	497.6	437.6	443.4	374.2	614.4	497.8	663.0	6760.8
	Year	1987	1978	2006	1997	1989	1996	2009	1975	2003	1975	1978	2000	
Max daily rainfall	mm	185.8	136.2	183.4	185.4	184.0	163.8	235.4	139.8	92.0	197.8	154.6	152.8	235.4
	Date	8.01.87	9.02.09	21.03.77	25.04.82	29.05.03	27.06.06	4.07.04	24.08.75	26.09.78	1.11.73	19.11.02	24.12.03	
Min monthly rainfall	mm	81.0	184.0	134.4	188.0	71.4	13.4	3.2	0.4	2.8	44.8	80.2	174.0	0.4
Sunshine	hrs	164.6	143.3	155.6	171.4	202.0	199.5	205.8	217.9	219.3	213.8	188.9	166.7	2248.8
Max Temp	°C	30.9	30.7	30.6	30.6	30.7	30.5	30.3	30.2	30.7	30.8	31.1	31.0	30.7
Min Temp	°C	23.9	23.8	23.8	23.9	23.9	23.7	23.5	23.7	23.7	23.8	23.9	23.9	23.8
R.Hum.	%	81	83	82	82	82	82	81	79	77	77	78	80	80.3

Source: PNG Weather Office

Cyclones are extremely rare as PNG lies above and outside the cyclone belt which is situated below PNG. There are no records of any recent cyclones affecting the area. The last cyclone that was recorded in PNG was cyclone Guba which occurred in November 2007 and came ashore near Popondetta on the north coast. The cyclone veered to the north from Vanuatu and dumped large amounts of rain causing 149 fatalities and significant damage to crops and roads and washed away several bridges on the Popondetta - Kokoda road.

No air quality measurements are available for the area and apart from highly localised areas of smoke from village cooking fires air quality in rural areas will be good.

PNG is exposed to climate variation[11] and has regularly experienced extreme weather conditions including; cyclones, landslides, flooding and droughts related to *El Nino* conditions. Evidence[12] shows that since 1977 mean temperature has increased by almost 0.5°C which is also consistent with a similar temperature rise in mean water temperatures. Rainfall shows great variability but there appears to be an increasing trend to drier conditions with decadal rainfall decreasing from 3,000 mm to 2,500 mm.. Climate models show that by 2050 temperature may increase by 1.2-1.3°C; rainfall may increase by 2.2% to 8.8%, droughts and floods will be more intense and sea level may increase by between 20-40cm. For this sub-project the main change will be extended periods of drought which will affect stream flows whereby low flows will become

[11] Office of Climate Change and Environmental Sustainability and World Bank, 2009. *Climate Change in Papua New Guinea: Framework for the National Climate Change Strategy and Action Plan.*
[12] *Ibid.*

smaller and high flows more extreme. The National Agricultural Research Institute (NARI) is predicting that a major drought will affect PNG in 2012[13]

3. Water Resources

The catchment areas for the five bridge sites are shown in Table 4 which shows that these range from 2207km^2 for the Gusap River to 6.6 km^2 for the Wasigo River. The catchment areas have been determined from 1:100,000 topographic maps and are expected to be reasonably reliable. The catchment areas for the Gusap, Bora are not shown in Figures 2 and 3 as the upper catchment areas are located on an adjoining map sheet.

Table 5: Catchment areas for bridges

Bridge	Distance (km)	Elevation at bridge (m)	Catchment area at bridge (km^2)	Drains to
Gusap River	17.2	463	207.0	Ramu River
Bora River	20.6	423	19.0	Ramu River
Dry Wara (Faria)	58.2	254	18.0	Ramu River
Wasigo River	154.2	104	6.6	North coast
Tapo River	159.5	147	23.5	North coast

The water resources of the Ramu valley are derived from fast flowing rivers and streams that drain from the Finisterre and Bismarck Ranges. Both the Gusap and Bora rivers are perennial while the Dry Wara has seasonal flows and flows may cease all together by the end of the dry season. The Gusap, Bora and Dry Wara Rivers are typical of these rivers which arise in the Finisterre range and flow south to the Ramu River. The rivers have built up extensive alluvial fan deposits of loose materials where they debouch onto the Ramu valley floor. All three rivers have cut down through these easily eroded deposits and are characterised by reasonably straight, steep sided channels that are deeply incised (4-5m) into the shingle based deposits. The flows in these rivers are swift and turbid and carry high suspended loads. Bed load is also high and moderately sized boulders are carried along during floods and deposited near the base of the fan where the channel velocity drops. These rivers have unstable channels and both the Gusap and Bora bridges have had to be moved to new locations about another 1km upstream where the rivers are more deeply entrenched and hopefully more stable. The bridges will be rebuilt at these new locations. By contrast the Dry Wara River channel is more stable with vegetated sides whereas the Gusap and Bora Rivers have channels with nearly vertical sides with exposed materials which are too steep for vegetation to establish.

There are no flow records available for the Gusap, Bora and Dry Wara Rivers. Table 4 shows that of the three Ramu based rivers the Gusap River has by far the largest catchment and will also have the largest flows which will make stabilisation of this bridge site challenging. The other two catchments are about 10% of the size of the Gusap catchment and will be somewhat less challenging in terms of bridge stability. Based on anecdotal evidence the highest flows are normally recorded from December through to March during the NW monsoon derived wet season, though intense thunderstorms which occur regularly within the valley outside the wet season will produce unseasonally fast flash floods which can erode the bottom of the channel making previously stable river crossings unexpectedly hazardous. Low flows occur from May to

[13] As quoted in the *Nation* Friday 7th May 2010. The Weather Office (who are not a party to the prediction) state that the prediction is based on the approximate 7 year cycles of higher and lower rainfall that is experienced by the country which bring either *El nino* or *La Nina* conditions. Based on this 2012 is expected to see the commencement of drier conditions.

June during the dry season (SE monsoon). At all three bridges the flow is contained within a single channel that is about 3.0m below the bridge deck.

The drainage system of the Finisterre Ranges is a complex pattern of dendritic water courses that arise within the steep rugged terrain. The southern side of the Finisterre Range drains to the Ramu River while the northern side drains to the coast. All of the watercourses have very steep gradients that change to moderate gradients as the channels emerge from areas of steep terrain. The channels are actively down cutting and are located in the base of "V" shaped valleys with limited channel sideways movement. Undercutting of the slopes which are composed of soft rocks makes the area prone to landslides. Where the channels emerge from the steep sided valleys the river gradient decreases and bed load accumulates in the lower valleys. Here the rivers flow over the accumulated deposits and become slightly braided with pronounced meander patterns limited by the narrow width of these valleys.

The Wasigo and Tapo Rivers have gravel channels and apart from high flows are basically non-turbid rivers. There are no flow records available and based on anecdotal evidence the flow in the river is maintained by the high rainfall that the area experiences with the highest flows normally recorded from December through to March during the NW monsoon derived wet season. Low flows occur from May to June during the dry season (SE monsoon). At the bridge and the open crossing the flow is contained within a single channel that has a gravel bed and small boulder and gravel deposits on the inside of the channel bends. There is an extensive accumulation of gravels and small boulders above the Tapo crossing as the crossing has created a small dam across the Tapo River. The Wasigo River is about 3.0m below the bridge deck. There is no evidence of this relatively small catchment having ever provided sufficient flow to inundate the bridge.

No water quality measurements are available for any of the watercourses and as there is limited human occupation in any of the upstream areas, water quality, apart from turbidity is expected to be reasonably satisfactory.

Good ground water resources will be available in the highly porous alluvial fan and valley floor deposits in the Ramu valley.

B. Biological Environment

Papua New Guinea is an island with high species biodiversity and belongs to the Indonesia-Malaysia region though it also shares similarities to northern Australia. It includes 39 Centres of Plant Diversity and Endemism as defined by the WWF and IUCN and includes 12 of the globally important Endemic Bird Areas recognised by Birdlife International[14].

Plant diversity is particularly concentrated with an estimated 15,000 to 21,000 higher plants and at least 2,000 pteridophytes and more than 3,000 species of orchids. Plant endemism is high at 10,500 to 16,000 species.

PNG's mammal diversity includes 242 species of which 57 species are endemic but does not include primates, squirrels, cats, viverrids or ungulates. Introduced species include deer, pigs, dogs and cats. Placental mammals include rodents and bats of which there are 92 species and 32 are endemic. Marsupial diversity is second only to Australia. Bird diversity is particularly high with 762 species of which 85 species are endemic. Reptiles include 305 species with at least 93 snakes, 190 lizards, 14 turtles and two crocodiles. Amphibians include 200 species of which 134 are endemic. PNG has 329 freshwater fish species (excluding the Bismarck Archipelago) of which 149 are endemic.

[14] This section is extracted from *"Megadiversity", Mittermeier et al, 1998.*

1. Flora.

The Gusap, Bora and Dry Wara Rivers are situated within grassland areas of the Ramu valley that have developed under fire management. These contain areas of both tall and short grasses and at the Gusap and Bora bridge sites the vegetation consists of scattered areas of short grasses including; Kangaroo grass (*Themeda australis),* Kunai (*Imperata cylcindrica)* and *Sorghum nitidum*. These are separated by exposed areas of gravelly soils. Scattered stands of the introduced leguminous shrub *Leucaena* grow alongside the road together with other commonly occurring short herbaceous plants. At the Dry Wara bridge site the stream side is covered with tall cane grass *Pit Pit* (*Saccaharum robusta)* with some *Phragmites* in wetter areas. Stands of *Leucaena* are also common in the area and result from seed being spread into the area. Other riparian vegetation within the dominant grassland includes bamboo, palms and coconuts.

In the Finisterre ranges the two sites at the Wasigo and Tapo Rivers are sited within heavily disturbed roadside corridor areas. The Tapo River being used as a car washing site and the river side has now been converted to a short grassland area. Only at the Wasigo River does tall cane grassland (*Saccaharum robusta)* occur which is the dominant species and is interspersed with some regenerating shrubs and palms and wild bananas. Along the roadside *Imperata cylindrica* and Sensitive Mimosa (*Mimosa pudica)* commonly occur.

2. Freshwater Aquatic system

Papua New Guinea has approximately 330 species of freshwater fish, including a few introduced species. Many of the native species share similarities with Australian fish fauna reflecting the close proximity and past links between these land masses. About 10% of the freshwater fish species found in PNG also occur in Australia. Approximately two thirds of the PNG native fish species spend their entire lives in freshwater and one third are thought to have an estuarine or seawater stage in their lifecycle. (Allen, 1991)

The aquatic habitats of the Gusap and the Bora rivers consist of fast, turbulent water contained within bouldery channels that are mainly devoid of vegetation. The flow is also turbid and contains coarse suspended sediments. It is not an ideal fish habitat and according to the local communities there are few fish or any other aquatic species are found in these rivers. The Dry Wara is seasonally dry and habitats are even more stressed in this river. In the Wasigo and Tapo Rivers these have perennial fresh water flows with less turbidity and have better aquatic habitats. In these rivers the gold catfish, eels and freshwater prawns are found. Fishing in these smaller rivers is often done by children as a recreational pastime.

3. Wildlife

There is no particular wildlife found at any of the bridge sites. In the Ramu Valley the remaining grassland areas which have not been converted to sugar cane, oil palm or grazing land provide habitats for common PNG fauna including feral pigs, bats, reptiles including lizards, carpet snakes and death adders, amphibians (including frogs and the introduced cane toad). Around the Wasigo and Tapo Rivers habitats within the lowland forest become progressively more intact the further away from the road and favour forest dwelling wildlife such as the cuscus, feral pig and flying foxes and bats. Reptiles and amphibian include the same species as already described while avian wildlife includes; sulphur crested cockatoo, heron, hawks, crows, starlings, wood pigeon and wild ducks - the last two being actively hunted.

4. Rare and Endangered Species

Protected fauna of PNG is listed under the Fauna (Protection Control) Act 1976 and subsequent amendments. None of the fauna found wthin these disturbed habitats is listed as rare or endangered.

5. Conservation Areas

There are no Conservation Areas (CA) or Protected Areas (PAs) that are close to any of the bridge sites that would warrant protection or be affected by the proposed development.

6. Invasive Alien Species

Biological impacts from introduced species and invasive species can cause a great deal of damage to naturally adapted systems. Invasive or introduced species are species that are non-indigenous and can colonise and out compete local species. Most of these species are a major threat to freshwater ecosystems of Papua New Guinea. Aquatic plants such as Salvinia (*Salvinia molesta*) and Water Hyacinth (*Eichhornia crassipes)* have been reported to cause major problems in Sepik river and other major rivers. Introduced species such as Tilapia and Mosquito fish are two examples that threaten natural freshwater fauna in the country. *Tilapia* is the only invasive noted in the area being purposefully introduced about 40-50 years ago. As it provides an ample source of protein it has been particularly well adopted by the local community.

C. Socio-economic Conditions

The population of PNG in the 2004 census was determined as being 5.7 million and is dispersed widely across the country. Since the 1970s the population has been growing at an average rate of 2.3 %/yr but in reality this may be higher. Accordingly the population has a broad based age-sex structure with about 40% of the population less than 15 years of age. This implies a very high level of youth dependency as well as a high child-woman ratio and a low median age of <20 years. With population doubling every 30 years pressure on available services and natural resources has increased dramatically during the last decade, which will require PNG to invest large amounts of capital not only in maintaining but developing the nation's physical and social infrastructure.

PNG is a culturally diverse country with over 875 different languages of which 87% of the population are still living in rural environments. While this has provided the country with distinctive cultures the isolation of these groups has also created a high dependence on natural resources. Development has not been uniform across the country and the resulting migration to urban areas has created landless people who live in squatter settlements in and around urban areas with accompanying high crime rates.

PNG's social environment is based on three key elements; (i) the traditional land tenure system whereby 97% of land is locked away in customary tenure; (ii) the "wantok" system whereby family and clan members support each other, and (iii) service delivery by churches and community groups which now provide around 50% of all health and education services in the rural sector.[15]

It is considered that despite some gains in the economy the number of people living in poverty has changed little during the last two decades with 30% of the population continuing to live below the 1996 criteria of K400/yr. Average life expectancy is 54 years. The national literacy

[15] United Nations and GoPNG, 2004. *Millennium Development Goals. Progress Report for Papua New Guinea 2004.*

rate is 62% which has slightly improved.[16] The population that is served by the Ramu Highway is estimated to be 98,200 which is based on the populations of the Markham, Middle ramu and Usino Bundi Districts[17]. Villages are based on family or clan group and consist of separate groupings of houses or hamlets. Details of villages that are closest to the bridge sites are shown in Table 6.

Table 6: Population and number of households within sub-project area

Bridge	Village	Distance from bridge (m)	Households (no)		Population (no)	
			At bridge	Below bridge	At bridge	Below bridge
Gusap River	none		none	none		
Bora River	none		none	none		
Dry Wara	Faria	250	17	none	170	
Wasigo	Bauri	50 -70-150	35	none	350	3 hamlets
Tapo crossing	Didiwala	50	12		120	
	Ato	70		8		80

Source: Sociology Study, 2011.

Table 6 shows that there are no communities living within the immediate area of the Gusap and Bora rivers as the surrounding land is owned and operated by Ramu Agro-industrial Ltd (RAIL) a company that has acquired a large area from the acquisition of two large cattle ranching properties; Gusap Downs and Dumpu. These areas have now been converted to sugar, cattle ranching and oil palm production. A small township called Ramu Central has been developed close to Gusap to support the agro-industrial estate and consists of houses, stores, a sugar mill, oil palm mill and an abattoir. The old Dumpu homestead area has been redeveloped as another support complex with worker accommodation and support facilities. A private airstrip is at Gusap while the Dumpu airstrip is no longer used and has been planted to oil palm.

At the Dry Wara bridge site, Faria village is located about 250 m distant from the bridge on the Madang side of the river and consists of about 17 households. There are no villages downstream of the bridge. At the Wasigo bridge site 3 hamlets belonging ot the Bauri village occupy the area around the bridge. All of these are upstream of the bridge site with the closest being about 50m from the bridge. At the Tapo crossing a small village called Didiwala has established as a small market and trading centre above the crossing. Didiwala has about 12 households who are mostly shop owners and traders that have established in the area to service those persons coming to wash their vehicles in the pond that has formed above the crossing. Another small community called Ato with about 8 households is situated about 70m below the bridge. These people also have trading links with the Tapo crossing householders.

Social infrastructure includes several first aid posts which are widely distributed throughout the area. Most larger villages have a centralised primary school while those children wanting secondary education have to travel to the main centres at Madang and Lae. There are also several churches in the immediate area. Drinking water is not collected from the Gusap and Bora Rivers as RAIL have developed piped water supply systems from bore hole sources. Faria village draws water from the dry Wara and from supplementary sources such as ponds from holes scraped within the stream bed. Water is mostly used for washing but people will collect drinking water from it when the water is clean. All villages have road access which were built to access oil palm plantings. Despite the high voltage transmission line being located alongside the highway none of the villages are connected to rural electricity.

[16] UN and GoPNG 2004, *op.cit.*
[17] As quoted in *Table 7.2 in the Interim Report: Adopted Population Factors*

Land Use. The upper Ramu valley which is traversed by the Ramu Highway has a lower rainfall and suitable soils. This extensive area which extends from north of Gusap to the Dry Wara River at Dumpu has been acquired by RAIL and has been converted to agro-industrial cropping and cattle ranching. Surrounding communities within this area work on the estate and carry out small scale cattle ranching selling cattle to RAIL. Otherwise outside the area of influence of RAIL, land is mostly operated as subsistence farms. Staples include taro, banana, cassava, sweet potato, sugar cane and corn. Gardens are cultivated within defined boundaries within the Ramu valley floor. The surrounding hills are mostly retained in grass with remnant forests remaining in the watercourses where they have been able to resist frequent burning of the grasslands. The upper grassland hill areas in the Ramu valley are used for hunting and as previously stated are burnt regularly to flush out game.

In the Finisterre Range the much higher rainfall has lead to a dominant rainforest cover. The terrain is steep and inhospitable and apart from a few settlements alongside the road the area is sparsely settled. Much of the original forest cover remains in these areas, but in places gardens have been developed and much of the produce is sold at the mountain market alongside the highway.

Cultural and Heritage Sites. There are no sacred or historical sites of significance alongside the road at any of the bridge sites.

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The replacement of the bridge will have few and limited adverse impacts which will be mainly experienced during the construction phase. As the bridge will be erected on their previous locations, construction will be carried out in already disturbed areas. Construction will create a range of expected minor impacts which can be easily addressed by conditions imposed in the Environmental Management Plan (EMP). No resettlement will be required, no cultural or heritage sites will be affected nor will any primary forest be cleared. While water quality may be temporarily affected during construction the flow in the watercourses will not be affected.

Construction of each bridge is expected to take about 6 months and would be constructed in sequence which may take about 2-3 years to complete all of the bridges in a contract. Construction will cause a range of minor impacts in terms of effects on water quality, noise, dust, employment opportunities and waste disposal. Construction will create some short term employment opportunities that will benefit the local communities. Construction impacts are of a general nature and as these are applicable to most projects these will be discussed in the EMP section.

The impacts are presented in terms of their impacts on the physical, biological and socio-economic environments. For each of these categories the impacts are discussed in terms of their decreasing order of magnitude. Only the main impacts are discussed in this section while a complete list of impacts and risks together with mitigation measures, areas of responsibility, costs and monitoring requirements are presented later in the EMP section.

A. Impacts on the Physical environment

No particular impacts have been identified for the physical environment.

B. Impacts on the Biological Environment

1. Work in the stream channel - water quality impacts - construction

During construction the following work within a stream/river channel will be required: (i) construction of a temporary road to support pile driving and other construction equipment to

piers, (ii) driving piles into the channel for bridge foundations, and (iii) construction of gabions and other river training work.

Foundations may either be constructed within the channel or away from the channel on the earth bank. For most bridges the bridge foundations will not need to be driven within the channel as in most situations these can be driven from firm ground into the side of the channel. However bridges that consist of several spans will require pier foundations to be constructed within the channel. Construction will require a pile driver to access the foundation which will require the construction of a temporary road to support the equipment, drive the concrete piles and then concrete is poured around and above the piles for the girder supports. During this time if the channel is accessed water quality will be affected from increased turbidity. Pile driving work and any other work in the stream channel may be completed within about 1 month.

This is unlikely to be a significant issue as all the bridges will require short single spans and no foundations will be constructed within the channels. Construction of the bridge on the Tapo crossing will require traffic to continue to access the stream crossing during construction. There will be a beneficial improvement in water quality following the construction of the bridge over the Tapo River as vehicles will now no longer need to access the river crossing. Depending on whether the crossing remains or is removed the precedent has been established for washing vehicles at this location and unless the crossing is removed or the access is blocked off the area may continue as a vehicle washing area for sometime.

Most bridges will require channel training to protect the bridge foundation. Gabions will normally be used which will be placed within the channel and backed by geotextile fabric. Some preparation of the channel base and bank will be required for the gabion baskets to be placed in their correct location. The baskets are filled with stone and then closed. Turbidity will be increased from this activity and again this will be short term and of little overall impact to downstream users.

If any of these activities will have concerns for downstream users the contractor will be required to advise these communities prior to the work commencing. Should the activity cause unacceptable deterioration of water quality then the contractor will need to schedule work i.e. stop work in the channel for a period so as to allow the turbidity levels to return to acceptable levels allowing downstream communities to access the resource. This is addressed by the EMP.

C. Impacts on the socio-economic environment

1. Road safety - operation and design

Traffic speed will increase with a new two lane bridge. In all situations it is not reasonable to expect heavily laden pedestrians especially women to dodge traffic on the bridge and a footpath will need to be provided in the bridge design.

The design will require suitable footpaths to be included within the bridge design. This is addressed by the EMP.

VII. ANALYSIS OF ALTERNATIVES

Alternatives are examined from aspects of replacing the bridge and re-erecting the bridge.

A. Alternatives to Location

The bridges In both situations will be predominantly replaced or re-erected on existing road locations and accordingly the bridge sites are site specific unless there are serious issues such as channel meanders which will threaten the bridge and its approaches. Thus it is expected that

most bridges will be replaced at or immediately alongside their existing locations. Bridges to be re-erected will first need an evaluation of the stream meander and alignment conditions at the site to verify that the site is suitable. In most situations the existing crossing will be suitable and the bridge will be re-erected at the existing channel crossing. For stable sites where there are no significant issues there are no economic, environmental or social advantages in reappraising the bridge sites.

B. Alternatives to Technology

Where single lane bridges will be replaced with permanent two lane bridges the bridges are likely to incorporate steel girders with concrete decks. Pre-stressed concrete girders would be an alternative but there is no ability to undertake pre-stressed concrete manufacturing in PNG. Accordingly there do not appear to be any other rational technical alternatives.

Bridges that will be re-erected will be Bailey bridges. For these bridges these will use existing technology and consequently there are no technical alternatives.

C. Alternatives to Design

Bridge design in PNG is based on assessing the 1:100 year flood plus the addition of 1m added to the calculated flood height to allow the flood to pass below the bridge sofitt (underside) of the deck. Assessing the situation in the field it appears as though design has not been rigorously applied and in the majority of situations the existing topography has determined the height at which the bridge has been placed. In situations where deep channels have developed this has added to bridge design safety whereas this is often compromised where channels have low banks. This probably accounts for why so many of the bridges have been inundated every year and in some instances the bridges have been washed away. Thus either the determination of the 1:100 year flood does not appear to have been rigorously applied or the flood estimation criteria are seriously deficient. Climate change determination within PNG has so far thrown up variable predictions including possibly more droughts or possibly more extreme rainfall events[18]. While it would be prudent to apply climate change adaptation to the hydraulic capacity of the bridge other variables such as channel aggradation and movement and build up of flood debris on the bridge also need to be considered and may even outweigh hydraulic capacity determinations. The areas of PNG that the bridge projects are located in are also outside the range of regular cyclonic activity which has removed short period extreme runoff events from the hydrological record. Consequently PNG rainfall and runoff data will demonstrate considerably less variation[19] than would be found in a country that is subject to cyclonic events.

While it appears that existing design standards will suffice for the 50 year life of the bridge there is concern that some of the runoff determination criteria may be at fault leading to under-estimation of flows with possible failure of the bridge. Thus there may be situations in large expensive bridges (i.e. multi-span bridges) where it would be good design practice to adopt the precautionary principle and opt for a greater degree of design safety as predicted from climate modelling.

Thus for high cost multi-span bridges the design should determine hydraulic requirements using both the accepted DoW procedure and the climate change prediction. If there is an apparent and concerning difference in favour of the climate change prediction then the additional cost of meeting climate change requirements can be met from the climate change fund that is administered by the ADB. It is recommended that the Design Engineer be assisted in assessing

[18] Office of Climate Change and Environmental Sustainability and World Bank, 2009. *Climate Change in Papua New Guinea: Framework for the National Climate Change Strategy and Action Plan.*

[19] Thus when determining flood return frequencies a more stable log linear plot of extreme annual flood events is demonstrated when plotted within the chosen probability graph.

bridge design with input from a Climate Change Specialist and that the ADB be aware of the possibility of funding the incremental costs to address climate change requirements.

D. Alternatives to Operation

There are no readily identifiable alternatives to operation of either of the bridge situations which in both situations are designed to pass traffic safely over the watercourse with the least amount of delay.

E. The "no project" alternative

Should the bridges not be replaced then there will be little immediate effect on traffic flow. Longer delays may be experienced at the designated replacement bridges as these are single lane, but as overall traffic counts are reasonably low and there will be little disturbance to traffic movement. Eventually the bridges will fail not so much from traffic use but from the lack of maintenance of the bridge.

In the re-erection situation the "no project" situation will continue to deny all weather access to rural communities. Without the sub-project the existing situation will continue as before with lack of connectivity impeding rural development.

F. Reasons for selection of the proposed sub-project

There are no outstanding clear alternatives to the replacement or re-erection of the bridges and these will be rebuilt or re-erected as determined mainly by the existing location of the roads.

VIII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

Both formal and community consultation meetings were held to discuss the bridges along the Ramu Highway. The village based consultation meetings involved both men and women. The consultations were held in conjunction with the social safeguards program and facilitated by the national consultants. At these meetings the Project was introduced to the participants together with an assessment of the probable positive and possible negative impacts. Following this the meetings were then opened for discussion to allow the participants time to discuss issues between themselves and with the national consultants. Women's issues were also canvassed via the national Gender and Social Development Specialist with women who were attending the same meetings. Details of the meetings are included in the Table 7 and and a list of participants is given in Annex 9.

A. Results of Consultations

1. Formal Consultation

A formal meeting was held with the acting Provincial Administrator –Corporate Services- Paul Ito on the 18th May 2011 at the Provincial Headquarters in Madang. The purpose of the meeting was to follow up on communications that had already been made to the Provincial Government concerning the sub-project. It was also held as a courtesy and awareness meeting on the Bridge Replacement to Improve Rural Access Project.

At the the Provincial Administrator Corporate Services, expressed great concern on the deteriorating conditions of most bridges and the need for repair, maintenance and construction. The provision of footpaths on bridges was also raised at this meeting.

The Provincial Government explained that it had long term plans for the bridge works but that all depended on funds availability. It was reiterated that most bridges were in need of repair even in need of replacement. Most provincial roads have streams but do not have bridges which makes

it difficult for the rural population to access goods and services in their respective districts and the Provincial towns.

Consultation meeting with the Provincial Works Manager Mr Wally Wigbert was held on the 19th May 2011. This was to establish the network at the provincial level. The Provincial Works involvement during this meeting was important as they are people on the ground and they will be part and parcel of the implementation process.

It was again raised at this meeting that a lot of provincial bridges including bridges along the Ramu Madang Highway were in need of repair and maintenance including replacement. Though the Madang Provincial Works and Provincial Technical Services have identified these bridges, there were no funds available for the works to be executed.

At both meetings the Provincial Government, Provincial Works and Lands representatives supported the sub-project as they see this as the only opportunity for the province to venture into other development projects that have been hindered due to inaccessibility from lack of bridges.

A formal meeting was held on the 20th May 2011 with the Provincial Lands adviser at the Provincial Lands Office, Madang regarding the status of the land where the bridges are located. The adviser emphasised that most land along the Ramu Madang Highway has already been acquired including the land where the bridges are proposed for construction. The provincial lands division was prepared to work closely with the developer, project donors, consultants, etc to ensure that any land issues dealing with the project are settled prior to construction.

Further consultation will be conducted by the Department of Works and the Department of Lands for the identification of legitimate landowners where the bridges are located through the land investigation process.

On the 23rd a meeting was held with the management of Ramu Agri-Industries Limited (RAIL) that included, the Community Relations Manager – John Piawu, the Agriculture Manager - Paul Wyatt, the Company Secretary - David Alderdaise. The meeting was held in regard to the Menia Bridge, Dry Wara Bridge, Bora Bridge and Gusap Bridges that are located within the Ramu Agri Industries Ltd lease area. The management of RAIL were pleased with the project and gave their consent to replace or re-erect the bridges without any opposition from the RAIL management. The management of RAIL were concerned with regard to the number of accidents and fatalities on the bridges along the highway. Most bridges were one lane bridges, have no guard rails and no footpaths. A lot of people especially pedestrians have died crossing those bridges. Bridges within the estate have to be designed to cater for the loads that RAIL carry at the estate. They emphasised to change the bridge design load and construct 70-80tonne load bridges within the estate instead of the 40 tonne.

2. Community Consultation and Participation

Three separate meetings were held with the landowners and other interested participants in the community on 21st May 2011 where the Tapo Ford, Wasigo Bailey Bridge and Kohu Bailey Bridges are located. Total attendance at these meetings were xx persons. In attendance were clan leaders and clan members and residents from the local area who reside near the vicinity of these bridges.

A formal meeting was held on the 22nd May 2011 with the community at Kesowai Village where the Kohu Bailey Bridge is located. In attendance were the landowners, their clan members and members of other clans in the Kesowai community.

At all the Community Consultations conducted along the Ramu-Madang Highway meetings the project details were explained to the community or participants and they were asked for their comments. Both men and women attended these meetings of which at all meeting 40% were women. The majority of the people were subsistence farmers from the surrounding area. There were also some government employees at these meetings.

During the meetings the village elders expressed a positive interest in the sub-project and stated that they will continue to support the investigations to see the project realized. People expressed concerns about possible safety issues. Several people mentioned land issues, however they will work together to resolve the ownership of land. Benefits that the participants identified would be employment, skills training and better road and bridge conditions. Apart from the land ownership issues there were no other significant adverse comments made regarding the sub-project and there was general consensus among the participants that providing land ownership is resolved to the communities' satisfaction the sub-project should proceed.

Table 7 lists the main issues and concerns raised by all participants during the community consultation meetings held along the Magi Highway. Also included in the table are the responses given by the Consultation Team to each issue or concern raised.

3. Conclusions and Further Consultation

The public consultation meetings showed that the communities supported the replacement of the bridges. All issues that were raised were of a minor matter. The request for walkways alongside the bridges has been transferred to the EMP and is to be addressed as a design requirement.

Future public consultation meetings will be required as the sub-project proceeds to explain the various processes that the sub-project will proceed through, this will be conducted together with the social safeguards personnel. A structured approach is to developed for additional public consultation that will focus more on awareness so that communities are informed of the project's plans, leading them through the compensation procedures and creating awareness concerning opportunities that the sub-project may present in terms of employment and marketing of produce to the contractor and workers. These meeting will also discuss the social risks of the construction phase with regard to the location of workers and HIV/AIDS infection that may be carried into their communities.

4. Disclosure

The ADB will arrange for the IEE to be posted on the ADB's website. Following approval of the IEE, a copy of the approval and the IEE document will be sent to all relevant local government offices. DoW will arrange for the IEEs to be posted on their website and copies will be made available to the public. Information regarding the bridge and the proposed environmental management measures will be posted at suitable locations in the Project area.

Table 7: Issues raised during public consultation

Issues raised by participants	Locations where issues raised	How you explained that the issue will be resolved
1. The community do not want the new bridge at Tapo Ford to cut off access to Roadside Market	Didiwala (Tapo)	The issue will be raised with the bridge designers.
1. Design & Safety Issues – bridge too narrow for trucks with wide load.	All communities consulted. Ramu Agri Industries Ltd	Some bridges are too narrow, therefore these bridges will be widened from 1 lane bridge to a 2 lane bridge.

Issues raised by participants	Locations where issues raised	How you explained that the issue will be resolved
2. Design and construct 40 tonne bridge to a 70-80tonne bridge	Ramu Agri Industries Ltd	The issue will be raised with the bridge designers.
3. Will there be any Vehicles access during construction.	All communities consulted. Ramu Agri Industries Ltd	Temporary Access will be constructed to allow for vehicle access during construction.
4. Want Local Employment	All communities consulted.	Local employment will be encouraged, Contractor will bring with it skilled employees. Contractor will employ semi-skilled if not available it will look elsewhere. Casual labourers will be locally employed on the project.
5. No walkway for pedestrians	All communities consulted. Ramu Agri Industries Ltd	Walkways will be provided on the new design.
6. Speeding Construction vehicles	All communities consulted. Ramu Agri Industries Ltd	Safety safeguards will be incorporated under the contract.
7. Will women be employed?	All communities consulted.	Yes as much as possible, ADB wants more people employed under all its funded project. Both Male and female are encouraged to be employed on this bridge project.
8. Landownership	All communities consulted.	Department of Works will work with relevant agencies will conduct surveys and do land investigation to identify the legitimate landowners and see if it is state land or customary land.

IX. 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.[20] 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. The process is also shown as a flow chart in Figure 3.

A. During construction:

i. Most complaints arising during construction are expected to be minor complaints concerning dust or noise that should be able to be resolved quite 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 has up to two days to resolve the compliant.

ii. 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

[20] 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.

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.

iii. 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 PIU.

iv. Should the AP not be satisfied, the AP may take the complaint to the Secretary in the Department of Environment and Conservation. (DEC) 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.

v. 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 Secretary of Environment and Conservation (SDEC).

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

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

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

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

x. 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, SDEC will have 90 days to reach a determination.

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

xii. 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.

xiii. Should the AP not be satisfied with the ruling of the Secretary of the DEC, 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 Secretary, or the administration have been negligent in making their determination the AP will be able to seek costs.

B. During Operation

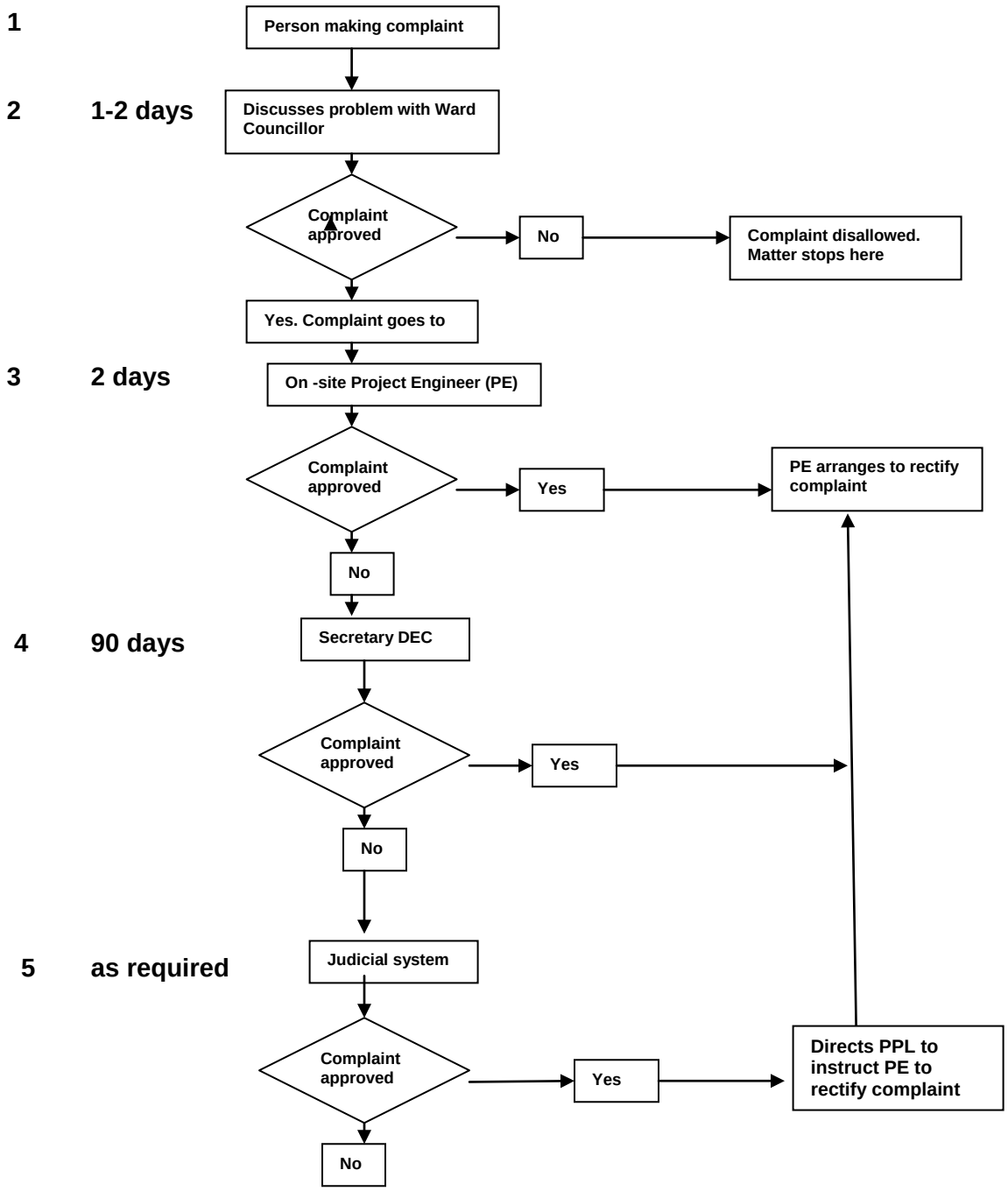
The same procedure is followed except that the complaint is now directed to the Power station Manager to rectify. During operation the same conditions apply; i.e. there are no fees attached to the AP for making a complaint, the complainant is free to make the complaint which will be treated in a transparent manner and the AP will not be subject to retribution for making the complaint.

C. Comments on the DEC grievance mechanism

The two main problems with the DEC procedure are: (i) establishing whether a PH is responsible for an impact (except where it is blatantly obvious) and (ii) reaching agreement on what is suitable compensation. Some compensation claims are still pending due to these uncertainties. This also underscores the need for sound baseline data against which questionable compensation claims can be evaluated. A further issue may be the reliance placed on the Ward Councillor to activate the grievance in accordance with these principles.

Figure 5: Flow Chart Outlining Grievance Review Mechanism

Step: Complaint to be actioned in:



X. ENVIRONMENTAL MANAGEMENT PLAN

This section identifies mitigation and management measures to avoid, reduce, mitigate or compensate for adverse environmental impacts that have already been identified in the previous sections. The environmental management plan (EMP) is a management tool and the issues are accordingly addressed with regard to the sequence of operations, i.e. those activities that apply to; pre-construction, construction and operation.

While the institutional arrangements are dealt with separately in the later part of the EMP it is noted here that the management system consists of:

(i) an existing PIU within the DoW structure. This is primarily to support engineering and contract establishment. As designed the PIU does not contain any safeguards staff and because of this is unlikely to be actively engaged in any safeguard management requirements.

(ii) a Supervising Consultant who will supervise the construction contract. The Supervising Consultant will appoint an international Environmental Specialist (ESS) who will assist one national Environmental Officer (EO). The EO together with the ESS will be responsible for implementing the EMP. Both the ESS and EO will work with the Project Engineer (PE) and the contractor to implement the EMP. While the EO is nominated in the EMP as being the person responsible for implementing the EMP, the ESS will initially assume the responsibility which will be progressively transferred to the EO as the EO develops capacity in assuming these responsibilities. As there is inadequate representation of safeguard requirements in the PIU the ESS will need to be appointed at an early stage in the project so as to supervise both pre-construction and construction requirements.

(iii) The Contractor will appoint two staff members an Environmental and Health and Safety Officer and a Community Liaison Officer who will be responsible for implementing the EMP.

A. Environmental Impacts and Mitigation Measures Needed during the Design/Pre-Construction Phase

The design and pre-construction phase will address the environmental mitigation measures that are outlined in this section. The majority of the measures are already established as Best Engineering Design Practices and would normally be expected to be addressed by the technical engineering team using their own procedures. The pre-construction work concludes with the integration of the EMP conditions into the Bid and Contract Documents and the evaluation and selection of the contractor. The responsibility for carrying out this work is shared by the Design Engineer and the ESS. No additional costs have been identified for this work and all work required at this time will be covered by the budget for the pre-construction work to be carried out by the Supervising Consultant. The following items are to be addressed during pre-construction.

(i) Acquisition of land and payment of compensation
(ii) Provision of footpaths in bridge design
(iii) Provision of climate change requirements in design
(iv) Review EMP, extract construction section of the EMP and attach to the B&C document
(v) Inclusion of Appendix 5 Prohibited Activities in Bid and Contract (B&C) Document
(vi) Bid evaluation and selection of contractor

Acquisition of land and payment of compensation: While the roads are contained with 40 m wide corridors the bridge sites will be contained within a 50m wide corridor. In some instances the corridor land has been acquired while in others this still remains to be done. This project will provide an opportunity to formalise and transfer land ownership of the corridor at each bridge site to the PNGov. Land acquisition and compensation will be addressed by the Resettlement Plan (RP). All land acquisition and compensation payments must be settled and completed before construction commences. The GoPNG Department of Lands which has this responsibility has already been informed and has accompanied the inspection teams to the field and has commenced preliminary discussions with the customary land owners. There do not appear to be any issues provided payment is made for the land. Land acquisition will need to be completed as soon as possible so as not to delay the implementation of the project. Implementation of the RP will be the responsibility of the Lands Department who will be directed to commence this by DoW.

Determination of compensation requirements will be the responsibility of the Department of Lands which will be arranged by DoW.

Provision of footpaths in bridge design: Public consultation has identified the need for adequate width footpaths to be provided as part of the bridge. Many of the users of bridges are women who may be carrying wide loads and it is unfair and dangerous for these people to be placed in a situation that compromises their personal safety. Footpaths should be at least 1.5m wide and be provided with an adequate safety rail and a solid floor.

The Design Engineer will be responsible for implementing this requirement.

Review of climate change requirements in bridge design: While there is some conflict in what may be expected from climate change one of the models predicts that by 2050 there will be increased rainfall and an increased frequency of extreme rainfall events. Stream flows will be more variable with greater extremes which will be manifest in lower minimum flows and higher maximum flows.

While it appears that existing design standards will suffice for the 50 year life of the bridge there is concern that some of the runoff determination criteria may be at fault leading to under-estimation of flows with possible failure of the bridge. Thus there may be situations in large expensive bridges (i.e. multi-span bridges) where it would be good design practice to adopt the precautionary principle and opt for a greater degree of design safety as predicted from climate modelling.

Thus for high cost multi-span bridges the design should determine hydraulic requirements using both the accepted DoW procedure which is compared with the climate change prediction. If there is an apparent and concerning difference demonstrated by the climate change prediction then the additional cost of meeting climate change requirements can be met from the climate change fund that is administered by the ADB. It is recommended that the Design Engineer be assisted in assessing bridge design with input from a Climate Change Specialist and that the ADB be aware of the possibility of funding the incremental costs to address climate change requirements.

Inclusion of Appendix 5 - Prohibited Investment Activities List - in Bid and Contract Document: It will be necessary to include in the B&C document reference to *Appendix 5 - Prohibited Investment Activities List* that is found in *The Safeguards Policy Statement - 2009*, especially *Item (ii) - production or trade in any product or activity deemed illegal under host country laws and regulations or international conventions and agreements or subject to international phase-outs or bans, such as (a) pharmaceuticals, pesticides, and herbicides (b) ozone-depleting substances, (c) polychlorinated biphenyls and other hazardous chemicals etc…..*

The Project Manager and ESP will be responsible for including reference to Appendix 5 Activities in the B&C document in the section "Special Conditions of Contract".

Review EMP, extract construction section of the EMP and attach to the B&C document: Experience shows that inadequate application of the EMP by the contractor may occur due to weak linkages of the EMP with the contract document. The EMP is a part of the work program and as such it must be addressed by the contractor and carried out as required. If the EMP is not satisfactorily addressed then the environmental safeguards and project sustainability will be compromised.

While a brief outline of the requirements are shown below preparation of Bid and Contract Documents is a specialised task and needs to be carried out by a person skilled in Bid and Contract preparation. Initially this will be challenging as few B&C templates are available for the inclusion of the EMP with the B&C documents[21]. In the B&C section "Special Conditions of Contract" list the EO will arrange the following; (i) prior to the tender being called the EO will revise and update the EMP and (ii) extract the construction section of the EMP and together with the PM will attach this to the Bid and Contract Documents in section; Part II - Requirements; Section 6 - Employer's Requirements. (iii) in Part 1 the Price Schedule 4 - Bill of Quantities this must include reference to particular requirements e.g. Preparation of Contractor's EMP (CEMP) including procedures and safeguards, as per Specification Clause x.x. which requires the bidder to specify the cost of the item within the Price Schedule. (iv) In the B&C section "Special Conditions of Contract" list the construction section of the EMP as forming part of the B&C document. The contractor will use this document to cost his compliance with the EMP.

This will be the responsibility of the ESP and PM who will assist the Procurement Officer in addressing this issue.

Bid evaluation and selection of contractor: If for any reason the B&C documents have not been prepared with adequate reference to the system outlined in RSC-C00919 (SOL) then the contractor will be required to provide a short statement that confirms the following three points. The statement is to be attached to the Bid in the section "Special Conditions of Contract".

(i) that the construction section of the EMP conditions have been costed into the bid price,
(ii) the contractor is to provide prior experience of working with an EMP,
(iii) the contractor is required to provided the name, details of qualifications and experience of two persons on the contractor's team (Environmental and Health and Safety Officer and a Community Liaison Officer) who will be responsible for meeting environmental compliance requirements of the EMP and developing community liaison.
(iv) At bid evaluation these requirements will be evaluated and awarded a possible 10% of the evaluation score.
(v) Should the contractor not provide these details, the bid will be judged to be non-compliant and the bid rejected.

The PM will be responsible for ensuring that these conditions are included as conditions in the B&C document

[21] It is recommended that the person preparing the documents obtain a copy of the following document from the Pacific Operations Department in the ADB. *ADB TA RSC-C00919 (SOL) Review of Environmental Safeguards Policy Implementation in ADB-Funded Projects in the Solomon Islands. October 2010.* This document evaluates the application of EMP safeguards to various construction activities undertaken in the Solomon Islands and sets out a practical system for incorporating the EMP into the B&C documents.

Both the PM and Environment Safeguards Specialist (ESP) are to be members of the bid evaluation panel. The ESP together with the EO will evaluate the contractor's environmental capability and present this to the evaluation panel.

B. Environmental Impacts and Mitigation Measures Needed during Construction

Environmental impacts identified during construction are limited in size, are site specific and temporary. The activities would normally be recognised and implemented as part of Best Construction Practices. For bridge construction projects of this size the contractor will require the usual range of facilities including site offices, workshops, storage areas and construction camps.

During construction, concrete will be prepared on site in a batching plant for the bridge foundations and deck which will require sand, aggregate and cement to be brought in. Road base fill for extending the bridge approaches will be sought from already opened sites. Asphalt will be required to seal the new approaches. Materials that may be brought to site that will have environmental implications include: fuel, concrete, asphalt and paint thinners. A list of materials is provided in Annex 7.

Excavated spoil which cannot be re-used in the reconstruction of the road abutments will be limited to soil materials high in organic content which can be satisfactorily disposed of as quality garden soil.

Machinery that may be used on the site is shown in Annex 6 and includes a range of heavy machinery and light machinery. The major item that will have environmental consequences will be the pile driver that will create both noise and vibration impacts during pile driving and the vibratory roller that will be used for settling the road abutments. Bulldozers and excavators will expose areas to soil erosion.

The project may employ about 230 people of which about 50 people may be employed from the local community. A summary is provided in Table 6 while actual details of numbers employed is given in Annex 5.

Table 8: Employment of Staff and Workers for Bridge Construction

	Contract	Replacement Bridge	Reuse Bridge
Professionals	20	6	1
Skilled	96	48	21
Unskilled	115	47	15
Total	231	101	37

Source: Project Engineer
Contract: are the possible number of workers that may be employed to complete all bridges within the contract package.
Replacement or Re-use bridge: lists the actual number of workers that may be employed on a particular bridge site.

Construction work includes the following activities arranged in order of undertaking:

(i) Transport of bridge construction materials and machinery to site.
(ii) Preparation of contractor's campsite.
(iii) Using fill broaden and raise the side of the existing road to provide access to the abutments for pile driving and concrete mixing machinery.
(iv) Drive piles into the channel for the bridge support foundations and into side of the river to form the bridge abutments.
(v) Prepare reinforcing steel, formwork and pour concrete for abutments.

(vi) Place steel girders.
(vii) Pour deck slabs and erect safety railings.
(viii) Finish by painting bridge steelwork.
(ix) Construct bridge approach roads and lay asphalt.
(x) Erection of guardrails and road signs.
(xi) Install abutment and river bank protection as required.
(xii) Dismantling any Bailey bridge for re-erection in another location.

Construction is expected to take 12 months with the most critical activity being pile driving for the bridge foundations which will need to take place during the dry season when the river is at its most accessible. Accordingly the following EMP conditions have been identified to address the above activities during construction.

(i) Contractor prepares CEMP
(ii) Induction of contractor to site
(iii) Control of invasive species
(iv) Establishment of contractor's facilities; camps, offices, quarries, concrete batching areas etc.
(v) Preparation of site. Removal and disposal of vegetation
(vi) Preparation of site: excavation, removal and disposal of unusable (incompetent) material.
(vii) Opening quarry and material fill sites
(viii) Work in and alongside the stream channel
(ix) Noise and vibration
(x) Dust management
(xi) Prevention of soil erosion on the construction site
(xii) Storage and handling of, (i) fuel and lubricants and (ii) bitumen.
(xiii) Public access to site
(xiv) Community safety from increased vehicle movements
(xv) Use of hazardous materials and application of Appendix 5 Prohibited Activities
(xvi) Workplace health and safety
(xvii) Worker issues - location of camps and employment of local labour
(xviii) Worker issues - provision of adequate living conditions within the campsite
(xix) Worker issues - camp water heating and cooking; use of fuelwood
(xx) Worker issues - hunting and sale of wildlife
(xxi) Worker issues - clearing of forest for gardens
(xxii) Disposal of site waste
(xxiii) Chance discovery of archaeological and cultural sites
(xxiv) Removal of old bridge and disposal of materials
(xxv) Clearance and rehabilitation of construction sites and removal of contractor's facilities.

During construction the contractor will work according to the requirements of the Contractors Environmental Management Plan (CEMP) which has been prepared by the contractor. Supervision and monitoring of the CEMP activities will be undertaken as follows;

(i) The contractor has the initial responsibility for supervising and monitoring the CEMP which is covered as a supervision item in the works contract.
(ii) The Project Supervising Engineer (PE) located within the Consultant's Supervision Unit (SU) will direct the contractor with regard to compliance with the

CEMP. The PE will be supported by the Environmental Officer (EO) and the Environmental Specialist (ESS).

(iii) The EO will carry out independent monitoring of the work and can issue Defect Notices to the PE who will issue these to the contractor.

(iv) The contractor will have his own representative on site – the Site Engineer (SE) who will be responsible for implementing the contract and complying with the CEMP.

Contractor prepares CEMP: following the award of the contract and before commencing work the contractor will be required to prepare a Contractors Environmental Management Plan (CEMP) that addresses the conditions of the construction EMP that has been attached to the B&C Documents. The CEMP will amplify how the contractor will address the activities in the construction section of the EMP. An outline of the CEMP will be provided by the EO. The contractor will submit the CEMP to the EO for approval and will forward this to the ESP for final approval. The contractor has 10 days to prepare the CEMP, the EO has 5 days to review the CEMP as has the ESP (5 days) .

Induction of contractor to site: Following the selection of the contractor and the approval of the CEMP, the contractor together with the person on the contractor's staff who will be responsible for supervising the CEMP will meet the EO on-site where the CEMP conditions will be confirmed with the contractor. When the EO is confident that the contractor understands and can comply with the CEMP, the EO will advise the PE that the contractor can now commence work.

Control of invasive species: invasive species have the ability to out compete local vegetation and the introduction of these into new areas is to be avoided.

(i) Prior to the contractor mobilising the EO will arrange to review the site and determine whether there is or is not any infestations of invasive species in the area.

(ii) The EO is to determine where the contractor's machinery was last used and whether the area is infested with any invasive species. Depending on the state of any infestation at the project construction site then the PE will advise the contractor whether or not machinery must be cleaned before moving to the site. This includes the removal of any potential seed sources such as earth and organic material that may be attached to the machinery.

(iii) The contractor and the EO will be required to observe for any infestations.

(iv) Should infestations occur on construction sites that are due or are not due to the contractor's activities the contractor will be required to control the infestation.

(v) Control and avoidance of the introduction of invasive species is the contractor's responsibility and this also extends to any sub-contractors that are working under his control.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor for this activity.

Establishment of contractor's facilities: This applies to all of the contractor's facilities, offices, worker camps, storage areas, workshops, quarries, concrete batching areas etc.

The sites are to be selected so that:

(i) they do not interfere with the welfare of surrounding communities in terms of noise dust and vibration from construction activities and their social wellbeing from their proximity to contractor's labour camps,
(ii) the areal extent of the contractor's facilities are to be limited to reduce unnecessary clearing of vegetation,
(iii) sanitary waste and grey water is not to be released untreated into surface water systems.
(iv) sites are to be properly drained. Paved areas, including vehicle parking areas, workshops and fuel storage areas are to drain to an oil and water separator.
(v) Fuel storage areas are not to be located within 20m of a water course.
(vi) The contractor's facilities are to be contained within an adequate security fence.
(vii) Concrete batching areas to be provided with bunds to control movement of runoff to waterways.
(viii) Quarries and fill material sites to be developed and closed according to Quarry Management Plan.

The location and development of contractor's facilities are to be approved by the PE and the EO.

Preparation of site: removal and disposal of vegetation : this applies to the intake area, the pipeline, powerhouse, the access road and the contractor's site facilities.

(i) Wherever possible limit area to be cleared and avoid excessive machine disturbance of the topsoil as this is required to be removed and stored.
(ii) Areas of significant vegetation within the cleared area have been identified and have been shown to machinery operators.
(iii) The area to be cleared is defined by a clearly established boundary.
(iv) 10 m wide buffer zones are to be established around watercourses and no clearing is permitted within this area.
(v) Machinery operators must be shown the boundaries of areas to be cleared.
(vi) Cleared material is to be pushed into manageable sized heaps according to disposal or re-use requirements.
(vii) Waste vegetation should be made available to villagers as fuelwood
(viii) If the material is an impediment to workers it may need to be burnt to clear the area. Wherever possible limit burning and if this is to be done ensure that the wood is dry so as allow a hot clean burn that produces little smoke.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Preparation of site: Excavation, removal and disposal of incompetent materials: this applies to all cleared sites where excavation will be undertaken and includes the intake area, pipeline, powerhouse, access road etc. The contractor is to arrange the following.

(i) Limit the areas to be excavated to those that can be effectively managed and protected.
(ii) Topsoil is removed and stored in separate heaps that are located in stable areas for later re-use for site rehabilitation.
(iii) Excavated material is sorted and stored as either competent (able to be reused) and incompetent (to be disposed of) materials.
(iv) At completion of work dumping areas to be re-topsoiled and revegetated.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Opening quarry and material fill sites: while the DoW maintains many quarries and sites for fill material the choice of locating the site rests with the contractor. If already opened sites are used the contractor is to follow established procedures for these sites. Should the contractor decide to open a quarry or a fill material site the contractor will first arrange to discuss the requirement with the PE and the ESS. Following this the contractor is to prepare a Quarry Management Plan that meets the requirements of the DoW Code of Practice which will include payment of a royalty to the landowners to extract materials from the site and closure of the site.

The contractors Site Environmental and Health and Safety Officer will be responsible for preparing the Quarry Management Plan which will be submitted to the ESS for approval. The Community Liaison Officer will be responsible for negotiating arrangements with the landowners.

Work in and alongside the stream channel. This applies to the bridge foundations should these need to be constructed within the river channel.

Turbidity will arise from increased disturbance from the following activities: (i) where foundations cannot be accessed from the bank a temporary road to allow the pile driver and other machinery to access foundation sites will need to be erected in the channel. This may be constructed by excavation direct from the channel and/or by dumping of fill in the channel, (ii) from vibration during pile driving and (iii) while laying gabions or other channel protection work. During construction large sized particles will settle quickly below the site while fine particles such as clay materials will be carried downstream which may impact on downstream communities who rely on clean water for domestic activities. Aquatic life is unlikely to be affected as it has already adapted to a wide range of turbid conditions arising from floods.

Receptors: People using the downstream area for water supplies and bathing may be affected by (i) increased turbidity arising from physical disturbance to the channel from construction activities and (ii) loss of water quality from pollutants that may be accidently spilled into the channel from refuelling operations.

Mitigation includes the following measures. Turbidity parameters established by the Environment Act 2000, state in *Table 1 Water Quality Criteria for Aquatic Life Protection* that turbidity is not to exceed 25 NTU this is a particularly low value and is rarely achieved in actual field conditions. In this case the contractor will be responsible for ensuring that water quality does not reach unacceptable levels (defined as exceeding existing turbidity levels that would be expected at the time) and cause complaints from downstream users.

(i) Plan work to be carried out in the river channels only for the dry season.
(ii) Plan operations to avoid creating excessive downstream turbidity.
(iii) No material that has been excavated outside the watercourse to be dumped in any watercourse.
(iv) No fuel, oil or other pollutants to be spilled or released from machinery working in channel.
(v) No machinery to be refuelled while working in the stream channel.
(vi) Work to stop if background turbidity increases above acceptable criteria or complaints are received from downstream communities.
(vii) Advise downstream village communities 24 hours before work is carried out in the stream channel.
(viii) If turbidity becomes a problem the contractor is to schedule work to provide periods where the stream channel is not disturbed. The contractor's Community Liaison Officer is to advise communities when stream water will be suitable for use.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Noise and Vibration: this applies to all machinery, vehicles and construction sites where noise and vibration may affect susceptible receptors. The principle sources of noise and vibration will be from pile driving and the use of vibratory rollers. The contractor will be responsible for ensuring that noise and vibration does not affect the surrounding communities. While it is unlikely that noise and vibration will be an issue due to the distance between the activities and the communities the contractor must be prepared to curtail work to daylight hours (0700hrs - 1900hrs) should the community find that any night time operations become a noise nuisance. Noise is not to exceed 45 dBA at the boundary of residential areas. Should vibration become an issue the contractor is to curtail activities to daylight hours (0700hrs - 1900 hrs).

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Noise and Vibration: this applies to all machinery, vehicles and construction sites where noise and vibration may affect susceptible receptors. The principle sources of noise and vibration will be from pile driving and the use of vibratory rollers. The contractor will be responsible for ensuring that noise and vibration does not affect the surrounding communities. While it is unlikely that noise and vibration will be an issue due to the distance between the activities and the communities the contractor must be prepared to curtail work to daylight hours (0700hrs - 1900hrs) should the community find that any night time operations become a nuisance. Noise is not to exceed 45 dBA at the boundary of residential areas.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Dust management: this applies to all of the construction sites, haul roads, quarries and topsoil and spoil dumps. Work that is carried out during the drier time of the year and especially when wind speeds increase may create localised dusty conditions. During construction when dust may be generated the contractor is to monitor the worksite conditions and apply dust control measures which includes reducing traffic movements and spraying water on exposed areas. Use of oil for dust control is not allowed. The contractor is to maintain a Dust Control Record that shows where and when dust control practices were carried out. This is to be made available as required when requested by the PE and/or the EO.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Prevention of soil erosion on construction site: this applies to all excavated sites. The contractor will be responsible for ensuring that the site is stable and that erosion is contained by appropriate soil conservation protection methods.

(i) Limit the extent of excavation to reduce soil erosion potential.
(ii) Soil conservation protection methodology is to be applied to susceptible areas to avoid storm water runoff carrying eroded materials either, off-site to susceptible areas or, else onto already finished work areas.
(iii) Where excessive areas are to be opened up, soil protection is unlikely to be effective or storm water drainage is likely to discharge sediment into neighbouring water courses sediment traps are to be used to settle eroded particles.
(iv) Avoid excavating areas and operating machinery in wet ground conditions.
(v) Excavated areas are to be revegetated as soon as possible at the completion of the site work.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Storage and handling of construction materials. (i) Fuel and lubricants and (ii) : Only small amounts of construction materials are likely to be brought to site. These will include sand, gravel and cement for concrete manufacture, reinforcing rods and steel mesh, wood and other construction materials, paint and thinners, fuel and lubricants.

(i) Storage areas to be prepared to avoid deterioration of materials.

(ii) Fuel should be stored in properly sealed containers. Larger than 5000 l to be stored on bunded concrete platform with 110% storage capacity.

(iii) All fuel storage areas to be security fenced and provided with oil and water separators. Fuel hoses and shut off valve to be locked.

(iv) All refuelling to be done at least 20 m away from waterways by trained personnel.

(v) All waste oil and oil filters to be collected and if possible recycled, otherwise to be disposed of to landfills.

(vi) The contractor is develop and Fuel Handling Procedure and to train refuelling personnel in these procedures.

(vii) The contractor is to have developed an Accidental Spill Reaction Procedure.

(viii) If water soluble bitumen is used this is not to be applied immediately prior to rain.

Any major spill into the watercourse is to be reported to the DEC. All waste oil, oil and fuel filters are to be collected and disposed of in secure landfill areas. At the closure of the site all contaminated soil is to be excavated, removed and replaced with fresh topsoil.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Public access to the site: this applies to the contractor's site and work areas. Access will be controlled to the contractor's facilities since this will be surrounded by a security fence. All visitors will be required to report to a check point before being allowed to enter the site. Other work areas will be demarcated by barrier tape and signs erected as required to warn people that there is no right of entry to these areas.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Community safety from increased vehicle movements: this applies to all vehicles and in particular haul trucks that have to pass through villages. The contractor is to ensure that all vehicles that may be required to pass through villages are operated and transport equipment and materials safely without endangering these communities. The contractor is to ensure:

(i) that trucks and other vehicles are maintained in a safe operating condition,
(ii) all drivers and machinery operators act responsibly,
(iii) all loads are to be secured and all loads with fugitive materials (e.g. excavated soil and sand) are to be covered with tarpaulins,
(iv) the contractor is to immediately remove any drivers that ignore any of the community safety requirements.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Use of (i) hazardous materials and (ii) Prohibited Activities:

(i) **Hazardous Materials**: Care will need to be taken should any hazardous (HAZCHEM) materials be required during construction. It is recommended that the contractor uses the HAZCHEM system which is based on the UN classification system. Details of the classification of dangerous materials can be found on the site http://www.minerals.csiro.au/safety/dangood.htm. The contractor will be required to prepare a list of all materials that are proposed to be brought to site together with their HAZCHEM rating. The EO is to verify the HAZCHEM rating and approve the use of any HAZCHEM rated chemicals. The contractor will also be required to display Material Safety Data Sheets (MSDS) in all work areas and to train workers in the safe use of these materials, including the provision of protective equipment for handling these substances.

(ii) **Prohibited Activities:** The contractor is to be aware of the activities shown in Appendix 5 of the of the ADB's *Safeguard Policy Statement, Prohibited Investment Activities List* that became effective in January 2010. Any listed Appendix 5 activities are prohibited. The PE and ES are to verify that the contractor is aware of the Appendix 5 requirements and that none of these activities will be sanctioned during construction.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Workplace health and safety: The contractor is expected to employ Workplace health and safety is covered by the Employment Act (1978). The contractor may employ up to 100 people at any one time of which all will have to be housed on site. The main workplace safety issues include:

(i) Hazards from operating and using machinery. Direct hazards to the machine operators and to workers working in the vicinity of the machine
(ii) Hazards from working in the pipeline trench where sides may collapse.
(iii) Hazards to workers exposed from heavy materials being lifted by cranes.
(iv) Refuelling hazards.
(v) Exposure to HAZCHEM materials.
(vi) Traffic accident hazards

Before commencing work in any of these activities (and in any other areas that the contractor identifies), the contractor will be required to prepare a brief Work Statement (WS) that identifies hazards that apply at a particular site together with an outline of the approved work procedure and details of protective safety equipment to be used by any person entering the specified work area. The WS is also to include an Emergency Response Procedure (ERP) to address serious accidents and nominate a person who is to be immediately contacted should an accident occur. A copy of the WS and the person to contact in case of an emergency is to be posted at the site where it is visible to all workers. Before commencing work the contractor is required to discuss the WS and ERP requirements with the workers.

(i) The ERP is to be submitted to the PE and ESS at least one week prior to work commencing on the site.

(ii) The WS is to be submitted to the PE and ESS for approval one week prior to starting work in any of these areas.

(iii) Erect warning signs and barriers around work areas
(iv) No drugs or alcohol allowed on-site
(v) Noise and dust to be controlled.

(vi) All workers provided with safety equipment appropriate for the task in which they are employed.

The contractor is to arrange for the following to be supplied on-site for workers:

- Potable water, chemical toilet, changing place with clothes storage, and washing and showering facilities.
- Work Statements prepared for each activity
- Prior to entering site for first time workers to be inducted to site and site hazards explained together with explanation of work site safety procedures.
- Medical and first aid facilities provided together with a person qualified in first aid.

A Record of Accidents and time lost from accidents will be required to be kept by the contractor which will be forwarded each month to the PM's representative for the attention of the ES.

The PE or EO will inspect and approve the adequacy of these arrangements.

Worker issues: (i) location of camps and employment of local labour: A construction site such as this may employ 20 persons some of who may need to be located on-site. There is a potential for conflict to develop with local communities should they be marginalised by the introduction of outside workers who then enjoy an enhanced economic status in comparison the local communities.

(i) Local communities to be preferentially offered employment for unskilled work.

(ii) Camps to be sited to avoid social conflicts.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Worker issues: (ii) provision of adequate living conditions within campsite: Workers will need to be provided with adequate housing, sanitation and recreational facilities.

The contractor will provide acceptable camp facilities with potable water, adequate food rations and recreational facilities to either meet requirements of the Employment Act (1978) or an acceptable international standard whichever is the higher. The contractor will be required to provide:

(i) adequate shelter
(ii) potable water
(iii) Sanitation and washing facilities,
(iv) Kitchen with adequate cooking facilities
(v) Nutritionally adequate food rations,

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Worker issues: (iii) camp water heating and cooking - use of fuel wood: To avoid sudden and unsustainable loss of any resources to the detriment of surrounding communities, the contractor will be required to address these issues as follows.

(i) Preferentially the contractor will provide gas and kerosene for water heating and cooking.
(ii) Locate camp away from significant forest areas, and: limit collection and use of fuel-wood.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Worker issues: (iv) hunting and sale of wildlife: To avoid sudden and unsustainable loss of any wildlife resources the contractor will be required to address these issues as follows.

(i) Labour employment agreement enforced by contractor that bans hunting and trading in wildlife by workers.
(ii) Contractor is to provide nutritionally adequate camp rations

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Worker issues: (v) clearing of forest for gardens: workers may want to clear areas for gardens. This will be driven by tradition rather than necessity as the contractor will be required to provide all workers with an adequate ration. While there is adequate land in the area this is owned under traditional systems. should workers want to prepare gardens they must:

(i) Seek the approval of the traditional land owner to avoid social conflict with the surrounding communities.
(ii) Workers will not be permitted to clear any forest for garden activities.
(iii) The contractor is to provide adequate and nutritionally balanced rations for all workers under his control that also incorporates traditional food items that would normally be sourced from markets.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Disposal of site waste: All construction waste materials including steel and timber off-cuts, sand and gravel, cement bags etc are to be collected and sorted. If these cannot be recovered for scrap value these materials are to be taken to an approved landfill sites and dumped there. Operation of landfill sites will be included as an item in the Environmental Permit.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Chance discovery of archaeological and cultural sites: Archaeological sites are protected under the National Cultural Property (Preservation) Act (1965). There are no known archaeological or cultural sites within the project boundaries. However, it is possible that “chance discoveries” may be made during development of the site. The contractor will be responsible for these finds and is to immediately stop work where the discovery has been made and advise the PE and the EO of the discovery. The EO will arrange to have the site evaluated. Depending on the evaluation of the discovery the contractor will be advised whether or not it is possible to resume work on the site.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Removal of old bridge and disposal of materials: This applies to situations where the old bridge will be removed and deals with the disposal of concrete and other discarded waste from the removal of the old bridge. Material which may require removal at the end of construction include bridges that may have had a concrete deck and foundations, the latter may also apply to Bailey bridges.

To reduce the impact on the watercourse consideration should be given to allowing concrete causeways to remain *in situ* unless these are badly broken. During dismantling of concrete deck type bridges all loose steel e.g. guard rails should be removed and sent to a scrap metal yard

for recycling. All concrete that is to be removed from the site is to be broken up and carted away to a stable excavated pit site where it is to be dumped and then covered by at least 1-2 m of earth that is then topped off with a final 0.2 m layer of topsoil which is then stabilised by revegetating the area. As the pit is to be returned to prior use the earth area may be lightly compacted but the topsoil area is not to be compacted. Some allowance will also need to be made for the earth to subside over time into the pit. The contractor will need to arrange for the excavation of the pit with the landowner and disposal will be at his cost. At the conclusion of work there should be no concrete remaining anywhere on the surface at the old bridge site. After filling, all temporary access roads to the pit are to be ripped to remove soil compaction. Where the Bailey bridge is removed all parts of the old bridge are to be removed. Unusable metal parts are to be collected and sent to a scrap yard for recycling. Nothing should remain at the site after completion of disassembly.

This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

Clearance and rehabilitation of construction sites and removal of contractor's facilities: It is the contractor's responsibility to address site clean up. This includes the removal all waste materials, machinery and any contaminated soil. All construction sites and work areas are to be rehabilitated so that these can be returned as close as possible to their previous use. This includes the stabilization and landscaping of all of the construction sites to re-establish site drainage. Any borrow pits or quarries that were operated by the contractor are to be reshaped and closed. Any contaminated soil must be removed from fuel and oil storage areas and the site revegetated. No waste is to remain behind after work is completed that will not naturally and safely decompose. Should waste not be removed DoW is entitled to withhold payment and arrange the clean up and deduct the cost of the clean-up from the final payment amount less an additional 10% for arranging the task.

The PE is to ensure that all waste is removed and the site restored. The EO will also inspect and approve the clean up of the site.

C. Environmental Impacts and Mitigation Measures Needed during Operation

During operation the main issues will be disposal of paint tins and solvents plus other waste from bridge maintenance.

Disposal of paint tins and solvents plus other waste from bridge maintenance: the bridge may require repainting about every 5 years and possibly of upwards of 200L of paint will need to be applied to the bridge as required for maintaining the structure. All used paint tins and other materials are to be collected and disposed of in a landfill area.

DoW will be responsible for supervising and implementing this requirement.

D. Monitoring

A matrix summarizing the monitoring that is required for the EMP is attached as Annex 3 which shows the monitoring measures that are required together with the frequency of measurement, the means of verification and who is responsible for monitoring the activity. Monitoring is carried out as follows:

Pre-construction: during preconstruction the EO under the supervision of the ESS will monitor the tasks identified within the EMP.

Construction: During construction monitoring of construction activities is carried out to ensure that construction work complies with the requirements of the EMP. Monitoring responsibilities are arranged as follows.

(i) The contractor has the initial responsibility for monitoring compliance with the Contractors Environmental Management Plan (CEMP). The responsibility for undertaking this is identical with the contractor's responsibilities for monitoring the construction works.
(ii) The Project Engineer (PE) is responsible for monitoring the contractor's compliance with the CEMP. The PE will be assisted in this role by the EO. In the initial stage of the project the EO is supervised and trained by the ESS.
(iii) The EO also monitors the work but has more of an auditing role. The EO can issue Defect Notices for non-compliant work and depending on the seriousness of the work may instruct the contractor that this is to be completed by a certain date. The Defect Notice is given to the PE who directs the contractor to undertake the work as shown in the Defect Notice. If the work is not completed by the due date then the PE can arrange for the work to be completed by another contractor and the cost deducted from the contract plus 10% as a management charge.
(iv) Monitoring may also be carried out by a Third Party e.g. the Environmental and Social Safeguards Officer who is attached to the PIU and the DEC. Both of these may make spot checks on the work being undertaken.

Operation: During operation monitoring will be undertaken by the DoW Environmental Monitoring Officer.

E. Implementation Arrangements

1. Implementation Schedule

The PPTA will be funded as a single loan facility which will be made available to the DoW who will act as both the implementing and executing agency. The project will be designed and constructed over a 60 month period. The Implementation Schedule is provided in Annex 4.

2. Institutional Arrangements

DoW are the Executing Agency (EA) for the project who will recruit a Supervising Consultant (SC) who will have overall responsibility for implementing the EMP. Other organisations involved in implementing the EMP include.

(i) **The Asian Development Bank** (ADB)
(ii) **Department of Lands** who will be responsible for assessing and paying compensation
(iii) **The Department of Environment and Conservation (**DEC) who will assist in environmental monitoring.
(iv) The **contractor** who will be responsible for mitigating and reporting on environmental activities during construction.

The Asian Development Bank (ADB) will be responsible for the following:

(i) Implementing the PAM.
(ii) Providing funds as required for the position of a Climate Change Specialist and a budget for meeting possible additional costs of addressing climate change requirements.

(iii) The ADB will review IEEs for Bridge Re-erection and any additional IEEs that may need to be prepared for replacement bridges.
(iv) Reviewing the quarterly reports sent to the ADB that contain the contractor's monthly environmental reports.
(v) Undertaking site inspection as required.

The Department of Lands will be responsible for assessing and paying compensation for loss of land and privately owned assets that may be affected within the 40m wide road corridor. This will be administered according to the Resettlement Plan (RP).

Department of the Environment and Conservation (DEC). DEC is responsible for the administration and enforcement of the Environment Act 2000 and its regulations. Due to the limited impacts of bridge replacement and re-erection DEC do not treat this as a notifiable activity under the Environment Regulation (2002). Accordingly DEC have no administration or monitoring role during project implementation. However in discussions with DEC they have requested that they be kept informed of the project and copies of the IEEs be sent to the DEC for their information. It is possible that DEC may be involved in monitoring the project and an allowance has been included in the budget for this possibility.

The Department of Works (DoW). Several PIU systems each with their own establishments are located within the DoW. Of these only the World Bank PIU includes an Environmental Manager (EM) who is on DoW establishment with the Contract Management Division. While this person is fully committed to the World Bank project the EM will need to be kept informed of the ADB TA and the need to assume safeguard management following the closure of the project when the management responsibilities will be transferred to the DoW.

For this project DoW will form a central PIU that will administer technical engineering and contract administration requirements but will not have any particular safeguards role. Safeguards will instead be addressed at a lower level by the Supervising Consultant.

The project will be implemented on behalf of the DoW by a Supervising Consultant who will undertake (i) detailed design and (ii) project implementation. The SC will recruit an international Environmental Safeguards Specialist (ESS) and a national Environmental Officer (EO) who will be responsible for implementing the EMP and EARF requirements.

The ESS will be recruited for 9 months and will divide his/her time as follows: 1 month for detailed design and 8 months for contract implementation. The EO's time (16 months) has been allocated as follows: 2 months detailed design and 14 months for contract implementation. Initially the ESS will be responsible for the implementation of the environmental program but this will be progressively transferred to the EO as the EO's capacity is built up. Both staff will need to liaise with the PIU and the Environmental Manager (EM) who is outside the project PIU but within the DoW structure. The ESS and EO will advise and work with the EM with regard to the project's implementation and at the same time improve the EM's understanding of the project and the on-going operations role that the EM will assume at the end of the project.

During **detailed design** the EO who will be assisted by the ESS will be responsible for the following:

(i) The EO with assistance from the ESS will prepare a Design Brief containing those issues that need to be addressed the SC technical engineering design team.
(ii) The EO/ESS will review and revise the EMP as required and extract the construction section from the EMP so that these will be attached to the Bid and Contract Documents.

(iii) The EO/ESS will evaluate and rank the bidders with regard to meeting the environmental requirements of the B&C documents.
(iv) Prior to construction commencing the EO/ESS will also evaluate and approve the Contractor's Environmental Plan (CEMP) and Community Awareness Plan (CAP). Both of these documents will be prepared by the Contractor as a condition of the contract and will be submitted to the EO/ESS for approval.
(v) Following approval of the CEMP and CAP the EO/ESS will arrange to induct the contractor to the construction site whereby the details of the CEMP and CAP are confirmed with the contractor. When the EO/ESS considers that the contractor is competent to undertake compliance with the CEMP and CAP the EO/ESS advises the PIU Project Supervising Engineer (PE) that the contractor may now commence work[22].
(vi) Liaises with the EM within the DoW as required.

During **construction** the on-site supervision of the construction program including responsibility for safeguard compliance will be managed by the Project Engineer (PE). The ESS will initially establish the environmental program for the construction phase and supervise the EO. The EO will progressively take over additional activities as his/her skills are developed. During construction the EO/ESS will have the following responsibilities.

(i) The EO/ESS will arrange public consultation with the SCD to advise affected communities of the scope and scheduling of the sub-project to raise awareness within the communities of the likely phasing of events that will occur within their social boundaries.
(ii) While the Contractor's SE will undertake day-to-day supervision of the CEMP, the PE who will be assisted by the EO/ESS will have overall site supervision responsibilities for ensuring that the Contractor is meeting the CEMP requirements.
(iii) The EO/ESS will arrange monitoring of the EMP with the Project Engineer and will assist the PE in monitoring the EMP.
(iv) During operation, the EO/ESS will also undertake regular monitoring as required by the EMP. The EO/ESS may issue Defect Notices concerning non-compliant work which are channelled to the contractor via the PE.
(v) The EO/ESS will prepare IEEs as required for any newly identified bridge sites as well as preparing IEEs for bridges to be re-erected. These will comply with the EARF requirements.
(vi) The EO/ESS will arrange to forward copies of IEEs and quarterly monitoring reports to the ADB.
(vii) The EO/ESS will prepare IEEs for other sub-projects as required and will also carry out monitoring and reporting as required.
(viii) Liaises with the EM within the DoW as required.

Job descriptions for the ESS and EO are attached in Annex 5.

The Contractor. The contractor's responsibilities include:

(i) At the time of bidding the contractor will submit the names and experience for two full time staff positions. These will be (i) Site Environmental and Health and Safety Officer and (ii) Community Liaison Officer, the requirements for these positions are given in Annex 4.

[22] This is also reflected in the PAM.

(ii) Prior to construction commencing the contractor will address the construction section of the EMP which has been attached to the Bid and Contract Documents and develop this into a detailed Construction Environmental Plan (CEMP) that amplifies the conditions established in the EMP. The CEMP also identifies persons who will be responsible for undertaking the work within the contractor's team. It will include a basic monitoring plan and a reporting program.

(iii) The contractor will prepare a Community Awareness Program (CAP). The CAP will show how the contractor will arrange a series of community meetings whereby the construction program, an HIV/AIDS awareness program and opportunities to provide unskilled work on the bridge site will be explained to the local communities.

(iv) The contractor arranges for the CEMP and the CAP to be submitted to the EO for approval.

(v) Following approval of the CEMP and the CAP the contractor is required to attend a site induction meeting where the CEMP and the CAP is discussed directly with the contractor to ensure that all compliance conditions are clearly understood.

(vi) Following clearance from the EO the contractor can now commence work.

(vii) The contractor will maintain a Dust Control Record which is to be available as requested for inspection by the Supervising Consultant.

(viii) The contractor will prepare a quarterly compliance report that will be submitted to the PIU. The report will also contain the Monthly Accident Report.

The EO will submit the report to DEC and include a copy for the ADB in the project's quarterly progress report prepared to meet the ADB loan requirements.

3. Environmental Assessment of Subsequent Projects:

Sub-projects will be funded as part of an MFF lending facility. Additional sub-projects may be added as required. An Environmental and Review Framework (EARF) has been prepared to guide the preparation of subsequent sub-projects.

4. Capacity Building

Capacity building will need to focus on four areas.

(i) existing institutional capacity within PNG organisations in this case the DoW and national staff that may be recruited to implement the project.

(ii) Internationally appointed staff and especially the PM if the person has limited experience or intention to implement environmental safeguards.

(iii) The contractor.

(iv) Integration of the EMP within the B&C documents is also critical to ensure that the EMP is treated as a serious document during implementation. Currently the B&C document is focussed to implementing engineering requirements and lacks any in built rigour with regard to implementing environmental safeguards.

Accordingly there is a need to develop capacity within the PNG staff, possibly within the internationally appointed PM and probably the contractor. There is also a requirement to effectively settle the EMP into the B&C document. This will be addressed by the appointment of an experienced international ESS for a period of 9 months (1 month during detailed design and 8 months during implementation) to ensure that the EMP is effectively integrated within the B&C document and is implemented and understood at the PIU, the Supervising Consultant and at the contractor's level. The ESS will be responsible for implementing the EMP and developing capacity within all three levels.

The DoW has already appointed an Environmental Manager (EM) to the Contract Management Division as requested by the World Bank. This person has been recruited from the DEC and brings with him prior extensive experience from this organisation. It is important that liaison be created with the EM during implementation of the project as the role of operations monitoring will transfer to the EM at the completion of the project. Accordingly the ESS will have an important role in ensuring that adequate communication and training links are created with the EM so that by the end of the project any remaining management and monitoring requirements can be effectively transferred to the EM.

5. Budget

The project budget for construction and supervision of the five road highways is US$100million. The budget for the environmental component for all five highways is shown in Table 8 and is costed at US$0.64 million. This includes the environmental management costs for both the PIU and the SC. The budget is split according to detailed design and implementation. The unit costs that have been adopted in the budget have been standardised with costs used in the project budget. This budget now needs to be carried through into the overall project budget.

Table 9: Budget requirements

Item	Inputs Req'd	Base	Unit	Years					Total
A. Supervising Consultant: Detailed Design				**1**	**2**	**3**	**4**	**5**	
International Consultant									
Environmental Safeguards Officer (ESC)	1 mth	27,000	/month	27,000	0	0	0	0	27,000
International travel (ESC)	1 trip	6,000	/trip	6,000	0	0	0	0	6,000
Per diem	1 mth	418	/day	12,540	0	0	0	0	12,540
Domestic travel and accom. ESC+EO	2 trips	1,200	/trip	2,400	0	0	0	0	2,400
National Staff									
Env Officer	2 mths	5,000	/month	54,000	0	0	0	0	54,000
Trips	2 trips	1,200	/trip	2,400	0	0	0	0	2,400
Incidentals			l.s.	5,000	0	0	0	0	5,000
Total Detailed Design Costs				**109,340**	**0**	**0**	**0**	**0**	**109,340**
B. Supervising Consultant: Implementation									
International Consultant									
Environmental Safeguards Officer (ESC)	8 mths	27,000	/month	0	81,000	54,000	54,000	27,000	216,000
International travel (ESC)	7 trips	6,000	/trip	0	12,000	12,000	12,000	6,000	42,000
Per diem	8 mths	418	/day	0	37,620	25,080	25,080	12,540	100,320
Domestic travel and accom. ESC+EO	18 trips	1,200	/trip	0	9,600	6,000	4,800	1,200	21,600
National Staff									
Environment Officer (EO)	14 mths	5,000	/month	0	20,000	20,000	15,000	15,000	70,000
Travel and accommodation	36 trips	1,200	/trip	0	10,800	10,800	10,800	10,800	43,200
Training costs			l.s.	0	10,000	5,000	5,000		20,000
Incidentals DEC monitoring etc			l.s.	0	5,000	5,000	5,000	2,000	17,000
Total Implementation Costs				**0**	**186,020**	**137,880**	**131,680**	**74,540**	**530,120**
TOTAL ALL COSTS (Design+Implementation)				**109,340**	**186,020**	**137,880**	**131,680**	**74,540**	**639,460**

XI. CONCLUSIONS AND RECOMMENDATIONS

The project will replace three reasonably large bridges along the Ramu highway and re-erect the dismantled Bailey bridges in new sites in rural areas. The project will enhance connectivity along the Ramu Highway but will make a substantial improvement in living conditions in rural areas where access is not possible due to the lack of bridges.

The IEE report has reviewed the environmental impacts associated with the sub-project and has developed a comprehensive EMP to address these activities. Overall there are few impacts associated with the project. Some minor land acquisition will be required to formalise the bridge approaches. Land ownership and compensation issues have been addressed by a Resettlement Plan and will be supervised by the PNG Department of Lands. All sites are significantly disturbed from the existing bridge sites and no significant flora or fauna will be affected by the project. The population of the surrounding areas who will benefit from improvements of bridges along the highway is 98,200 persons located within urban areas, in scattered settlements alongside the road and in the interior. The communities are mainly subsistence farmers with some cash crops. Health and education facilities are limited. The communities have limited cash resources and normally only grow enough food to support their requirements.

Pre-construction requirements include payment of land compensation, determination of climate change requirements and the preparation of the EMP as a contractual document.

Construction activities will be localised to the bridge location and will occur over a 12 month construction period. All impacts will be of a relatively small size and can be addressed by the EMP. The only possible adverse impact that has been identified is possible lowered water quality arising from increases in turbidity while the bridge foundations are being prepared in the river bed. The river is naturally turbid and while there may be short term increases in turbidity the contractor will be required to mitigate this by scheduling work to avoid decreasing water quality at times when communities may be collecting water. The local community will be encouraged to seek work on the bridge sites and will be advised of opportunities by a series of planned awareness meetings. Some land acquisition will be required and this is addressed in a Resettlement Plan. The project will not cause any loss of primary forest, conservation areas or areas of significant ecological diversity. No cultural or heritage sites will be affected.

During construction the contractor will be initially responsible for monitoring and supervising compliance with the EMP. The PE will be assisted by the EO to supervise the contractor while the EO will monitor the work and report any defects to the PE as required.

The EA for the project is the DoW who will appoint a Supervising Consultant to implement the project. One international staff and one national staff will be appointed by the SC to review and manage the implementation of the EMP. A budget has been determined of which the direct cost for the implementation of the environmental safeguards has been determined as US$0.64 million.

The following recommendations are made in the report:

(i) That the ADB meet the costs associated with recruiting a Climate Change Specialist and that funding be available for climate change augmentation should this be needed for any of the major bridges.

(ii) that the institutional responsibilities of the PIU be expanded to include safeguard management requirements.

(iii) That the internationally appointed ESS be recruited for at least 9 months including 1 month for pre-construction activities and 8 months during project implementation. The time allocated to the ESS needs to address the evolving requirements for implementing EMP safeguards within the B&C documents, capacity building within the PNG staff, the Supervising Consultant and the contractor, and construction monitoring. Apart from monitoring the others are new activities and unless these are recognised and adequately resourced it is unlikely that the EMP will achieve its stated goals.

Based on the above it is concluded that the project has few adverse impacts and all impacts can be satisfactorily managed by the application of the EMP

A. Conclusions

The Project is classified as a Category B project that requires an IEE to be completed. The IEE shows that all impacts can be satisfactorily mitigated and an EMP has been prepared that contains practical and realizable mitigation measures.

The IEE concludes that adverse environmental impacts arising from the replacement of bridges along the Ramu Highway can be minimized to insignificant levels. Therefore, a full EIA is not warranted.

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ANNEX 1: ENVIRONMENTAL MANAGEMENT PLAN

IMPACT MITIGATION					
Project Activity	Applies to	Potential Environmental Impact and/or consequence	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost
PRE-CONSTRUCTION ACTIVITIES					
Acquisition of land and payment of compensation.	Constructed area	Social disaffection with project. Possible use of bridge denied by landholders.	Resettlement Plan	SCD, DoW and Lands Department	To be determined
Provision of footpaths in bridge design	Bridge design	Without footpaths there is a potential for accidents especially for women carrying heavy wide loads across the bridge.	Provision of footpath approx. 1.5m wide with adequate safety railings and solid deck.	DE and EO	Project technical cost
Provision of climate change requirements in design	Hydraulic design of bridge and capacity of watercourse	Flood return frequency will reduce. If structure is hydraulically under sized there will be an early and expensive loss of the structure	Determine hydraulic capacity for expensive bridges assessing both: i. DoW procedure and ii. Climate change procedure. If considerable difference shown by climate change procedure additional bridge design cost to be covered by ADB climate change fund.	DE, Climate Change Specialist and EO	Project technical cost
Review EMP and extract construction section of EMP.	EMP	Avoids loss of environmental competence in project	EMP to be revised before extraction of construction conditions to B&C document. EMP re-issued before construction commences.	EO	Project cost
Inclusion of Appendix 5 *Prohibited Investment Activities* in B&C document	B&C documents	Loss of environmental values from application of banned materials.	Appendix 5 Prohibited Activities to be included as a requirement under "Special Conditions of Contract" within the B&C document.	PM and EO	Project cost
EMP construction conditions included in Bid Documents	B&C documents	Loss of environmental values and project sustainability.	EMP construction conditions included in B&C documents in Part II - Requirements; Section 6 - Employers Requirements. List EMP construction section as a Special Condition of Contract.	PM and EO	Project cost
Selection of contractor	Contractor	Selection of competent contractor will ensure that the environmental integrity of the sub-project is maintained.	EO to evaluate each bid for environmental competence of contractor. Rank bids and advise Bid Evaluation Panel.	EO	Project cost
CONSTRUCTION ACTIVITIES					
Contractor prepares CEMP	Contractor	Maintains environmental integrity of the project.	Contractor prepares Contractor's Environmental Management Plan (CEMP) that establishes the contractor's management and compliance requirements with the construction section of the EMP.	Contractor	Contractor's cost.
Induction of contractor to site.	Construction site	Maintenance of environmental values by ensuring that contractor understands and addresses the CEMP conditions.	Before commencing work the CEMP conditions are confirmed with the contractor at an on-site meeting. When the EO considers that the contractor is competent to comply with the CEMP the EO advises the PE that the contractor can now mobilise.	EO and PE	Project cost.
Control of invasive species	Construction site	Loss of indigenous vegetation.	i. EO to evaluate sites for presence of invasive species. ii. If site is not infested with invasive species the PE is to advise the contractor that if moving from an infested site all earth must be removed from machinery and machinery washed down before moving to site. iii. Any outbreaks are to be controlled and this is the contractor's responsibility.	EO, PE and contractor	Costed by contractor and cost carried into contract.

IMPACT MITIGATION					
Project Activity	Applies to	Potential Environmental Impact and/or consequence	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost
			iv. Applies to all sub-contractors under the contractors responsibility.		
Establishment of contractor's facilities (camps, offices, quarries, concrete batching areas etc).	Construction site	i. Maintains environmental integrity of site. ii. Avoids water and soil pollution, iii. Maintains harmonious relationships with surrounding communities.	i Sites are located so that they do not interfere with the welfare or social cohesion of surrounding communities ii. Site is limited to reduce unnecessary clearing of vegetation. iii. Sanitary soakage areas from offices and camps to be sited so that effluent is treated. iv. No discharge of grey water or sewage allowed to surface water systems. v. Workshops to be provided with oil and water separators. vi. Fuel storage areas not to be located within 20m of watercourse. vii. Contractor's storage facilities may need to be surrounded by a security fence. viii. Concrete batching areas to be provided with bunds to control movement of runoff to waterways. ix. Quarries and fill material sites to be developed and closed according to Quarry Management Plan.	Contractor	Costed by contractor and cost carried into contract.
Preparation of site: clearing of work areas. Removal and disposal of vegetation	Construction site	Minimise loss of vegetation	i. Limit area to be cleared ii. Identify areas with any significant vegetation. iii. Areas to be defined by a clear boundary. iv. Clearing boundaries shown to machinery operators. v. Vegetative material to be offered to communities for disposal as fuel wood or vi if an impediment to work may otherwise be disposed of by clean burning fires.	Contractor	Costed by contractor and cost carried into contract.
Preparation of site: excavation, removal and disposal of unusable (incompetent) materials.	Any areas to be excavated including road approaches	a. Lowered water quality from eroded material. b. Loss of visual amenity from poorly located and finished dumpsites	i. Limit area to be excavated. ii. Topsoil to be removed and stored for re-use. ii. Excavated incompetent material to be disposed of outside and away from the work area. iii. At completion of work dumping areas to be re-topsoiled and revegetated.	a. Contractor to arranges location of topsoil and material dump sites with PE. b. PE and EO	Costed by contractor and cost carried into contract
Opening quarry and material fill sites	Quarry and road fill sites	a. Impaired water quality from uncontrolled runoff. b. Loss of soil resources c. Loss of aesthetics.	i. Contractor to prepare Quarry Management Plan (QMP) that meets the DoW Code of Practice. The QMP is to address quarry opening, extraction and closing requirements. ii. The contractor is to arrange payment of extraction royalties.	Contractor's staff. i. SEHSO submits QMP to ESS/EO for approval. ii. CLO arranges royalty payments.	Costed by contractor and cost carried into contract
Work in and alongside stream channel	Bridge foundations and river protection works.	Increased turbidity of downstream areas which may affect downstream communities.	i. Avoid establishing coffer dam or working within stream channel during wet season. ii. Plan operations to avoid creating excessive downstream turbidity. iii. All excavated material to be disposed of outside watercourse.	Contractor	Costed by contractor and cost carried into contract.

IMPACT MITIGATION					
Project Activity	Applies to	Potential Environmental Impact and/or consequence	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost
			iv. No fuel, oil or other pollutants to be spilled or released from machinery working in channel. v. No machinery to be refuelled while working in stream channel. vi. Work to stop if background turbidity increases above acceptable criteria. vii. Advise downstream village communities 24hours before work is carried out in channel. viii. Schedule work to provide periods where stream channel is not disturbed. Advise communities when stream water will be suitable for use.		
Noise and vibration	Construction site including road approaches	Noise and vibration nuisance to surrounding communities. Impact will be mainly limited to pile driving and compaction of access road.	i. If particularly noisy activities are required work may need to be limited to daylight hours. ii. Noise not to exceed 45dBA at boundary of any residential area.	i. and ii. contractor	Costed by contractor and cost carried into contract.
Dust management	Construction site including road approaches and aggregate heaps.	Dust may be generated from activities. Will affect air quality of workplaces and surrounding areas	When dust is carried towards residential areas or becomes problematic on-site, the contractor is to apply dust control measures	Contractor	Costed by contractor and cost carried into contract.
Prevention of soil erosion on construction site.	Construction site	a. Loss of soil resources. b. Water quality affected. c. Eroded soil interfering with construction activities.	i. Apply soil conservation and erosion protection technologies. ii. Avoid operating machinery in adverse ground conditions. iii. Protect and revegetate newly excavated areas as soon as possible	Contractor EO will advise on revegetation requirements	Costed by contractor and cost carried into contract
Storage and handling of: i. fuel and lubricants ii. bitumen.	i. Fuel storage and handling equipment. Refuelling of plant and machinery. ii. Bitumen	Pollution of soil and water resources	i. Storage areas to be prepared to avoid deterioration of materials. ii. Fuel should be stored in properly sealed containers. Larger than 5000 l to be stored on bunded concrete platform with 110% storage capacity. iii. All fuel storage areas to be security fenced and provided with oil and water separators. Fuel hoses and shut off valve to be locked. iv. All refuelling to be done at least 20 m away from waterways by trained personnel. v. All waste oil and oil filters to be collected and if possible recycled, otherwise to be disposed of to landfills. vi. The contractor is to train refuelling personnel in these procedures. vii. The contractor is to have developed an accidental spill handling action plan. viii. If water soluble bitumen is used this is not to be	Contractor	Costed by contractor and cost carried into contract

IMPACT MITIGATION					
Project Activity	Applies to	Potential Environmental Impact and/or consequence	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost
			applied immediately prior to rain.		
Public access to site	Construction site	Accidents to surrounding communities	i. Erect warning signs and barriers around work areas. ii. Site can only be accessed with permission of contractor. iii. Visitors to be inducted to site with an explanation of the site hazards that may be experienced.	Contractor	Costed by contractor and cost carried into contract.
Community Safety from increased vehicle movements	Villages situated on haul roads.	Accidents to surrounding communities from vehicles transiting villages.	i. All vehicles to be properly maintained and operated in accordance with road laws. ii. All loads to be properly secured and fugitive loads to be covered. iii. Drivers to be fired if ignore safety requirements.	Contractor	Costed by contractor and cost carried into contract.
i. Use of hazardous materials and ii. Prohibited activities	Construction site	Health dangers to workers and the environment. Loss of water quality	i. Contractor to provide list of all HAZCHEM products to be used on site ii. List verified against HAZCHEM. iii. Contractor to display MSDS sheets in work areas. iv. Contractor to abide by Appendix 5 Prohibited Activities (SPS, June 2009)	Contractor and EO.	Costed by contractor and cost carried into contract.
Workplace health and safety	Labour working on construction site	Workplace accidents and health of workers. Loss of productivity.	Workers to be provided with safe working environment including: i. Erect warning signs and barriers around work areas ii. No drugs or alcohol allowed on-site iii. Noise and dust to be controlled. iv. All workers provided with safety equipment appropriate for the task in which they are employed. v. To be supplied on-site for workers: Potable water, chemical toilet, changing place with clothes storage, and washing and showering facilities. vi. Work Statements prepared for each activity vii. Prior to entering site for first time workers to be inducted to site and site hazards explained together with explanation of work site safety procedures. ix. Medical and first aid facilities provided together with a person qualified in first aid.	Contractor	Costed by contractor and cost carried into contract.
Worker issues (i): Location of camps and employment of local labour	Surrounding communities	Social unrest from poor location of camps and perceived bias in employment policy if local workers not hired	i. Local communities to be preferentially offered employment for unskilled work. ii. Camps to be sited to avoid social conflicts.	Contractor	Costed by contractor and cost carried into contract.
Worker issues (ii): provision of adequate living conditions within campsite.	Labour	Poor health and loss of worker productivity.	Camp conditions to meet Labour Law requirements. Provide: i. adequate shelter ii. potable water iii. Sanitation and washing facilities, iv. Kitchen with adequate cooking facilities v. Nutritionally adequate food rations,	Contractor	Costed by contractor and cost carried into contract.
Worker issues (iii): Camp water heating and	Labour	i. Unsustainable removal of forest resources to detriment of surrounding	PREFERENTIALLY i. the contractor will provide gas and kerosene for	Contractor	Costed by contractor and

IMPACT MITIGATION					
Project Activity	Applies to	Potential Environmental Impact and/or consequence	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost
cooking. Use of fuel wood.		communities. ii. Disturbance to forests, wildlife, and biodiversity	water heating and cooking. ii. Locate camp away from significant forest areas, and: limit collection and use of fuel-wood.		cost carried into contract.
Worker issues (iv): Hunting and sale of wildlife by workers	Labour	i. Unsustainable loss of wildlife and ii. affect on biodiversity.	i. Labour employment agreement enforced by contractor that bans hunting and trading in wildlife by workers. ii. Contractor is to provide nutritionally adequate camp rations	Contractor	Costed by contractor and cost carried into contract.
Worker issues (v): Clearing land for gardens	Labour	i. Cause of social conflict with surrounding communities.	i. Approval to clear land must be obtained from traditional owner. ii. No approval will be given to clear forest land. iii. Contractor to provide adequate and nutritionally balanced rations.	Contractor	Costed by contractor and cost carried into contract.
Disposal of site waste	Construction site	Soil and water pollution.	All waste materials to be collected and sorted; (i). those that can be recycled and (ii) those that need to go to an approved landfill site for disposal.	Contractor	Costed by contractor and cost carried into contract
Chance discovery of archaeological and cultural sites	Construction site	Loss of cultural values	No known sites. Chance discoveries are to be notified to the PE who will advise the EO. EO to advise on procedure for dealing with chance discoveries..	Contractor, PE and EO	Costed by contractor and cost carried into contract.
Removal of old bridge and disposal of materials	Old bridges	Loss of aesthetics	i. Avoid removing concrete causeways if practicable ii. Collect all steel and send to a scrap yard. iii. Dispose of concrete in excavated pit and cover with 1m earth and 0.2 m topsoil. Avoid compaction iii. Remove compaction from access track	Contractor, PE and EO	Costed by contractor and cost carried into contract.
Clearance and rehabilitation of construction sites and removal of contractor's facilities.	Construction site	Re-establishes environmental values	i. All solid waste to be removed from sites and disposed in approved landfills. ii. All contaminated soil to be removed. iii. All sites to be rehabilitated and restored to original condition. iv. Drainage to be re-established. v. To be included as part of Final Inspection before payment made.	Contractor	Costed by contractor and cost carried into contract
OPERATION ACTIVITIES					
Disposal of paint tins and solvents plus other waste from bridge maintenance.	Bridge	Lowering of soil and water quality.	i. All maintenance waste collected ii. Site kept tidy and no waste allowed to build up in yard.	DoW	DoW operating cost

DoW = Department of Works; EO = Environmental Officer attached to Supervising Consultant; PE = Project Engineer based with Supervising Consultant; MSDS material safety data sheet.

ANNEX 2: MONITORING CHECKLIST

IEE MONITORING REQUIREMENTS

For this project, a table summarizing the monitoring requirements shown in the Environmental Management Plan (EMP) is attached as Appendix A for pre-construction and construction. The matrix shown in Appendix A shows the mitigation measures, monitoring requirements and responsibilities of the various persons that need to be addressed during design/pre-construction, construction and operation phases. Only the main monitoring requirements are shown in Appendix A and will need to be revised as follows.

At the start of the project and before monitoring begins the Environment Officer (EO) will review the monitoring activities shown in Appendix A and update the monitoring requirements to conform with any changes that have been made to the sub-project design and activities.

Monitoring will be addressed as follows.

During **pre-construction** monitoring of these activities will be carried out by the EO. The EO in association with the Design Engineer (DE) will be responsible for ensuring that the issues that are to be addressed by the technical design team are implemented as required in the EMP.

During **construction** monitoring will be carried out as follows; the contractor will have the initial responsibility for self-monitoring his work which will be undertaken according to the CEMP. The contractor will appoint a person on his team who will have overall responsibility for ensuring that the CEMP requirements are complied with. The PE will supervise and monitor the contractor's work and direct the contractor accordingly. The EO will support and assist the PE in monitoring the contractor's work. The EO will also independently monitor the construction activities and will issue Defect Notices for non-complying work to the contractor via the PE.

APPENDIX A: ENVIRONMENTAL MONITORING PLAN

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
PRE-CONSTRUCTION										
Acquisition of land and payment of compensation.	Pre-construction	Resettlement Plan	i. Road corridor land transferred to DoW. ii. Landowner satisfaction	Once verify transfer	EO					
Provision of footpaths in bridge design	Design	Provision of footpath approx. 1.5m wide with adequate safety railings and solid deck.	Footpath provided in design that meets these specifications.	Once verify design.	DE and EO					
Provision of climate change requirements in design	Design	Determine hydraulic capacity for expensive bridges assessing both: i. DoW procedure and ii. Climate change procedure. If considerable difference shown by climate change procedure additional bridge design cost to be covered by ADB climate change fund.	i. Design considers climate risk requirements. ii. Additional cost of climate change met from ADB climate change fund.	Once. i. compare design outcomes. ii. ADB climate change fund meets additional costs of complying with climate design.	DE Climate Change Specialist and EO					
Inclusion of Appendix 5 *Prohibited Investment Activities* in B&C document	Bid and Contract Documents	Appendix 5 Prohibited Activities to be included as a requirement under "Special Conditions of Contract" within the B&C document.	Appendix 5 attached to B&C documents	Once verify that Appendix 5 has been attached ot the B&C documents.	EO and PM					
Review EMP and extract construction section of EMP	EMP	EMP to be revised and re-issued at the completion of the pre-construction tasks.	EMP revised and changes incorporated in it.	Once. EMP re-issued.	PM					
EMP construction conditions included in Bid Documents	Bid and Contract Documents	EMP construction conditions included in B&C documents in Part II - Requirements; Section 6 - Employers Requirements. List EMP construction	EMP construction conditions attached to B&C documents.	Once verify EMP construction section attached to B&C documents.	EO and PM					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
		section as a Special Condition of Contract.								
Selection of contractor	Bid and Contract Documents	EO to evaluate each bid for environmental competence of contractor. Rank bids and advise Bid Evaluation Panel.	Bids evaluated for compliance with environmental conditions.	Once. EO has verified environmental conditions of Bids.	EO and PM					
CONSTRUCTION ACTIVITIES										
Contractor prepares CEMP	Contractor	Contractor prepares Construction Environmental Management Plan (CEMP) that establishes the contractor's management and compliance requirements with the construction section of the EMP.	CEMP prepared by contractor and approved by EO and ESP	Once. CEMP; (a) prepared and (b) approved.	EO					
Induction of contractor to site.	Contractor	Before commencing work the CEMP conditions are confirmed with the contractor at an on-site meeting. When the EO considers that the contractor is competent to comply with the SEMP the EO advises the PE that the contractor can now mobilise.	Record of induction meeting and decision advising contractor to mobilise.	Once. Verify that induction has been carried out and contractor is competent to undertake CEMP.	EO					
Control of invasive species	Contractor and all construction sites.	i. EO to evaluate sites for presence of invasive species. ii. If site is free of invasive species the PE is to advise the contractor that all earth must be removed from	Site kept free of invasive species.	Monthly during wet season or as required until site has been cleared of introduced invasive species. Verify that contractor has washed down	EO, PE and contractor					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
		machinery and machinery washed down before moving to site. iii. Any outbreaks are to be controlled and this is the contractor's responsibility. iv. Applies to all sub-contractors under the contractors responsibility.		machinery.						
Establishment of contractor's facilities (camps, offices, quarries, concrete batching areas etc).	Construction sites	i Sites are located so that they do not interfere with the welfare or social cohesion of surrounding communities ii. Site is limited to reduce unnecessary clearing of vegetation. iii. Sanitary soakage areas from offices and camps to be sited so that effluent is treated. iv. No discharge of grey water or sewage allowed to surface water systems. v. Workshops to be provided with oil and water separators. vi. Fuel storage areas not to be located within 20m of watercourse. vii. Contractor's storage facilities may need to be surrounded by a security fence. viii Concrete batching areas to be provided with bunds to control movement of runoff to waterways. ix. Quarries and fill material sites to be	Compliance with proposed mitigation measures	At commencement of site establishment, then as required.	Contractor					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
		developed and closed according to Quarry Management Plan.								
Preparation of site: clearing of work areas removal and disposal of vegetation	Construction sites	i. Limit area to be cleared ii. Identify areas of significant vegetation. iii. Areas to be defined by clear boundary. iv. 10 m wide buffer zones established around water courses. v. Machinery operators to understand boundaries. vi. Vegetative material to be disposed of by communities for fuel wood or vii if an impediment to work may otherwise be burnt by clean fires.	Site cleared and vegetation removed according to EMP specifications.	Weekly or as required until site has been established. Verify that contractor's facilities meet mitigation requirements.	Contractor, PE and EO					
Preparation of site: excavation, removal and disposal of unusable materials (incompetent) materials	Areas to be excavated including road approaches	i. Limit area to be excavated. ii. Topsoil to be removed and stored for re-use. ii. Excavated incompetent material to be disposed of outside and away from the work area. iii. At completion of work dumping areas to be re-topsoiled and revegetated. .	Site excavated according to EMP specifications.	Weekly or as required until site has been established. Verify that excavation has met mitigation requirements.	Contractor, PE and EO					
Work in and alongside stream channel	Bridge foundations and river protection work.	i. Avoid establishing coffer dam or working within stream channel during wet season. ii. Plan operations to avoid creating excessive downstream turbidity. iii. All excavated	Turbidity not to exceed acceptable levels as determined by surrounding communities.	i. While work in stream bed is being undertaken. ii. Community complaints.	Contractor, PE and EO					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
		material to be disposed of outside watercourse. iv. No fuel, oil or other pollutants to be spilled or released from machinery working in channel. v. No machinery to be refuelled while working in stream channel. vi. Work to stop if background turbidity increases above acceptable criteria. vii. Advise downstream village communities 24hours before work is carried out in channel. viii. Schedule work to provide periods where stream channel is not disturbed. Advise communities when stream water will be suitable for use.								
Noise and vibration	Construction sites	i. If particularly noisy activities are required work may need to be limited to daylight hours. ii. Noise not to exceed 45dBA at boundary of workplace.	i. Noise complaints from surrounding communities. ii. Noise measurement	At start of noisy activities then as required. Community complaints. 45 dBA measured at workplace boundary.	Contractor, PE and EO					
Dust management	Construction sites	When dust is carried towards residential areas or becomes problematic on-site the contractor is to apply dust control measures	Work areas are acceptable with regards to generation of dust.	i. As determined by wind and site conditions.. ii. Complaints from communities.	Contractor, PE and EO					
Prevention of soil erosion on construction site.	Construction sites	i. Apply soil conservation and erosion protection technologies. ii. Avoid operating machinery in adverse ground conditions.	Soil erosion and sediment supply to water courses controlled.	Monthly and then as required. Sites are stable.	Contractor, PE and EO					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
		iii. Protect and revegetate newly excavated areas as soon as possible								
Storage and handling of construction materials. Fuel and lubricants.	Storage areas for materials, fuel and lubricants	i. Storage areas to be prepared to avoid deterioration of materials. ii. Fuel should be stored in properly sealed containers. Larger than 5000 l to be stored on bunded concrete platform with 110% storage capacity. iii. All fuel storage areas to be security fenced and provided with oil and water separators. Fuel hoses and shut off valve to be locked. iv. All refuelling to be done at least 20 m away from waterways by trained personnel. v. All waste oil and oil filters to be collected and if possible recycled, otherwise to be disposed of to landfills. vi. The contractor is to train refuelling personnel in these procedures. vii. The contractor is to have developed an accidental spill handling action plan. viii. If water soluble bitumen is used this is not to be applied immediately prior to rain.	Storage areas prepared. Fuel and oil storage and handling procedures practiced and well understood	Initially once to approve storage and handling procedures then as required. Verify that storage and handling of construction materials, fuel and lubricants meet these requirements.	Contractor, PE and EO					
Public access to site	Construction sites	i. Erect warning signs and barriers around work areas.	Warning signs and barriers erected around	Weekly. Accident reports involving community.	Contractor, PE and EO					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
		ii. Site can only be accessed with permission of contractor. iii. Visitors to be inducted to site with an explanation of the site hazards that may be experienced.	work places. Access to work areas controlled.							
Community Safety from increased vehicle movements	Villages along haul routes	i. All vehicles to be properly maintained and operated in accordance with road laws. ii. All loads to be properly secured and fugitive loads to be covered iii. Drivers to be fired if ignore safety requirements.	Trucks and vehicles operated safely	Weekly. Accident reports. Community complaints	Contractor, PE and EO					
i. Use of hazardous materials and ii. Prohibited activities	Materials brought to site	i. Contractor to provide list of all HAZCHEM products to be used on site ii. List verified against HAZCHEM. iii. Contractor to display MSDS sheets in work areas. iv. Contractor to abide by Appendix 5 Prohibited Activities (*SPS, June 2009*)	a. List of chemical compounds and their hazard ratings. b. Appendix 5 activities	At start of work and whenever any hazardous compounds are to be brought to site. b. No Appendix 5 activities initiated	Contractor, PE and EO					
Workplace health and safety	Construction sites	Workers to be provided with safe working environment including: i. Erect warning signs and barriers around work areas ii. No drugs or alcohol allowed on-site iii. Noise and dust to be controlled. iv. All workers provided with safety equipment	Provision of safe and healthy workplace, safety procedures and equipment. First aid equipment.	Spot checks and weekly inspections. Accident record.	Contractor, PE and EO					

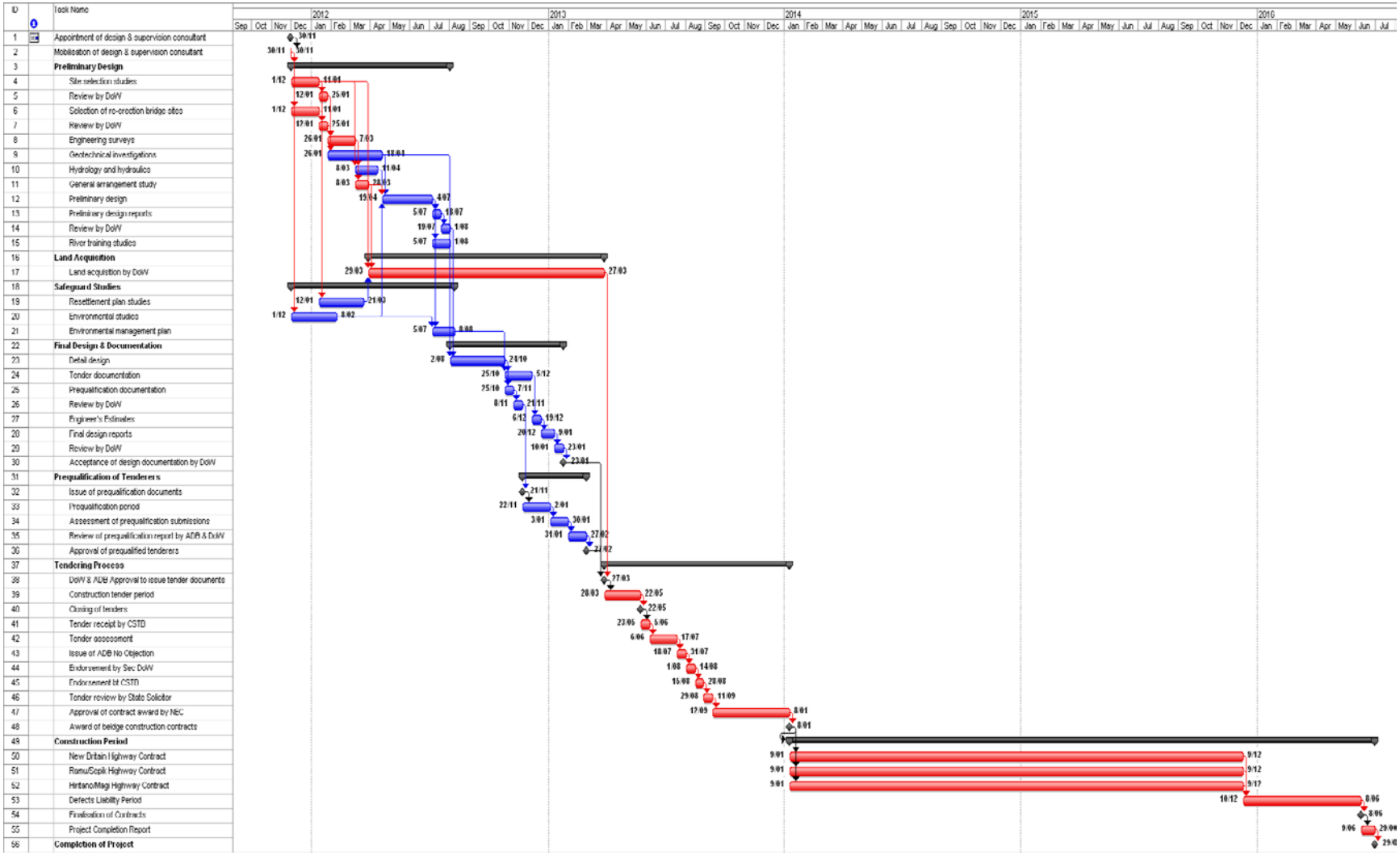
Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
		appropriate for the task in which they are employed. v. To be supplied on-site for workers: Potable water, chemical toilet, changing place with clothes storage, and washing and showering facilities. vi. Work Statements prepared for each activity vii. Prior to entering site for first time workers to be inducted to site and site hazards explained together with explanation of work site safety procedures. ix. Medical and first aid facilities provided together with a person qualified in first aid.								
Worker issues (i): Location of camps and employment of local labour	Worker camps and surrounding communities	i. Local communities to be preferentially offered employment for unskilled work. ii. Camps to be sited to avoid social conflicts.	i. Local people employed ii. Harmonious conditions established (lack of complaints)	i. Monthly checking of employment records. ii. Grievance records from surrounding communities.	Contractor and PE, EO					
Worker issues (ii): provision of adequate living conditions	Worker camps and workers	Camp conditions to meet Labour Law requirements. Provide: i. adequate shelter ii. potable water iii. Sanitation and washing facilities, iv. Kitchen with adequate cooking facilities v. Nutritionally adequate food rations,	Worker satisfaction	i. Monthly checking of first aid records. ii. Complaints from workers.	Contractor and PE, EO					
Worker issues (iii): Camp water	Worker camps and workers	i. the contractor will preferentially provide gas and kerosene for	i. Gas or kerosene used for camps.	Monthly verify i. camp cooking facilities.	Contractor and PE, EO					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
heating and cooking. Use of fuel wood.		water heating and cooking. ii. Locate camp away from significant forest areas, and: limit collection and use of fuel-wood.	ii. Limited harvesting of fuel wood	ii. access to forests for fuel wood.						
Worker issues (iv): Hunting and sale of wildlife by workers	Worker camps and workers	i. Labour employment agreement enforced by contractor that bans hunting and trading in wildlife. ii. Provision of adequate camp rations	Wildlife being traded from camp area	Monthly Verify prosecution and dismissal of employees for wildlife infringements..	Contractor and PE, EO					
Worker issues (v): Clearing land for gardens	Worker camps and workers	Contractor to provide adequate and nutritionally balanced rations	Illegal occupation of land that has been cleared for gardens.	Monthly Complaints from communities	Contractor and PE, EO					
Disposal of site waste	Construction sites	All waste materials to be collected and sorted; (i). those that can be recycled and (ii) those that need to go to an approved landfill site for disposal.	Sites cleaned of materials. Materials dumped in approved sites	Spot checks and weekly inspections. Waste being collected and disposed of to meet requirements.	Contractor, PE and EO					
Chance discovery of archaeological and cultural sites	Construction sites	No known sites. Chance discoveries are to be notified to the PE who will advise the EO. EO to advise on procedure.	Contract document, and specification	Yearly. Notification of chance discoveries	Contractor, PE and EO					
Removal of old bridge and disposal of materials	Old bridges	i. Avoid removing concrete causeways if practicable ii. Collect all steel and send to a scrap yard. iii. Dispose of concrete in excavated pit and cover with 1m earth and 0.2 m topsoil. Avoid compaction iii. Remove compaction from access track	i. All bridge materials removed from site. ii. Disposed of in stable excavated earth fill site. iii. Pit closed and site restored. iv. Pit access road restored.	At completion all old bridge materials have been removed. Pit has been stabilised and site revegetated. Access road ripped.	Contractor, PE and EO					

Project Activity	Applies to	Proposed Mitigation Measure	Parameter to be monitored	Frequency and means of Verification	Monitoring responsibility	Achieved Yes or No	Date of Verification	Name of person verifying	Signature of person verifying	Remarks: e.g. Defect Notice Issued etc
Clearance and rehabilitation of construction sites and removal of contractor's facilities.	Construction sites Worker camps Contractor's work areas	i. All solid waste to be removed from sites and disposed in approved landfills. ii. All contaminated soil to be removed. iii. All sites to be rehabilitated and restored to original condition. iv. Drainage to be re-established. v. To be included as part of Final Inspection before payment made.	Sites cleared, waste removed, sites landscaped and revegetated.	At completion of construction. Site has been cleared of materials, rehabilitated and returned to original state.	Contractor, PE and EO					

EO = Environmental Officer attached to PNG Power; PE = Project Engineer based in PIU; MSDS material safety data sheet. While the EO is shown as being responsible for these activities, the EO will initially be assisted by the ESS until the EO is sufficiently competent to adopt the management responsibilities.

ANNEX 3: IMPLEMENTATION SCHEDULE



ANNEX 4: TERMS OF REFERENCE FOR ENVIRONMENTAL SAFEGUARD POSITIONS[23]

1. Supervising Consultants Staff

1.1 Environmental Safeguards Specialist (International: part-time, 12 person-months)

Objective/ purpose of assignment

Ensure that environmental safeguard policies of the ADB that are identified in the *Safeguard Policy Statement (June 2009)* are applied. The reference base for these will be the documents that have been prepared for the project during the PPTA which include the: the IEE, EMP, the EARF and the Resettlement Plan. These have been prepared for the bridge replacement sites but have not been prepared for the sites for re-erection of the Bailey bridges. The location of these sites will be arranged by the DoW and will be controlled by the EARF.

Scope of work:

One position an Environmental Safeguards Specialist (ESS) will be appointed who will implement the environmental safeguards.

The Environmental Safeguards Specialist will have capacity and experience in the following:

(i) Be an experienced specialist with sufficient experience in conducting environment studies and preparing IEEs and EMPs to comply with the *ADB Safeguard Policy Statement, 2009* and relevant PNG requirements for construction projects with environmental impacts similar to those of the Project.
(ii) Be an experienced specialist with sufficient experience in preparing Bid and Contract documentation in PNG, monitoring contractors' compliance with environmental provisions of the contract and.
(iii) Capacity to train staff and contractors in environmental safeguards.

The Environmental Specialist will undertake the following activities during detailed design:

(i) Ensure that the recommendations contained in the IEE EMP are incorporated into the detailed design;
(ii) Update the EMP as necessary to revise or incorporate revised or additional environmental mitigation and monitoring measures, budget, institutional arrangements, etc, that may be required based on the detailed design;
(iii) If required, prepare a new or supplementary environment assessment report for additional components or changes in the project during detailed design (for example if there is a substantial change in alignment) that would result in adverse environmental impacts not within the scope of the PPTA IEE;
(iv) Prepare IEEs as required for either the replacement or re-erection of Bailey bridges. The location of Bailey bridges to be re-erected at new locations will be advised by DoW. IEEs will be prepared according to the requirements of the EARF that was prepared during the PPTA.

[23] The Terms of Reference for these positions are suggested only and are provided to the ADB for their consideration with regards to framing any scope of work for subsequent consultancy services.

(v) Obtain timely approval for the IEEs so that these are in keeping with the project timelines.
(vi) Ensure that any EMP has been revised as required to reflect changes in sub-project design that may have affected the environmental parameters;
(vii) Ensure that the requirements of the construction EMP are carried as specifications into the Bid document;
(viii) Ensure that the bidding documents and civil works contracts contain provisions requiring contractors to comply with the mitigation measures in the EMP and that relevant sections of the project EMP (or updated EMP, if prepared) are incorporated in the bidding and contract documents;
(ix) Review IEEs to meet ADB requirements as expressed in the EARF and DoW requirements for those sites where Bailey bridges will be re-erected;
(x) Arrange for approval of the IEEs by the ADB and DoW Manager Environmental Services;
(xi) Arrange for distribution of IEEs to DEC and the ADB for their information;
(xii) Assist the Bid Evaluation Committee in evaluating and ranking the bids for compliance with the environmental specifications;

The Environmental Specialist will undertake the following activities during construction:

(i) Prior to mobilization approve the contractor's Contractors Environmental Management Plan (CEMP);
(ii) Induct the contractor to site and ensure that the contractor understands and can comply with the CEMP and the CAP.
(iii) Following the successful induction of the contractor advise the Project Engineer that the contractor is now cleared to start work at the site.
(iv) Assist the Project Engineer in supervising the contractor in complying with the CEMP.
(v) Implement a training program for the EO and for relevant contractors' staff for compliance with the EMP.
(vi) A Grievance Redress mechanism for environmental issues
(vii) Ensure that the contractor meets his obligations with regard to the CEMP, CAP and HIV/AIDS awareness programs.
(viii) Carry out monitoring of the contractor's compliance with the EMP; including the CAP, the Grievance Redress mechanism and HIV/AIDS awareness programs. Monitor construction and issue Defect Notices as required to correct any of the contractor's work.
(ix) Assist the PE in checking work and approving payment to the contractor.
(x) Prepare environmental monitoring reports as required to meet the reporting schedule.
(xi) Prepare and arrange to forward quarterly reports as required for the ADB.

1.2 The Environmental Officer

The Environmental Officer will be recruited at the national level and has the same duties as the ESS.

2. Contractor's Staff

The contractor is to appoint two staff as fulltime positions. These staff will be located at the construction site.

3.1 Environmental and Health and Safety Officer (EHS)

The EHS Officer will be responsible for the contractor and his staff complying with (i) the CEMP and (ii) health and safety requirements. The EHS will have suitable qualifications and be experienced in both of these areas. The EHS reports to the Contractor's Site Engineer (SE) and will be responsible for the following:

(i) Preparation of the CEMP
(ii) Ensuring the contractor and sub-contractors comply with the CEMP requirements.
(iii) Preparation of a Fuel Handling and Accidental Spill Reaction Procedure.
(iv) Training of personnel in these procedures.
(v) Monitoring the CEMP and taking correction action as required to address issues arising from the monitoring.
(vi) Preparation of Emergency Response Procedure (ERP) - to be submitted to the SC before one week before work begins on site.
(vii) Preparation of Work Statements to the SC one week before a new activity commences.
(viii) Work Statements (WS) and
(ix) Issuing of safety equipment
(x) Induction of workers and visitors to site
(xi) Liaising with the ESS on all environmental and health and safety issues.
(xii) Preparing the monthly Environmental and Health and Safety Report and sending this to the ESS.

3.2 Community Liaison Officer (CLO)

The CLO will be appointed by the contractor and will be responsible for ensuring that good community relationships are developed between the contractor and the affected communities. The CLO reports to the SE and will be responsible for the following:

(i) Preparation of a community liaison program that encapsulates the requirements of the IEE, the Gov PNG and the DoW requirements.
(ii) Before the contractor commences work the CLO will arrange meetings with the affected communities and explain the work program to them including its hazards and benefits in terms of recruiting workers.
(iii) Establishment of the HIV/AIDS program with the Ministry of Health.
(iv) Implement the Resettlement Plan with the assistance of the Department of Lands.

ANNEX 5: LIST OF WORKERS THAT MAY BE EMPLOYED DURING CONSTRUCTION

Worker		Contract	Replacement Bridge	Reuse Bridge
Professionals				
	Project manager	1	1	0
	Project engineer	3	2	1
	Civil engineer	1	1	0
	Surveyor	1	1	0
	Accountant	1	0	0
	Book keeper	3	1	0
	Secretary	2	0	0
	Procurement officer	2	0	0
	Staff officer	2	0	0
	Environmental officer	1	0	0
	Public liaison officer	1	0	0
	Compensation officer	1	0	0
	HIV trainer	1	0	0
	Sub-total	***20***	***6***	***1***
Skilled				
	Supervisor	4	1	1
	Foremen	8	5	2
	Leading hands	12	6	2
	Pile driving operator	4	3	2
	Plant operator	10	6	3
	Carpenter	10	4	2
	Concreter	8	6	4
	Welder	3	2	1
	Mechanic	5	1	0
	Electrician	2	1	0
	Boiler maker	3	1	0
	Painter	2	2	0
	Storeman	5	2	1
	Laboratory technician	5	2	0
	Driver	15	6	3
	Sub-total	***96***	***48***	***21***
Unskilled				
	Labourers	95	40	12
	Security guard	15	5	2
	Cleaner	5	2	1
	Sub-total	***115***	***47***	***15***
	Total	**231**	**101**	**37**

Source: PPTA Engineering Specialist. Contract: workers that may be employed to complete all bridges within the contract package.

Replacement or Re-use bridge: is actual number of workers who may be employed on a particular bridge site.

ANNEX 6: LIST OF MACHINERY THAT MAY BE REQUIRED DURING BRIDGE CONSTRUCTION

Machinery	Contract	Replacement Bridge	Reuse Bridge
Bulldozer D9	1	1	0
Bulldozer D6	2	1	1
Excavator	4	2	1
Front end loader	3	1	1
Grader	1	0	0
Vibratory Roller	2	2	1
Tip truck	4	1	0
Flat bed truck	5	1	1
Low loader	1	0	0
Bus	3	1	1
Crane 80t	1	1	0
Crane 40t	1	1	1
Welder	1	1	0
Mechanical workshop	1	0	0
Testing laboratory	1	0	0
Survey equipment	1	0	0
Fuel truck	2	1	1
Pile driving leads large	1	1	0
Pile driving leads small	1	0	1
Scaffolding	1	1	0
Compresser	3	2	1
Rock drills	4	2	0
Spray painters	1	1	0
Bitumen truck	1	1	0
Bitumen kettles	1	1	0
Demountable buildings	5	2	1
Camp buildings	4	0	0
Gravel screening plant	1	0	0
Concrete mixer large	2	2	1
Concrete mixer small	2	2	1
Concrete kibble	3	2	1
Safety equipment			
4WD vehicles	14	6	2
Total	**78**	**37**	**16**

Source: PPTA Engineering Specialist
Contract: machinery that may be used to complete all bridges within the contract package.
Replacement or Re-use bridge: is actual machinery that may be used on a particular bridge site.

ANNEX 7: LIST OF MATERIALS USED DURING BRIDGE CONSTRUCTION

Materials
Fuel
Lubricants
Spare parts
Cement
Reinforcement
Steel piles
Structural steelwork
Bitumen
Paint and thinners
Timber
Plywood
Fencing
Geotextile
Drainage pipe
Gabions

Source: PPTA Engineering Specialist

ANNEX 8: BRIDGE INSPECTION REPORT

Ramu Highway, Madang/Morobe Province

1. Gusap Bridge - Ch 17.2. The bridge is a 13 bay compact 200 DSR2 EW with steel decking. The bridge is in good condition. The banks have been noted to be stable naturally with the river defining its own original bed. A new bridge to be set immediately downstream of the existing bridge is considered appropriate at this site. The bridge would have to be 45 metres in span.

Bridge elevation

View upstream

2. Bora Bridge - Ch 20.6. The bridge is a 14 bay compact 100 DSR2 EW with steel decking. The bridge is in good condition. The banks have been noted to be stabilizing naturally with the river defining its own original bed. It will be necessary to further reinforce the protection work locally to encourage the river to flush out the gravel deposit in the river channel and stabilize the river bed. A new bridge to be set at the existing alignment is considered appropriate at this site. The bridge would have to be 45 metres in span.

View towards Madang

Bridge Elevation

View upstream

3. Dry Wara Creek Bridge - Ch 58.2. The existing bridge is a 13 bays DSR2 super bailey with steel decking. The bridge is in poor condition. The bridge had undergone a fair bit of impact. The banks are unstable upstream and widens up downstream of the bridge. An inventory of the missing bridge elements would need to be conducted to enable maintenance work to be carried out. A new bridge to have a span of 40 metres is suggested to be placed along the alignment of the existing bridge. River training works will be required to realigned the river channel and minimize erosion to the Madang side of the river bank. A temporary crossing an old ford crossing is located downstream of the existing bridge.

View towards Madang

Impact damage to truss member

View upstream

4. Wasigo Bridge - Ch 154.2. The existing bridge is a 13 Bay DSR2 super bailey bridge with steel decking. The decking is in poor condition. The abutments are seated on driven steel

piles. The banks are stable upstream of the bridge. Generally, there appears to be lack of maintenance. A general inventory of the bridge elements would have to be conducted and maintenance carried out accordingly to improve capacity of the bridge. A new bridge would have to be placed upstream of the existing bridge.

View towards Madang

View towards Ramu

View of fallen transom clamp

5. Tapo Ford - Ch 159.5. Tapo creek is a low level creek crossing consisting of a reinforced concrete. The creek is stable upstream and fens out immediately downstream of the causeway.

Overall view of crossing

View of Causeway

View towards Ramu

ANNEX 9 : ATTENDEES AT PUBLIC CONSULTATION MEETINGS

Kohu Bridge: Attendance List

Name	*Gender (M/F)*
1. Mike Mutu	Male
2. Delta Edemesi	Female
3. Rita John	Female
4. Miriam Raymond	Female
5. Ruth Andrew	Female
6. Lillian Winis	Female
7. Mariah Edemsi	Female
8. Joshua Edemsi (Pastor)	Male
9. John Yawo	Male
10. Moron Yawo	Female
11. Miriam Michael	Female
12. Yonime Winis	Female
13. Winis Mutu	Male
14. Simon Minato (Councillor)	Male
15. Kuku Minato	Female
16. John Minato	Male
17. Sirin Kesepun	Male
18. Gahu Kesepun	Male
19. Mata Mutu	Female
20. Rose Mutu	Female
21. Anas Mutu	Female
22. Yoma Mutu	Female
23. Julie Mutu	Female
24. Sabeth Mutu	Female
25. Lovelyn Mutu	Female
26. Mattew Mutu	Male
27. Yume Mutu	Female
28. Joseph Mutu	Male
29. Naomi Mutu	Female
30. Kesapun Gahu	Male
31. Matilda Gahu	Female
32. Jacklyn Gahu	Female
33. John Gahu	Male
34. Lasarus Gahu	Male
35. Sape Gahu	Female
36. Sirin Kesapun	Male
37. Salome Kesapun	Female

Tapo Ford: Attendance List

Name	*Gender (M/F)*
1. Gigimas Uwaru	Female
2. Manima Isoru	Female
3. Figali Uwaru	Male
4.Igirin Uwaru	Male
5. Wau Fai	Male

6. Meregina Uwaru	Female
7. Iaubi Morio	Male
8. Save Iaubi	Female
9. Aiaba Iaubi	Male
10. Dumu Iaubi	Male
11. Kalalu Farara	Male
12. Sebis Kalalu	Male
13. Iovo Kalalu	Female
14. Jessie Kalalu	Male
15. Gurudu Kalalu	Female
16. Melu Kalalu	Female
17. Tema Kalalu	Female
18. Hosi Kalalu	Female
19. Ruth Kalalu	Female
20. Kubua Farara	Male
21. Hona Kubua	Female
22. Sari Kubua	Male
23. Ase Kubua	Male
24. Mulo Kubua	Male
25. Meti Kubua	Female
26. Karai Kubua	Male
27. Pereres Kubua	Female
28. Luke Tiapa	Male
29. Timothy Tiapa	Male
30. Peter Tiapa	Male
31. Pauline Tiapa	Female
32. Ikel Tiapa	Female
33. Umebi Maulu	Female
34. Maga Maulu	Male
35. Hetbesi Maulu	Male
36. Asaiah Maulu	Male
37. Jeremiah Maulu	Male
38. Gorebai Uwaru	Female
39. Gamarau Iamua	Male
40. Iobena Isogu	Female
41. Kusi Gamarau	Female
42. Pariwa Gamarau	Male
43. Helen Gamarau	Female
44. Jennifer Gamarau	Female
45. Magani Goiowei	Male
46. Alisa Tumuru	Male
47. Walter Kubua	Male
48. Abraham Kalalu	Male
49. Jonathan Aduminei	Male

Wasigo Bridge: Attendance List

Name	***Gender (M/F)***
1. Joe Soroi	Male
2. Gabriel Agia	Male
3. Gama Pius	Male

4. Ismael Sogumara	Male
5. Mumex Marapu	Male
6. Lulua Guligau	Male
7. Aima Nunua	Female
8. Emon Peter	Female
9. Binana Morio	Female
10. Damai Nunua	Female
11. Nunua Nunua	Male
12. Pukali Tawa	Male
13. Malle Tawa	Male
14. Malaku Nunua	Male
15. Saiba Nunua	Male
16. Tiepa Peter	Male
17. Albert Peter	Male
18. Jacob Peter	Male
19. Nogos Pokali	Male
20. Mexie Malle	Male
21. Gabutu Malle	Male
22. Lemsol Pukali	Male
23. Sanana Malle	Male
24. Tantan Tawa	Female
25. Waiar Malle	Female
26. Margaret Nunua	Female
27. Bita Soroi	Female
28. Susie Soroi	Female
29. Norman	Male (from East Sepik)
30. Kauka Auma	Female
31. Robin Auriba	Male
32. Rabika Auriba	Female
33. Kaukwasi Auriba	Female
34. Maurice Auriba	Male
35. Iso Auriba	Male
36. Malapo Auriba	Male
37. Punikau Moroio	Male
38. Warima Gunikau	Male
39. Uduagu Gunikau	Male
40. Dauru Gunikau	Female
41. Saula Gunikau	Female
42. Solifa Gunikau	Female
43. Iahu Ameri	Female
44. Uniaka Tawan	Female
45. Mek Tawan	Female
46. Kiat Tawan	Male
47. James Tawan	Male
48. Moses Maurice	Male
49. Aaron Maurice	Male
50. David Maurice	Male
51. Solomon Maurice	Male
52. Miriam Maurice	Female