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GUIDELINE FOR PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT FOR HYDRO POWER DEVELOPMENT

Prepared by ADB Consultant Team

Asian Development Bank

Information Guideline

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GUIDELINE FOR PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT FOR HYDRO POWER DEVELOPMENT

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ABBREVIATIONS

ADB	Asian Development Bank
CEMP	Contractor's Environmental Management Plan
DEC	Department of Environment and Conservation
DO	Dissolved Oxygen
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIR	Environmental Inception Report
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
FSL	Full Supply Level
GWh	Giga Watt hour
kV	kilo Volts
LARP	Land Acquisition and Resettlement Plan
MDS	Material Data Sheet
MSL	Mean Supply Level
MW	Mega Watt
PPL	PNG Power Ltd
SPP	Site Protection Plan
TWL	Top Water Level
WB	World Bank

1 THE HYDROPOWER GUIDELINE

1.1 INTRODUCTION

Papua New Guinea is entering into an era of rapid development which requires increased energy generation. There is large untapped hydropower potential within the country's water resources which if developed correctly will provide a long term, economic and renewable source of energy.

The guideline is intended to assist and guide prospective developers (and/or their consultants) to undertake environmental assessments of hydropower projects. The development of this guideline is based on significant field experience gained from working in hydropower development while the process shown here typically follows that used by multilateral lending agencies and in particular the Asian Development Bank[1].

This Guideline addresses the range of legislation and regulations that applies to the development of hydropower projects and associated activities from Levels 1 to 3. As the assessment of Level 3 activities requires the preparation of a detailed Environmental Impact Statement (EIS) the guideline principally addresses the preparation of the EIS, the EMP and monitoring program for Level 3 projects.

It is intended to provide hydropower development proponents, DEC and other stakeholders with a description of the range of possible potential environmental impacts arising from hydropower development. These will need to be considered within the EIS so that DEC can base its assessment and subsequent approval on the adequacy of the EIS.

1.2 LEGISLATION

Within PNG environmental activities are addressed by the *Environment Act, 2000* and the *Environment (Prescribed Activities) Regulation 2002* which defines three levels of activities from *Level 1* (low risk activities) to *Level 3* (high risk activities) which require differing degrees of compliance. These are categorised in the DEC *Information Bulletin Notification of Preparatory Work on Level-2 and Level-3 Activities, 2004*.

Two further Operational Procedures have been issued by DEC:

i. *Procedures for Permit Applications and Revised Procedures for Registration of Intent to Undertake Preparatory Work on Level-2 and Level-3 Activities, Nov 2012* and;

ii. *Information Requirements for Permit Applications and Registration of Intention to Carry Out Preparatory Work, March 2013*.

1.2.1 Level 1 Activities

No hydropower activities are listed as Level 1 activities. However, it may be assumed that maintenance activities of existing hydropower stations could be considered as a Level 1 activity. It is recommended that should PPL arrange maintenance of existing hydropower or thermal generation stations that an EMP

[1] Asian Development Bank. *Safeguard Policy Statement*, 2009.
Asian Development Bank. *Sourcebook for Safeguard Requirement 1: Environment*, 2010.

is prepared to guide the contractor carrying out the maintenance procedure. The EMP should be prepared to comply with DEC *Guideline for Preparation of an Environmental Management Plan, 2013.*

1.2.2 Level 2 Activities

For Level 2 activities the Nov'12 and March'13 procedures outline a two step procedure for undertaking Level 2 projects.

i. The first step (*Preparatory Work*) requires the proponent to register their intention (*Environmental Permit Application*) to undertake such an activity and submit a 1-2 page description of the preparatory works to allow DEC to determine whether a Permit is required to undertake the works. Schedules 1 and 2 of the March '13 Procedure contain outlines for completing an *Environmental Permit Application* which is to be lodged with DEC who will advise the proponent of the required *Level and Category*.

ii. The second step (*Activity*)

   a. for Level 2A projects the primary information requirement is an Environmental Management Plan. The EMP is to be prepared to comply with DEC *Guideline for Preparation of an Environmental Management Plan, 2013*.

   b. For Level 2B projects the proponent is required to prepare a baseline environmental study and an EMP together with a monitoring program. The outline for a Level 2B environmental study is given in *Schedule 3 General Guidelines on the Additional Information Required to Support a Permit Application for a Level 2B activity*. The EMP is to be prepared to comply with DEC *Guideline for Preparation of an Environmental Management Plan, 2013*.

The following activities are specifically covered in *Environment (Prescribed Activities) Regulation 2002*, under the following sub-categories;

Level 2 activities include both Level 2A (low risk) and Level 2B (higher risk) activities.

Level 2A activities include:

Sub-category 13: Other Activities

13.1 Damming or diversion of rivers and streams.

13.3 Abstraction or use of water for commercial purposes, except where such discharge is ancillary or incidental to, or associated with, any other activity in this Regulation in which case that category of activity will apply to the abstraction or use of water.

Level 2B activities include:

Sub-category 10: Energy Production

10.1 Operation of hydroelectric Plants with a capacity of more than 2 MW.

Sub-category 12: Infrastructure

12.6 Construction of electricity transmission lines greater than 10km in length.

1.2.3 Level 3 Activities

Level 3 activities contain a high degree of risk and the *Permit Application* requires a detailed study including the preparation of an *Inception Report* (scoping document), *Environmental Impact Statement* (EIS) and an *EMP*.

Details of how to prepare these documents are provided in the following DEC Guidelines:

i. *Guideline for Preparation of an Environmental Inception Report, 2004*.

ii. *Guideline for Conduct of an Environmental Impact Assessment and Preparation of Environmental Impact Statement, 2004*.

iii. *Guideline for Preparation of an Environmental Management Plan, 2013*.

Hydropower projects that are triggered by inclusion in *Level 3: sub-category 19 Infrastructure Construction* will be required to complete an EIS and include:

> *19.1 Construction of major hydropower schemes or water supply reservoirs inundating an area greater than 5km^2.*

1.2.4 Procedure and Application of Guideline

It should be noted that the Environmental Impact Assessment process and the EIS are key inputs, together with comments received from referral bodies and other stakeholders that will be used by DEC to assess whether or not a proposal is recommended for approval.

If information relevant to a *proposal* is *not supplied, the application may be rejected or its acceptance for assessment delayed until the required information is received in an acceptable form. Statutory approval for* a *project will only be granted if DEC is satisfied that the assessment and resulting EIS covers all relevant issues relating to all possible adverse impacts on the environment.*

Both Level 2 and Level 3 activities require the developer to first complete a *Notification of Preparatory Work on Level-2 and Level-3 Activities (DEC Publication: IB-ENV/01/2004* in accordance with *Section 48* of the Act. The *Notification* is submitted to DEC who will review the *Notification* and confirm to the developer whether the activity is a *Level 1, 2* or *3* activity and the required documentation to complete the application.

1.2.4.1 Level 1 Activities

i. For Level 1 activities; PPL is required to submit a statement to DEC requesting approval of the project or activity as a Level 1 activity together with an EMP[2].

ii. DEC will advise PPL either confirming the level and approving the activity/project, OR if DEC does not agree with the requested level, DEC will change this to a different level and advise PPL accordingly.

[2] For every level of project the EMP is prepared according to Section 10 of this guideline *The Environmental Management Plan*. An EMP prepared for a Level 1 project will not be as detailed nor as complex as an EMP prepared for a Level 3 project.

1.2.4.2 Level 2B Activities

i. For Level 2B activities PPL will be required to register their intention in an *Environmental Permit Application* to undertake such an activity and submit a 1-2 page description of the *Preparatory Works* to allow DEC to determine whether an *Environment Permit* is required to be issued by DEC to undertake the works. *Schedules 1 and 2* of the March '13 Procedure contains an outline for completing an *Environmental Permit Application.*

ii. The *Environmental Permit Application* is to be lodged with DEC who will advise PPL of the required *Level and Category*. Upon receipt of this PPL can advise the proponent to engage their consultant and start the assessment process.

iii. The second step (*Activity*) for Level 2B projects is for the proponent to prepare a baseline environmental study and an EMP together with a monitoring program. The outline for a Level 2B environmental study is given in *Schedule 3 General Guidelines on the Additional Information Required to Support a Permit Application for a Level 2B activity*. The EMP is to be prepared to comply with DEC *Guideline for Preparation of an Environmental Management Plan, 2013*.

1.2.4.3 Level 3 Activities

i. For Level 3 activities which contain a high degree of risk PPL will notify DEC (*Notification to Carry out Preparatory Works*) by providing the information required on pages 1 and 2 of *Notification of Preparatory Work on Level-2 and Level-3* Activities.

ii. DEC will confirm the level and if it considers that this is a Level 3 Activity will advise PPL to proceed. At this stage PPL can advise the proponent of the approval to commence who can arrange to mobilise their consultants to undertake a Level 3 Activity which requires an Environmental Impact Assessment process to be completed.

iii. The consultant commences the study by preparing an *Environmental Inception Report* (EIR) which acts as a scoping study that establishes the Terms of Reference (ToR) for the subsequent *Environmental Impact Statement* (EIS) and *EMP*.

iv. PPL submits the EIR to DEC who confirm or reject the EIR.

v. If the EIR is approved, PPL advise the consultant to prepare the EIS and the EMP.

vi. The EIS and EMP is submitted to DEC who arrange for the EIS and EMP to be reviewed and get the Minister's approval in principle to the EIS.

vii. DEC advise PPL of the requirements for public advertisement and consultation and following the successful completion of these tasks, DEC will issue an Environment Permit to PPL with conditions which will most likely contain monitoring requirements to comply with the EMP.

Details of how to prepare the documents required for an EIS are provided in the following DEC Guidelines:

i. *Guideline for Preparation of an Environmental Inception Report, 2004*.

ii. *Guideline for Conduct of an Environmental Impact Assessment and Preparation of Environmental Impact Statement, 2004.*

iii. *Guideline for Preparation of an Environmental Management Plan, 2013.*

The EIS must provide full documentation of all environmental and social issues and relevant mitigation measures in relation to the development activity. The EIS should substantially comply with this Guideline.

2 CONTENT OF THE ENVIRONMENTAL IMPACT STATEMENT

The Environmental Impact Statement (EIS) is developed according to the findings of the Environmental Inception Report (EIR) which is essentially a scoping document to prepare the Terms of Reference (ToR) for the following EIS study. Following the review and acceptance of the EIR by DEC the Proponent is advised of the scope of the study in the ToR. Accordingly the requirements of the EIR are addressed within the EIS. The contents of the EIS are listed in the order shown below and are described in the following sections:

- Executive Summary
- Introduction to the Project
- Objectives and Justification of the Project
- Institutional and Legal Considerations
- Description of the Project
- Assessment of Alternatives
- Characterisation of the environment affected by the Project
    - Physical Environment
    - Biological Environment
    - Social Environment
- Assessment of Environmental Impacts
- Mitigation Measures
- Environmental Management Plan
    - Monitoring Requirements
    - Institutional Arrangements
    - Costs of EMP
- Technical or knowledge gaps in the study
- Public Consultation
- Findings and Recommendations
- Conclusions

3 EXECUTIVE SUMMARY

The Executive Summary (ES) is to provide a brief explanation of the project's design, assessment of the main impacts and their mitigation. The ES should be non-technical and understood by lay persons. The ES is written at the completion of the study and condenses information already contained in the EIS. No new conclusions or material is to be introduced in the ES.

Information provided in the ES shall briefly describe the following:

- An opening paragraph providing a brief overview of the project including its location, rationale for development, basic design, generated energy, installed capacity and cost.
- Brief description of the design and its relation to the site conditions.
- Brief description of why an EIS is required and how the EIS was undertaken.
- Brief description of the physical, biological and social environments.
- Brief description of possible alternatives

- Brief description of main impacts and their proposed mitigation measures
- Comments on the content of the Environmental Management Plan including monitoring requirements.
- Issues raised by stakeholders and any outstanding issues
- Project costs including environmental costs.
- Findings and conclusions.

NOTE:
The Executive Summary should not be more than five pages in length and be prepared in English, Tok Pisln and Motu.

4 INTRODUCTION TO THE PROJECT

A brief introduction to the project is all that is required here, which provides some details of who is funding the project and who the EIS is being prepared for. A statement that an EIS is required and the process to date that the environmental assessment has progressed through which includes the preparation of Terms of Reference for the EIS from the scoping study carried out by the EIR. This concludes with an outline of the report structure and supporting annexes which includes the detailed Terms of Reference for the EIS.

5 BACKGROUND, OBJECTIVES AND JUSTIFICATION FOR THE PROJECT

This requires information on the following;

5.1 BACKGROUND TO THE PROJECT

Provide any details about previous studies and the current stage that the project investigations are at. Including whether it is a new project, expansion of an existing project or retro-fitting of an existing operation.

5.2 PROJECT OBJECTIVES

This can be quite a short statement advising what the overall objective of the project is addressing. It includes the general and specific objectives of the proposed project.

5.3 JUSTIFICATION FOR THE PROJECT

Clear reasons should be provided as to why the project is needed. Hydropower projects will generally be built to address a shortfall in energy generation and this needs to be quantified together with the expected growth in demand from the particular load centres and how the project will address this shortfall. It may be possible that the project will replace thermal generation. Show how the project will benefit surrounding communities and address economic development requirements of the region and Papua New Guinea.It must also address the following:

- that the development is in line with the Fourth National Goal and Directive Principle of the National Constitution of PNG,

- that the proposed development is compatible with National, Provincial and Local Level Government development goals and planning guidelines,
- it must detail the economic benefits to the Nation, Province, Local Level Governments and to the local community being impacted. and
- it must show that the development meets the objectives of Vision 2050.

5.4 PROJECT PROPONENTS

Names, addresses, contact telephone numbers of:

i. the developer (the Proponent – the organisation authorising the EIS) and

ii. the name of the organisation or consultant that prepared the EIS.

5.5 ORGANISATION OF THE EIS STUDY

- Description of how the study has progressed with regard to previous studies and the requirement for an EIS.
- The start and finish dates for the study including field work and ancillary studies including public consultation etc.
- Mapping and Imagery details. Show the sources of maps and imagery that has been used in the study.
- The organisation of the report including supporting annexes.

This section shall provide information on the multidisciplinary team that prepared the EIS. The professionals included in the team shall be appropriate to the type of project and the type of environment in which the project is located and may include (but not be limited to) engineers, architects, biologists, geologists, hydrologists, air quality experts, anthropologists, sociologists and economists. The following information is needed to be provided for each member of the EIS team.

- Names of each specialist who worked on the EIS together with the area of the EIS that the specialist addressed. Their qualifications and experience.
- Acknowledgements.

6 INSTITIONAL AND LEGAL CONTEXT

6.1 INSTITUTIONS

Define the institutions that will be involved with the project, during design and approval, construction and operation. This may apply to both the generation facility and the transmission line.

Separate these into:

6.1.1 Institutions with Direct Responsibilities

These will include institutions that have direct responsibilities for the design, supervision of construction and operation of the project. At the minimum this will include the organisation or government corporation responsible for promoting the project, the organisation that will own and operate the project, and the organisation that the EIS will be submitted to for approval.

Each of the organisation's roles in the project should be clearly stated.

6.1.2 Institutions with Indirect Responsibilities

It would be expected that there will be other organisations that may have an input into the approval of the project either during the design and feasibility stage of the project or they may have a role during construction and design. For example consider organisational responsibilities required during construction for obtaining permission to clear forests and open quarries and borrow pit areas.

6.2 RELEVANT LEGISLATION, REGULATIONS AND STANDARDS

This section of the EIS shall define the legal framework which the EIS must address to comply with relevant legislation and regulations. It will address legislation that any direct and indirectly responsible government organisations defined above will be responsible for. At a minimum it will include a review of the following:

i. Environmental Legislation including any associated Regulations that define the approval process and the requirements that the EIS must address together with any requirements for construction and operation
ii. Water legislation dealing with water use requirements.
iii. Any legislation that addresses the operation of electricity generation and distribution systems that contains environmental requirements.

Other legislation and standards that may be triggered by the project could include:

iv. Land acquisition compensation requirements and procedures.
v. Forest clearance
vi. Removal of aggregate for concrete making including the opening and closure of quarries, borrow pits.
vii. Noise, dust and vibration legislation including applicable PNG emission standards.
viii. Water quality standards.
ix. Cultural and heritage legislation.
x. Labour laws.
xi. Protection of Flora and Fauna.
xii. National Conservation Areas.
xiii. Guidelines and Codes of Conduct that may deal with storage of fuel etc..
xiv. International Covenants that PNG is a signatory to that may be affected by the project during construction and operation.
xv. Environmental requirements of any lending bodies; e.g. the World Bank, the Asian Development Bank, AusAID. Financial organisations who have arranged to finance the project who may have implemented the Equator Principles.

7 PROJECT DESCRIPTION

The project proponent shall submit a full technical description of the proposed project. A short paragraph should introduce the type of hydropower development i.e., run-of-river or reservoir storage design, the installed capacity of the project, the location of the project and the situation of the project with regard to topography, identification of the water resource to be used and its mean annual flow, and site access so

that the reader may have a brief introductory setting to the project's components within the physical environment. The physical environment will be explained in more detail in a later section.

Each of the project's components need to be technically defined. A good source of this material is the project technical design, parts of which can be carried across to the EIS. Depending on the actual technical design this may include a reservoir, but it will include penstocks, power house and tailrace. Describe if other water courses may be diverted to augment the flow to the powerhouse.

A description of each project component needs to be developed with regard to relevant environmental parameters so that the reader is able to focus on essential technical aspects of the design that need to be considered from an environmental viewpoint. These include:

7.1 DAM AND RESERVOIR

If a reservoir or headpond is to be used the dimensions need to be provided. This includes[3]:

- Length, width and depth (m) parameters of the reservoir together with area (km^2 or ha) and volume ('000 m^3) inundated at TWL[4].

Description of the dam, e.g. concrete gravity arch, earth filled, roller compacted concrete dam etc. Whether the dam is stand alone or is part of a cascade development. In particular provide information on quantities of excavated volumes as this material will need to be disposed of in spoil heaps or re-used e.g. as road fill.

- Provide top height[5] of dam embankment from river bed, base width, top width, length of top of dam embankment (m) etc..
- Provide details of equipment to be provided on the dam. Number of spillways, invert height of spillway. Spillway width x height. Method of spillway control e.g. curved roller gates (no. width x height). Bottom opening gates etc..
- Dam design: TWL (max design flood) with recurrence frequency. Height of flood relative to dam embankment height.
- Operational range of reservoir/headpond with heights, areas and volumes (m^3) of operations for Full Supply Level (FSL) = top of intake and Minimum Supply Level (MSL) = height of lowest operational water intake, i.e. the reservoir will not fall any lower than this level.
- Description of the "work in river channel" which may require a diversion tunnel and coffer dam.
- Any other features which may be built into the dam structure such as; log barriers, trash racks, fish passes, facilities to provide a downstream environmental release etc..

7.2 INTAKE STRUCTURE AND POWER HOUSE

Provide details of the penstock/s (pressure tunnel), number, type e.g. steel which may be buried or carried in a tunnel or may be built above ground. Hydraulic head, Dimensions; length, and cross sectional area, discharge capacity. If tunnels or canals are required provide details of length, width and m^3 of spoil that will be derived from the excavation.

[3] The parameters shown here are for guidance only. The actual design may employ other parameters and these should be addressed.

[4] Top Water Level = the area at spill height plus flood surcharge when the dam is passing flood flows over the spillway.

[5] All heights should be quoted to a constant base datum so that all of the project components can be related to one another.

Powerhouse details, whether aboveground or underground (if underground show the quantity of spoil to be removed including the access tunnels), installed capacity (MW), number of turbines and type of turbine. Mean annual energy production (GWh). Location of transformer area, exported energy voltage (kV).

Provide details of the tailrace and how this has been designed to reduce excessive discharge energy as the flow re-enters the main channel.

Determine whether there is any section (km) of the original channel that will be dewatered. If there is provide the length of the dewatered section.

A table that summarises the main project technical details should be provided. A suggested layout for a run-of-river project is shown below. For reservoir dams more detail will be required especially as regards the reservoir.

Project Item	Detail
Location	Intake: xx River, xx District, xx km east of xx Powerhouse: xxx River
Total Catchment Area to intake	xxx River: xx km²
Annual Mean Flow	x.x m³/s
Mean annual yield	xx Mm^3
Type of development	Run-of-river
Intake Elevation	xx m asl
Gross head	xx m
Diversion weir, height above river bed	xx m
Diversion weir, crest length	xx m
Diversion Weir, 100 year design flood	xx m³/s
Water tunnel	xxxx m long, also contains the xx kV transmission line cable
Water tunnel cross-sectional area	xx.x m^2
Penstock	xxxx m; buried xxx m, located within tunnel xxx m long. The xx kV cable is buried alongside the penstock
Powerhouse and transformer cavern	Underground. Excavated size xxxx m^3.
Installed Capacity	x units x xx MW Francis turbines = xx MW
Firm flow 52% (90% availability)	xx.x m^3/s
Design Discharge, both units at full load	xx.x m³/s
Tailrace	Xxx m x x.x m^2. Discharges to xx river. At full load discharge exits at x m/s.
Mean annual energy production	xxx GWh 2010 rising to xxx GWh from 2018 onwards
Transmission line	xxx kV: by underground cable from powerhouse to intake area switchyard. By xx km overhead cable carried on steel lattice towers from intake area switchyard to xx sub-station
New roads and access	i. Intake: xx – intake switchyard, x.x km Road tunnel - intake, xxx m ii. Powerhouse internal roads x.x km Serviced by xx m long concrete jetty at xx beach
Land required	i. Intake area: x.x ha; main office, switchyard and spoil areas

	ii. Powerhouse area: x.x ha, operator's, village workshops iii. Transmission line easement xx km x xx m wide = xx ha
Construction cost	US$ xx.x M
Construction time	x.x years – the water tunnel will require the longest construction time

7.2.1 Operation of Powerhouse

Show how the powerhouse will operate with regard to seasonal hydrology and requirements for peaking or base flow. Use a table to show the operation of the powerhouse with regard to mean monthly flow available at the powerhouse.

7.2.2 Operation of the Reservoir

Show how the reservoir level will fluctuate with regard to powerhouse operation. Use a table to show how this affects height, volume and area of the reservoir.

7.2.3 Project Operation on Downstream Hydrology

Show how the powerhouse releases will affect the downstream channel hydrology. Compare this to a "before project" and "after project" scenario. Include environmental flows in the assessment if required. For stand alone dams continue the assessment downstream until the next major inflow occurs so as to evaluate the effect of this inflow on modifying the altered release.

7.3 ACCESS AND SUPPORT FACILITIES

Access: describe the type of access required to the site as well as road infrastructure requirements for servicing construction (temporary) and operation (permanent) requirements within the project area. Show as required on the Locality Map and infrastructure connections on the Site Plan.

Describe the supporting facilities required for construction and operation including their location and size of worker camps and housing, water supply and source, sanitation, and electricity requirements and sources, workshops, storage areas, fuel stores (capacity in litres), concrete batching plants, sand and aggregate storage requirements (m^3) etc. Provide details of off-site facilities such as location and haul distances for quarries borrow pits and spoil disposal areas. Show these on a Site Plan.

7.4 PROJECT LOCATION

7.4.1 General Locality

Show on a map the general location of the project. This will be the General Locality Map and will be developed at a scale of ~ 1:100,000 or as appropriate to fit on an A4 sheet, together with UTM grid, north and scale. The General Locality Map is to show the following:

i. The location of the project site together with access road connecting to main feeder highways/roads. Any ports or harbours that may be used to bring in materials.

ii. Main topographical features using contour lines at say 50-100m intervals.

iii. Location of main administrative centres, together with boundaries for province, district, town or other relevant administrative units.

iv. Show the location of the water course together with the extent of the catchment above the dam-site or intake area.

v. Location of transmission line route to export energy from the site to the connection point[6].

vi. Any other features that may be required to demonstrate the interaction of the project site with the provision of services and significant environmental resources. This may include locations of quarries or borrow pits if these are at some distance to the project site and cannot be shown on the Detailed Location Map.

The EIS is also to provide supporting documentation as required explaining the location of the project within the general locality.

7.4.2 Detailed Location

A Detailed Location Map that shows the project features at a scale of ~1:5,000 – 1:10,000 should be provided on an A3 or for smaller projects A4 size sheet. The map should show the project layout and facilities together with the various infrastructure requirements to service the site. The map should show a contour interval of ~5m which will show where natural drainage will be directed to.

The EIS is also to provide supporting documentation as required explaining the requirements and location of the project facilities within the project site.

7.5 PROJECT CONSTRUCTION DETAILS

i. Provide a detailed schedule of construction activities together with start and finish times on a graphical chart.

ii. Show cost of project and source of funds.

iii. Provide a list of the main machinery required for construction. Identify which machinery will have the potential for excessive noise, vibration and dust producing characteristics.

iv. Calculate anticipated consumption of fuel and fuel storage facilities required as well as number of fuel deliveries required/week or month during construction to meet construction needs. Specify size of road tanker, fuel collection point, route and length of delivery.

7.5.1 Personnel Required during Construction

Provide number of personnel to be employed on-site including technical staff and non-technical locally recruited day labour. It must be shown how the technical and non-technical staff will be accommodated and provided for with regard to kitchens, washing and sanitation facilities. As personnel numbers will vary depending on the stage of the project vary, numbers need to be shown for each phase of the construction schedule.

7.5.2 Personnel Required during Operation

Show numbers of technical and non-technical staff to operate the powerhouse and facilities. Show facilities required to accommodate and support these staff.

8 PROJECT ALTERNATIVES

Where significant adverse impacts that are diverse, irreversible or unprecedented the proponent will examine alternatives to the project's location, design, technology, and components that would avoid or minimise adverse environmental impacts and risks.

[6]A significantly long transmission line will have its own impacts and may require a stand alone EIA study. The proponent will be advised by DEC if this is required.

All project alternatives that are reasonable and feasible and meet the purpose and need for the proposed project shall be identified, summarized and evaluated in this section of the EIS as appropriate. The rationale for selecting the particular project location, design, technology and components will be evaluated including cost benefit analysis of the various environmental costs and benefits.

Alternatives need to consider the following:

- Alternatives to design: e.g. use of thermal generation systems, wind power and solar energy options.
- Alternatives to location: normally hydropower sites are specific to the site to maximise the use of topographic features e.g. head and limiting the length of construction requirements e.g. embankment length, length of penstocks and tunnels.
- If the project is located within a conservation area or ecologically fragile area, the description of the alternative must include a clear justification for not opting for another site.
- The "No Project" alternative also needs to be developed. i.e. what will the consequences be of not building the hydropower project?

Identify which alternatives will be carried through the analysis in the EIS and the basis for that decision.

9 ENVIRONMENTAL SETTING

This section characterises the physical, biological and socio-cultural environments of the project. Each will have their own area of influence.

The study will be based on primary and secondary sources of data, including specialised studies that are supported by literature searches. All sources of data must be cited in the EIS.

This section shall describe the environmental setting of the project. Impacts of the project on these resources are not assessed in this section; they are assessed in the next section.

9.1 OBJECTIVES OF THE STUDY

Define the study objectives.

9.2 STUDY ORGANISATION

Show how the study was organised and the various study disciplines.

9.3 STUDY AREA

Define the study area for the physical, biological and socio-economic environments. The study area is defined as the area in which the impacts will be mainly experienced. This is generally easy to define for the physical and biological environments while the socio-economic impacts may cover a much wider area. Particular care needs to be taken with defining the land acquisition area and the affected communities within this area whereas wider regional and national socio-economic impacts can be assessed in less detail.

9.4 PHYSICAL ENVIRONMENT

Studies will define the following. The data will be presented as two assessments. (i) as a general overview of the area and (ii) in more detail for each of the particular components i.e. reservoir and powerhouse. If

the transmission line is included as part of the study a detailed assessment of the transmission line will also be required.

9.4.1 Topography

Provide a detailed description of the project area's topography which includes reference to the main topographic features that influence the project's environment. This should provide the reader with a clear understanding of the significant topographic features, from river valleys to mountains. For the project area and in particular the reservoir provide a breakdown of topography by elevation class (low, middle, high and mountainous). Also provide a slope assessment (flat, undulating, hilly, and steep) and discuss the implications of topography on the project.

Discuss the topography implications in terms of elevation and slope for each major component i.e. reservoir, powerhouse and tailrace and if required for the transmission line and access roads. Provide latitude and longitude references for the project.

Provide two maps showing (i) elevation classes and (ii) slope classes for the project area.

9.4.1.1 Aesthetic and Visual Resources

Describe and locate on a map any significant visual resources.

9.4.2 Geology

Provide a description of the area's geology and geomorphology. This can generally be summarised from the geo-technical reports that will be done for the project design.

9.4.2.1 Seismology and Slope Stability

Describe and locate various seismic features that have been identified and evaluate possible risk to the project as activity arising from the location of the project relative to plate tectonics. Provide an account of historic earthquakes together with accounts of damage and loss of life from these events.

Volcanic activity (must be provided by all the projects that are located within a radius of 30 km from an active volcanic emission centre)

- Indicate the general volcanic features of the area near the site
- Historical eruptions
- Period of recurrence
- Type of eruptions
- Affected areas and high risk areas

9.4.2.2 Geo-technical and Project Design Considerations

Describe project areas susceptible to landscape instability including: liquefaction; and areas of potential ground failure, such as subsidence, slumping, and land sliding. Determine if there is any karstic terrain located within the project area.

9.4.2.3 Mineral Resources

Locate on a map and discuss any mineral resources of the area together with their current status and planned, active, and abandoned mines.

9.4.3 Soil Resources

The EIS shall describe the soil resources of the project area, and make use of maps, tables and accompanying narrative text to describe the soils upstream, downstream and in the area of the project with regard to the main soil groups. Characterise the soil groups in terms of their location within the topography, profile description, internal drainage, soil chemistry, nutrient status and erodibility for both natural and disturbed situations.

9.4.4 Climate

Characterise the climate of the area in terms of a general climate description. Provide meteorological parameters; mean monthly rainfall, max and minimum monthly rainfall, max daily rainfall, no. of rain days; max temp, min temp; humidity; wind run and evaporation.

Provide source of data, location (Lat. and Long.) elevation of meteorological station and length of record for each meteorological parameter.

9.4.4.1 Air Quality

Discuss air quality at project site.

9.4.5 Water Resources

9.4.5.1 Surface Water Hydrology

Describe and locate on a map the length of the watercourse that is being utilized together with significant lower inflows that will help to mitigate the impact of the project. Also show and describe wetlands, lakes and reservoirs within the area of influence.

Describe the affected water course in terms of its physical and geomorphological characteristics (slope, width, depth, meander, waterfalls and rapids, bed characteristics and stability, etc). Show these features by river length (km).

Provide a table that shows the watercourses hydrological characteristics in terms of; mean monthly flow, max and min monthly flow (m^3/s) at the project site. Support the origin of this data by its source and reliability. Show the location of any gauging stations that have been used in deriving the data and indicate the length of record of the data and its reliability. For synthesised data show how the data has been derived and determine the confidence of the modelled data.

Discuss the river discharge regime and provide details of significant historic floods, year and month of their occurrence and resulting damage.

9.4.5.2 Surface Water Quality

Provide details of surface water quality sampling that may have been undertaken during the study. Show the location of the sampling areas on a map. Provide a summary of the water quality sampling and parameters measured which should include pH, dissolved oxygen, major ions, metals and nutrients. Include larger amounts of raw data in the appendices. Discuss water quality in terms of the various sampling parameters.

Describe the use of surface water by surrounding communities. Sources of pollution.

9.4.5.3 Groundwater

Describe the groundwater resources of the area with regard to depth to groundwater, quality of groundwater, use of groundwater by surrounding communities. Describe and map known inflow and emergent areas via caves and springs[7]. Provide details of any groundwater measurements to build up an account of the role of groundwater in the project area.

9.5 BIOLOGICAL ENVIRONMENT

The EIS shall provide detailed information on the location and condition of ecosystems in and around the project area in the form of narrative, maps and tables, including the following:

9.5.1 Vegetation/Flora

Describe the vegetation within the project area in terms of its vegetation communities which may include a range of dryland (forest, shrubland, grassland etc.), wetland and riparian communities, and cultivation and occupied areas. Define the communities in terms of its location with regard to habitat, floristic composition with a description of the main vegetation found within the community.

Note any particular species of conservation interest which may also be included within the IUCN Red Book. In particular note the presence of any primary forest that is included within the project area and whether this will be affected. Describe any species that may be threatened.

Establish the presence of any invasive species.

Determine community use of any vegetation systems for food or gathering of forest products.

9.5.2 Terrestrial Vertebrate Fauna

Characterise these as; birds, land mammals, bats, reptiles (snakes and lizards).

Establish if any of these are of particular conservation interest and are listed in the IUCN Red Book.

9.5.2.1 Wildlife Hunting

Establish the main wildlife hunted in the project area, the communities that undertake hunting and whether or not this is sustainable.

9.5.3 Areas of Conservation Importance

Determine whether there are any conservation areas or areas of significant ecological value that are located within the proximity of the project area. Name the area and give its area, together with the reason/s why the area has been designated for conservation, the organisation responsibility the area's management and its legal status. Locate any of these areas on a map.

Should significant areas be located within the project boundaries a competent assessment of the national park or conservation area needs to be carefully undertaken, which would include an assessment of the various floral habitats so that these may be assessed in terms of loss of habitat in the section on impacts.

[7] Karstic geology where groundwater intake or emergent areas are located will provide significant challenges to development of hydropower projects.

9.5.4 Freshwater Ecosystems

Define the main freshwater ecosystems that will be affected by the project. This could include:

- Surface rivers and watercourses
- Groundwater fed springs and subterranean aquatic systems.

Define the drainage pattern for these systems and determine whether these are closed or open systems.

Define the following:

i. Water quality as measured by a portable water quality meter used during the study; (temperature pH, DO, conductivity). Summarise the information in a table and discuss the results.

iii. Describe the various aquatic habitats found within the water course as benthic or surface aquatic systems.

iv. Describe the aquatic life found within the water course which may include; phytoplankton, macrophytes, zooplankton, macro invertebrates, macro-crustacea and fish. Other aquatic life may include reptiles and amphibians. Should karstic systems be involved an assessment of stygofauna may be required.

v. For fish species establish food sources and determine whether any of these have migration requirements for breeding.

vi. If the project is located on a coastal area, marine habitats and marine aquatic life will need to be described. This includes corals, marine fish communities, reptiles, mammals etc. Also identify any coastal breeding areas e.g. for turtles.

ii. Presence of any marine reserves which may be affected.

9.6 SOCIAL ENVIRONMENTAL SETTING

Provide the following information:

9.6.1 Population and Local Administration

Provide a description of the population of the various local administrative areas together with gender and age distribution. Show how the local government administration system is arranged. Identify those communities and the population that will be affected by the project.

9.6.2 Cultural characteristics

Ethnic composition, languages spoken, if applicable define traditional roles of village organisation, gender roles, religion and any other attributes.

9.6.3 Quality of Life

Most of this section will be built up from data collected in the field or from statistics. Quote sources of data. Provide data for the general area but provide more detailed information and comment for the project area, i.e. those communities that will be impacted by the project ("affected communities").

iii. Sources of employment (livelihoods and poverty). Formal and informal (traditional) sources of income for the affected communities

iv. Health; number and kind of medical facilities, numbers and kind of medical or health staff, adequacy of pharmaceutical supplies with regard to provision of medical and health services. Diseases in the project area. Details on HIV/AIDS. Sources of drinking water and sanitation.

v. Education; number and kind of facilities, numbers of staff and pupils, literacy rates.

vi. Access to electricity and communications e.g. roads, telephone and cell phone systems.

vii. Community organizations: skills, services and goods availability in the communities.

9.6.4 Cultural Values and Heritage Sites

9.6.4.1 Cultural Values

Define cultural systems as they affect social life and in particular describe any systems or beliefs that may have an impact on the project.

9.6.4.2 Heritage Sites

Define and locate on a map any cultural or heritage sites that may be located within the project area.

9.6.5 Land Ownership and Settlement

Describe the system of land ownership and traditional settlement within the communities. For each project component define the area to be acquired, the number of landholders affected and from which communities.

9.6.6 Use of Natural Resources

Describe how the local communities may use the surrounding natural resources. Land, forests (non forest products, wood fuel requirements, cultural or traditional uses of forests etc), wildlife, water and fish stocks.

9.6.6.1 Agricultural Systems

As the project will particularly require land resources it is important that the communities use of land is well developed. Describe the agricultural farming system, types of crops grown, the rotation system and its inherent sustainability, use of fertilisers, crop yields, main pests and diseases, crop marketing. Livestock raising systems and health etc. Fish farming etc.

9.6.7 Infrastructure

Describe the physical infrastructure serving the area, including

- Roads and their condition, airports or airstrips, harbours etc.
- Communications infrastructure including telephone and cell phone access.
- Locations of transmission lines (if applicable)
- etc.

10 ASSESSMENT OF IMPACTS

The EIS shall identify potential direct, indirect cumulative and induced impacts to the physical, biological, socioeconomic and physical cultural resources and determine their significance and scope in consultation with stakeholders. Where significant adverse impacts that are diverse, irreversible or unprecedented the proponent will examine alternatives to the project's location, design, technology and components that would avoid or minimise adverse environmental impacts and risks. Impacts are to be considered for the following situations:

i. The primary project site/s and related facilities that the proponent or the contractor may develop or control. This includes such items as power transmission corridors, canals, tunnels, roads, borrow pits, quarries, disposal areas and construction camps.

ii. Associated facilities that may not be owned by the proponent but are essential for the construction and operation of the project.

iii. Areas and communities that may be potentially affected by the cumulative impacts from further planned expansion of the project.

iv. Areas and communities that may be affected by impacts from unplanned but predicable development caused by the project which may occur in a different area.

The magnitude and frequency of potential impacts resulting from pre-construction, construction, operation and closure of the proposed project on the physical, biological, and social environments will be assessed and reviewed. The assessment of impacts must be undertaken in consultation with the various stakeholders.

Where appropriate, assessment shall use predictive methods, such as models (especially for reservoir water quality determination), to determine the specific range of impacts on environmental and socioeconomic resources. The EIS shall identify which impacts are significant and the criteria used to make this judgment.

Impacts will be determined for the input data provided in the previous section that established the project description and environmental setting. This date shall be used as the baseline upon which potential impacts are forecast. The EIS shall also identify sources of data used in the analysis and the uncertainties associated with the outputs of each method used.

Impacts are also to be considered with regard to whether the project may create disproportionate impacts on vulnerable groups of people and whether any trans-boundary impacts may result, both nationally or internationally.

The assessment of impacts, definition of mitigation measures and monitoring of the mitigation measure is the formative part of the Environmental Management Plan (EMP). Equally important is the allocation of responsibilities to mitigate and monitor the result of the mitigation measure.

Where impacts and risks cannot be avoided or prevented and impacts, mitigation measures and actions are to be identified to reduce or minimize adverse impacts so that the project is constructed and operated in compliance with applicable legislation and “best practices”. Mitigation measures are to be provided for each impact that has been identified. The project Proponent must include measures considered to be “best practices” in the design of all alternatives.

Key considerations includes the mitigation of potential adverse impacts to the level of “no significant harm to third parties”, the polluter pays principle, the precautionary approach and adaptive management. Should residual impacts remain, compensatory measures or offsets are to be considered, e.g. in replacing forest losses.

For each mitigation measure allocate who and which organisation will be responsible for implementing the measure. Also determine the timing of implementing the measure.

10.1 IMPACTS RESULTING FROM THE DESIGN/PRE-CONSTRUCTION PHASE

Activities that are scheduled for the preconstruction phase are dealt with here. These may also include assessment of the design that may need revision to reduce impacts.

Apart from identifying the impacts and outlining the mitigation measures, responsibilities for implementing the mitigation measures are to be identified.

10.1.1 Project Design Issues

This section describes issues that have been raised by the analysis and should be addressed by changes in design. These may include changes to location of the intake to ensure that it does not draw in poor quality water. Requirement for a gate for an environmental release, a fish pass etc.

10.1.1.1 Climate Change

Discuss any climate change predictions and likely possible changes that may affect the climate of the surrounding area or the design of the project.

10.1.2 Project Location Impacts

Location impacts will apply to the location of the reservoir area and the project components and the impact that these will have particularly on the socio-economic environment and to lesser extents on the physical and biological environments. Consider the following in the EIS.

10.1.2.1 Land Acquisition and Compensation Requirements

Specify the areas of land required for each project component including borrow pits and spoil dump areas. Land acquisition and compensation requirements would normally be determined by a specialised investigation such as a Land Acquisition and Resettlement Plan (LARP) which will categorise losses of private land and property including buildings, crops and tree crops. Show how the land and compensation requirements were obtained and summarise the costings for this. Outline procedures and responsibilities for acquiring sites that may have cultural significance. Allocate responsibilities.

10.1.2.2 Inundation Losses of Infrastructure

Check the reservoir inundation map and establish that losses of infrastructure that will occur from flooding have been satisfactorily mitigated in the design. E.g. access roads, transmission lines, etc.. If required re-address these in design.

10.1.2.3 Dewatered areas

Establish if there are any dewatered water course lengths and determine whether these can be avoided. Otherwise check that the design can allow downstream environmental releases to this area if required.

10.1.2.4 Other Location impacts

This may include location impacts concerning siting of the project components that result in losses of the following. For each loss identify the project component that causes the loss, together with the area or magnitude of the loss for any of the following[8]:.

[8] This is not an exhaustive list for impacts caused by design, construction or operation. Each EIS proponent will need to consider the situation as it applies to the specific project that is being analysed.

- Losses of conservation areas; losses for particular vegetation types including forests, wetlands, coastal mangroves etc.; losses of wildlife habitat for terrestrial species; loss of access for wildlife to feeding and breeding grounds; loss of landscape aesthetics especially from transmission lines, losses of mineral resources etc.
- Determine if there will be increased loss of any natural resources caused by improved access to the project site.
- Loss of access to communities that may now be denied access to their villages after the reservoir forms.
- Establish the risks to human communities of electromagnetic effects from the location of high voltage transmission lines.

10.2 IMPACTS DUE TO CONSTRUCTION

Define the length of construction and the sequence in which the construction activities are scheduled. For each activity define responsibilities for ensuring the mitigation measure is implemented. Should the contractor employ sub-contractors it is important that the contractor also assumes responsibility for sub-contractor actions.

Many of the mitigation measures that are shown below can be addressed by plans for the specific activities. These are shown at the end of this section on construction impacts. Outlines of the plans are required so that the contractor can develop these into detailed plans which are to be prepared by the contractor before commencing work[9].

10.2.1 Clearing of Vegetation

Clearing of vegetation and disposal would be addressed within a *Site Clearing Plan*.

10.2.2 Control of Invasive Species

Address possible introduction of aggressive invasive species by an *Invasive Species Control Plan.*

10.2.3 Site Excavation – Erosion and Sedimentation

Site erosion risk and protection is to be addressed by a *Site Protection Plan* (SPP). This would identify the erodibility risk of the soil and erosion parameters such as rainfall intensity, length and degree of slope and cover protection requirements. Outline procedures to protect excavated areas during construction.

10.2.4 Disposal of Spoil from Excavation Activities

Identify quantities and types of spoil to be produced from surface and subsurface excavation activities. Quantify those amounts that may be reused and those that will need final disposal. Determine whether there are any adverse chemical compounds within rock or soil waste that may require specialised disposal. Show where and how these quantities will be disposed. Address this within a *Stockpile and Spoil Heap Management Plan.*

10.2.5 Sources of Materials for Concrete Making

Identify requirements to make concrete and the source of sand and aggregate. Locate any project site sources and determine requirements and mitigation measures within a *Site Materials Plan* that includes methodology to close and rehabilitate the sites.

[9] Normally before commencing work the contractor is required to review and revise the EMP and submit these to the proponent for approval. The revised EMP with the contractor's work plans is normally referred to as the Contractor's Environmental Management Plan (CEMP).

10.2.6 Work in the Water Course

Establish the methodology for diverting the water course and working in the channel while the dam foundations are excavated. Determine quantities and where excavated spoil may be disposed of. Examine effects of turbidity on aquatic life and establish working procedures to address these issues.

10.2.7 Construction of Temporary Access Tracks

Determine mitigation measures to ensure that any temporary access tracks for construction activities including temporary access to transmission tower sites are safely constructed and stabilised. Include methodology for the stabilisation of access tracks within the *Stockpile and Spoil Heap Management Plan*.

10.2.8 Discovery of Artefacts

Determine procedures for preserving archaeological "discoveries" resulting from accidental exposure.

10.2.9 Storage and Handling of Dangerous Materials

Establish a procedure for the transport, storage and handling of notified Dangerous Materials. This includes fuel storage. Storage and handling of large quantities of fuel will need to be addressed by a *Fuel Handling Plan*.

10.2.10 Storage and Handling of Hazardous Wastes

Identify which materials are classified as hazardous materials. These would have a HAZCHEM rating and be accompanied by a Material Data Sheet (MDS). Using the MDS develop a plan the store and handle these materials together with the appropriate safety and training procedures for workers who may be required to handle these materials.

10.2.11 Management of Construction Camps and Workers

Establish how construction camps for contractor's technical staff and labour will be organised and managed with regard to location to avoid conflicts with neighbouring communities. Determine requirements for the supply of water and sanitation and how various types of camp waste will be handled and disposed of. Establish how worker access will be controlled with regard to exploitation of forest and wildlife resources. Prepare an *HIV/AIDS Awareness Program* for workers and the surrounding local communities.

10.2.12 Management of Construction Noise and Vibration

Establish impacts from blasting and vibration from impact machinery on workers and surrounding human and wildlife communities. Determine safe noise and vibration levels for workers, communities and surrounding buildings. Establish times when noise and vibration levels should be minimised. Incorporate safe work place standards for noise, dust and vibration in the *Worker Health and Safety Plan.*

10.2.13 Dust

Establish dust control procedures which may include spraying water on dust prone areas, covering transported loads with tarpaulins, reducing vehicle speeds. Consider impacts at "on" and "off-site" areas to ensure that workers and local communities are not affected. Incorporate safe dust standards and procedures for dust abatement within the *Worker Health and Safety Plan.*

10.2.14 Worker Health and Safety

Prepare a *Worker Health and Safety Plan* that identifies work related accident risks, exposure to work place dust, noise and vibration and their associated mitigation procedures. Address health requirements to ensure that workers remain healthy with regard to infections and diseases.

10.2.15 Community Health and Safety

Prepare a *Community Health and Safety Plan* to minimise harm to communities from the actions of the contractor during construction. This includes vehicle movements from both service and haul vehicles transiting villages. HIV/AIDS awareness also needs to be addressed within this plan.

10.2.16 Waste Management

Establish sources and types of waste, management and handling requirements for construction activities. Incorporate these measures in a *Waste Management Plan.*

10.2.17 Closing Construction Sites

Clearly state how the contractor will remove all machinery and waste from all construction sites and facilities on completion of the works or at the time of completing the project. Repairing damage to community access roads from construction activities will need to be addressed. Site closure and rehabilitation will be addressed by a *Site Rehabilitation Plan*.

10.2.18 Other Activities

List any other impacts and required mitigation measures from construction activities that may be required to be addressed.

10.3 OPERATION IMPACTS AND MITIGATION MEASURES

Discuss those impacts that are associated with the operation of the project. These may include:

10.3.1 Inundation Impacts from Flooding the Reservoir

Loss of land from inundation and compensation requirements which is a major issue has already been discussed as a location issue and is not needed to be discussed here again. Other inundation issues include:

- Define the reservoirs physical characteristics in terms of volume stored, depth and area for various seasonally determined operating conditions.
- Determine new seasonal flow regime in downstream areas.
- Sediment inflow to reservoir. Review reservoir sediment characteristics defined in the technical reservoir sedimentation study. Determine if increased human induced erosion in upper watershed will result in increased sedimentation within reservoir above and beyond the technical assessment. If warranted prepare a Watershed Management Plan.
- Determine the seasonal inflow to the reservoir and method of operation of the reservoir.
- Determine the overall retention time for runoff entering the reservoir and model the reservoir stratification.
- Determine water quality issues from stratification and from decaying vegetation[10] for the reservoir and downstream areas.

[10] The height of the intake to the turbines will need to be examined with regard to its position relative to possible stratification arising within the reservoir that may allow poor quality/anoxic water to be released downstream.

- Determine the impact on downstream human and biological communities from alteration of flow and changes in water quality.
- Determine the impacts on aquatic life including – changes to fish migration and changes in fish species and feeding habitats within a reservoir environment. Define if there will be improvements in fish productivity and catch and for its sustainability. Need for a fish program to restock the reservoir and develop fishing procedures.
- Possibility of the reservoir or lower areas of the water course becoming "infected" from translocation of invasive aquatic species, from connection to another "infected" watercourse or from non compatible species passing through the powerhouse to lower "uninfected" areas which may result in a adverse species change within the reservoir, and within upper and lower sections of the water course.
- Loss of vegetation – define vegetation losses within the reservoir and develop a reservoir clearing plan that will also help address the next item on water quality. Establish the amount of carbon that will be released from the reservoir from various clearing program strategies .
- Loss of wildlife habitat from flooding of forest, loss of nesting areas on point bars.
- Possible increase in water bird habitat.
- Increased incidence of water borne diseases.
- Changes in groundwater level alongside reservoir.
- Excessive loss of stored water from reservoirs with poor storage characteristics i.e. large shallow reservoirs.
- Inundation losses of mineral resources, cultural heritage areas, conservation areas etc.

10.3.2 Waste Management

Establish sources and types of waste, management and handling requirements arising from the operation of the power station and clearing of vegetation along the transmission line and access tracks.

10.3.3 Other Operation Issues

Include any other operation issues that need to be considered; e.g. clearing and maintenance of vegetation within transmission line RoW. Maintenance of access tracks to transmission towers, etc.

10.4 DECOMMISSIONING

State how long the project's useful life may be. Provide a brief account of the possible steps in decommissioning the project and dismantling the various project components. Identify any hazardous waste that may need to be disposed of.

11 THE ENVIRONMENTAL MANAGEMENT PLAN

The EMP includes the following sections[11].

i. Summary of Impacts and Mitigation Measures
    a. Impacts Resulting from Design/pre-construction
    b. Impacts due to Construction
    c. Impacts due to Operation
    d. Decommissioning

[11] This section is based drawn extensively on the following documents; the *Safeguard Policy Statement 2009* and *Environmental Assessment Guidelines ADB, 2003.*

ii. Environmental Monitoring
iii. Public Consultation Plan
iv. Implementation Arrangements
    a. Implementation Schedule
    b. Institutional and Organisational Arrangements
        i. Responsibilities for Mitigation and Monitoring
        ii. Reporting and Review
    c. Cost Estimates

11.1 SUMMARY OF IMPACTS

The assessment of impacts, definition of mitigation measures and monitoring of the mitigation measure is the formative part of the Environmental Management Plan (EMP). Equally important is the allocation of responsibilities to mitigate and monitor the result of the mitigation measure.

In this section identify and discuss those impacts that will provide moderate or major risks to the physical, biological and socio-economic environment. These will be impacts that are difficult to mitigate or may be irreversible and will need special attention during the preparation of the EMP. For each mitigation measure allocate who and which organisation will be responsible for implementing the measure. Also determine the timing of implementing the measure.

11.1.1 Mitigation Plans for Construction Activities

The following is a list of plans that may be required to address possible mitigation measures within the EMP. At the time of preparing the EMP the plans should provide sufficient detail for the contractor to evaluate their requirements at the time of bidding. When the project proceeds to implementation the plans will need to be developed in more detail for the contractor to implement them. Ideally the contractor would refine the plans as part of the Contractor's EMP (CEMP). Otherwise if the contractor lacks the capacity or experience to develop the plans then the contractor may need to employ an experienced environmental consultant to develop the plans to the standard required for implementation. The following is a list of the more likely plans that may be required in the EMP. The EMP would develop other plans as required to address particular requirements of the project.

i. SITE CLEARING PLAN: The objective of the plan is to clearly identify the area to be cleared and avoid excessive clearing of vegetation. It will require definition of areas of vegetation not to be cleared e.g. vegetation with high conservation value, buffer strips along water courses, etc. Show how the vegetation is to be disposed of after clearing – try and avoid burning and explore methods of allowing adjoining communities to collect and dispose of the material. Define methods for stripping topsoil and stockpiling it for later use in site rehabilitation.

ii. INVASIVE SPECIES CONTROL PLAN: where aggressive invasive species – both flora and fauna – may be present which may invade the area as a consequence of the project either from construction or operation, the plan is to address methods of controlling the inadvertent spread of these species by project activities.

iii. SITE PROTECTION PLAN. This plan would identify the erodibility risk of the soil and causes of erosion such as rainfall intensity, length and degree of slope and cover protection

requirements on the construction site. The plan may require the construction of temporary or permanent installations to stabilise areas to control erosion and prevent the delivery of sediment into waterways.

Where extensive roading is required design principles to establish stable drainage systems may need to be included and or evaluated in the design. Roadside drainage systems need to be evaluated with regard to their long term stability in terms of their length of slope and degree of slope and the stability of the outlet. Excessive lengths and slopes of bare earth channels should be broken up by increasing the number of outlets or stabilising the channels with non-eroding materials such as half section corrugated steel pipes or concrete lined channels[12].

iv. SITE MATERIALS PLAN: Quarry sites and borrow pits for sources of concrete making aggregate and gravels will normally be required. Both solid rock quarries and river floodplain gravel sites may need to be accessed and the SMP will need to develop procedures to access the area if it is held privately or in customary title. It will need to advise whether licences or approvals are required. Following completion of construction all quarries and borrow pits will need to be "closed" by being landscaped, topsoil being respread and revegetated.

v. STOCKPILE AND SPOIL HEAP MANAGEMENT PLAN: The objective of this plan is to identify methods to locate stockpiles so that they do not erode thereby preventing sediment entering watercourses. The placement of stockpiles must ensure that natural drainage channels are not restricted and that spoil heaps and stockpiles are constructed and maintained in a manner which ensures that they are stable. Following completion of construction the areas must be closed by rehabilitating the site. Access roads to any dump sites must also be closed and rehabilitated. Where access roads are to be closed and will no longer be used the road will need to be ripped by heavy machinery to remove soil compaction before being revegetated.

vi. SITE REHABILIATION PLAN: As work is completed in construction sites, quarry/borrow pit sites, and road batters, the Site Rehabilitation Plan will determine the methodology to be applied to these areas. Saving and stockpiling topsoil is an essential part of the plan together with recommendations for rehabilitating the disturbed sites including revegetation of exposed areas. Rehabilitation plans should be discussed with local landowners who may be able to undertake the rehabilitation and attendant revegetation work as a local community contract. The plan will also detail methodology to be used in closing work areas such as contractor's facilities which may require the removal of contaminated soil from fuel storage areas and workshop facilities.

vii. FUEL HANDLING PLAN: Where large quantities of fuel are to be stored on-site this plan will address the design of fuel storage areas so that spills are contained on-site. Fuel handling and transfer procedures for refuelling from mobile tankers should be addressed with regard to where refuelling operations can be safely undertaken. The plan will also need to address training of refuelling staff in fire safety procedures and spill clean up.

viii. WASTE MANAGEMENT PLAN: For all construction sites a Waste Management Plan is required to address the collection, handling and disposal of waste. This would address all wastes to be used on site including organic and inorganic waste and dangerous and hazardous

[12] Tipping rocks into eroded channels will not stabilize channels unless they are placed on a geotextile membrane.

wastes. Clean up procedures for handling spills of dangerous and hazardous wastes must also be addressed. Waste Management Plans must be compliant with national legislation.

ix. COMMUNITY CONSULTATION AND GRIEVANCE REPORTING PLAN: Consultation with local and provincial governments, communities and stakeholders along the project route or area is imperative as an absence of consultation often ends up with misinformation and miscommunication that can hinder project activities. Consultation must be carried out prior to the project commencing and this should be frequent throughout the life of the project.

To address these issues and the complex land ownership and cultural environments that often operate within the project area a Community Consultation Plan should be prepared for projects or situations where these issues will arise. The plan will develop methodology for delivering effective and participatory consultation to the affected communities. The plan will address the project's implementation and advise on issues that the project may cause or exacerbate by its construction and operation e.g. material sources which are identified during implementation, location of labour camps, recruiting labour, community safety where haul trucks may pass through villages, dust management within villages etc. Community consultation can also be used to facilitate dialogue in arranging small community based contracts for labour intensive work such as site clearing or rehabilitation. For these situations the plan would recommend that a specialised person be included within the Contractor's team structure and costed in the Bid offer to facilitate community consultation.

Grievance Reporting Mechanism: A grievance reporting mechanism should also be included as a part of the Community Consultation and Grievance Reporting Plan which provides a method for resolving community grievances or complaints, raised during the construction phase. Normally these would be raised first with the contractor. Should the contractor be unable to resolve the issue the issue is then passed to the next higher level which in most cases would be the PMU or if no PMU has been formed then directly to the Environmental Unit (EU) in the DoW for a decision. Complaints must be made and dealt with openly and without any fear of retribution to the person making the complaint.

If a reporting procedure has not already been prepared and approved by the EU the contractor is required to prepare a Grievance Reporting Procedure that establishes the steps for any person making a complaint. All complaints will be addressed by the contractor and recorded in a Complaints Register which will be kept on site[13]. will be reported in the contractor's monthly reports.

The contractor is responsible for implementing the procedure which includes maintaining the Complaints Register which is to be available to the public at the work site. The contractor will be responsible for ensuring that complaints are registered and dealt with according to the procedure.

x. COMMUNITY HEALTH AND SAFETY PLAN: this plan specifically addresses community health and safety issues in such areas as developing HIV/AIDS awareness, providing briefing

[13] *The Complaints Register should be triplicate book with the original of the complaint being returned to the person making the complaint. The duplicate being sent to the PMU or EU, and the triplicate being retained in the book. Both the duplicate and the triplicate should show the action that was taken as to how the complaint was resolved. At the end of the month the status of any complaints raised that month is addressed in the contractor's monthly report.*

on the increased traffic in their areas from contractor's vehicles, procedures to access the work site etc. The plan will also need to have a grievance redress mechanism in it for communities to be able to effectively raise health and safety issues with the project management. This is where a Community Liaison Officer will be able to resolve many of these issues as an intermediary between the community and the project management.

xi. WORKER HEALTH AND SAFETY PLAN: this will address requirements of the PNG labour legislation and provide methodology to mitigate possible adverse work place accidents and ensure a safe and healthy work place.

xii. WATERSHED MANAGEMENT PLAN: if it is possible that the watershed above the project may become compromised by logging or other activities that may lead to the watershed deteriorating a watershed management plan will be required. This plan will not be activated by the contractor but by the proponent.

11.2 MONITORING

For each mitigation measure identified the EMP is to provide a monitoring schedule that shows the following:

i. Activity with potential impact

ii. Proposed mitigation measure

iii. Responsibility for supervising and managing the implementation of the mitigation measure.

iv. The cost of mitigating the impact

v. The Parameter to be monitored.

vi. Frequency of monitoring and means of verification that the measure is achieving its result.

vii. Who is responsible for monitoring the parameter.

viii. The cost of monitoring the parameter.

11.2.1 Monitoring Program

The EMP will identify how the monitoring program will be organised throughout the life of the project and identify the position of the person within the organisation that will have the overall responsibility for supervising the program. Define whether any other organisations may have secondary independent monitoring roles to validate the data. Schedules and procedures to review the mitigation measures should be provided to assess after a period of time whether any of the mitigation measures are not responding in the way that the EMP predicted. Should this be demonstrated then the mitigation and associated monitoring requirements will need to be redesigned to accommodate these changes. Changes may also be needed in the monitoring program as parameters change or become irrelevant.

Prepare a matrix of the monitoring program that summarises the above eight parameters for pre-construction (design), construction and operation.

11.3 IMPLEMENTATION ARRANGEMENTS

This section defines the EMP implementation schedule and identifies the roles of the various organisations responsible for supervising the implementation of the mitigation and monitoring measures.

11.3.1 Implementation Schedule

Provide a schedule of the project's main phases (design and pre-construction, construction and operation) as a time based chart together with the main activities and show this in relation to the mitigation and monitoring activities.

11.4 ORGANISATIONAL ARRANGEMENTS AND ROLES

For each activity where mitigation and monitoring measures have been identified, identify who (a person within an organisation) and which organisation will be responsible for implementing the measure.

Responsibilities are then allocated between those organisation with primary direct responsibilities and those with indirect or secondary responsibilities.

11.4.1 Organisations with Direct Responsibilities

11.4.1.1 PNG Power

PNG Power (PPL)[14] will need to identify a management and organisational structure to manage the project including the environmental requirements, together with personnel to implement and supervise the EMP. If neither suitably qualified personnel nor a suitable management structure exists PPL will need to arrange to recruit personnel and establish the management organisation. For smaller projects it may be possible to arrange the supervision of the EMP by hiring an environmental consulting organisation. The management and reporting structure is to be included as part of the EMP [15].

Identify and define the roles of the those personnel who will be responsible for supervising the EMP[16] including the following personnel; the Project Manager, the Supervising Engineer, the Environmental and Social Safeguards Officer and any other appointments e.g. Community Liaison Officer etc., that are necessary to ensure the EMP is adequately supervised.

Provide an organisational structure showing the relationship of any environmental unit that may be formed within the overall PMU organisational structure together with the number of safeguard personnel so that lines of responsibility are clearly shown.

Provide a Statement of Duties for each of the social and environmental safeguard positions.

Examine each of the project activities with regard to legislative requirements and ensure that the EMP addresses all of the requirements that the project will need in terms of licences and approvals, during construction. Provide details of the legislation that applies to the activity and the organisation responsible for providing the approvals .

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[14] In this situation PPL is considered as being the "Proponent", however should another organization be responsible for implementing the EMP, PPLwill need to reallocate the roles as required between the other organization and PPL.

[15] The structure of the management unit is often referred to as a Project Management Unit or PMU. Within the PMU an Environmental Unit (EU) may be organized and depending on the project's scope and objectives the EU would contain at least one person responsible for supervising environmental compliance and normally another person to address social and land acquisition issues. For smaller projects one person may manage the requirements for both environmental and social issues. The Proponent is required to address the management organizational structure for implementing the EMP as a part of the EMP.

[16] Roles are normally defined within the persons ToR, e.g. the Project Manager's ToR should include a statement – *the Project Manager will be responsible for ensuring that the EMP is applied and satisfactorily implemented to meet the requirements of the EMP.* The Supervising Engineer may have the following included in their ToR … *the Supervising Engineer will be responsible for supervising and directing the Contractor to comply with the EMP.*

PPL will be responsible for ensuring that the EMP is attached to the Bidding documents so that the EMP requirements can be addressed and costed when the contractor bids for the project. This ensures that the cost of carrying out the EMP is included within the bid price.[17]

PPL will also need to review the contractor's bid and establish the following:

i. The contractor has addressed and costed the EMP.

ii. The level of specialisation and competence within the contractor's team to effectively comply with the EMP requirements. If the contractor is unable to meet these requirements and PPL wishes to proceed with the bid, PPL will need to consider training the contractor to build up capacity in environmental management and supervision of the EMP[18].

PPL will also be responsible for establishing the monitoring program requirements as set out in the EMP. Normally the contractor has the primary responsibility for monitoring the EMP which requires PPL to independently monitor the contractor's work.

PPL will submit regular reports as required to those organisations identified in the project management/loan agreement.

11.4.1.2 Contractor's Role

The contractor will have a major role in implementing the EMP during construction.

i. At the time of bidding the contractor is required to review the EMP, cost the program and advises on the number of safeguard staff to be appointed together with their experience and whether these are fulltime positions or not.

ii. The contractor is also required to include in the Bid the structure and experience of the work's supervisory team. Depending on the size of the project the contractor may include several positions for managing the EMP.

iii. Before construction commences the EMP is to be reviewed and re-issued by the contractor as a contractually binding document (the Contractor's EMP (CEMP)). The CEMP will address the impacts and their mitigation measures as shown in the original EMP. The CEMP will provide workable plans to comply with the EMP requirements. The second role of the CEMP is to identify staff within the contractor's project management organisation to supervise compliance with the CEMP including monitoring. The CEMP is submitted by the contractor to PPL for approval and is submitted prior to starting work. Work cannot commence until PPL have approved the CEMP. A copy of the CEMP may need to be sent to DEC to comply with their requirements.

iv. During construction the contractor will have the primary role of monitoring and supervising the CEMP.

[17] To ensure that the EMP is costed, (i) the EMP needs to be attached as a Specification in the Bid document and (ii) a budget line needs to be included in the cost of the bid where the cost of complying with the EMP is specified. Usually the Project Manager would be identified as the person with the primary responsibility for ensuring the EMP is attached to the Bid Documents. The Environmental Officer should also verify that this has been done before the Bid Document is released.

[18] As EMP compliance is a relatively recent requirement, contractors have often had little exposure to implementing an EMP. To familiarize contractors with EMP compliance requirements PPL should consider establishing a national training program for contractors in implementing the EMP requirements.

v. The contractor will be required to submit monthly reports to PPL showing how the CEMP is being implemented and monitored.

11.4.1.3 DEC Role

Define DEC's role in supervising the EMP. This may include approving the EMP and further roles in monitoring and auditing of the EMP.

11.4.2 Other Responsible Organisations with Indirect Roles

Identify other organisations who will be required to supervise the implementation of the EMP and determine their role.

Some of these organisations may have approval and implementation responsibilities for e.g. paying compensation for land acquisition as shown by the LARP, approving the clearing of forest land, extraction of gravel from rivers and opening quarries, etc.. The role of these supporting organisations need to be clearly established so that at the time of implementing the EMP there are no surprises in not having the necessary approvals in place.

For projects that may be financed by multi-lateral agencies such as the ADB and WB an assessment of the organisations capacity to effectively undertake their roles may be required. If capacity needs to be strengthened, a capacity building program needs to be identified and costed.

11.4.3 Financier's Role

Define the financier's role in addressing any requirements in the EMP. For multilateral lending agencies specific reporting and monitoring procedures may be required to meet the agencies lending conditions.

Where funds have been sourced from private lending institutions, *Equator Principles*[19] can be expected to apply.

11.4.4 Reporting and Review

This section of the EMP identifies the reporting requirements to meet the needs of the PPL, DEC and possibly the financier.

Normally reports will be generated from the contractor to PPL as monthly reports that show progress as to how the CEMP is being implemented and includes the contractor's monitoring reports.

PPL will normally aggregate the contractor's monthly reports into a quarterly report and together with its comments forward these as required to the financing organisation and possibly DEC.

11.4.5 Cost Estimates

Collect all of the costs of the EMP in this section. Include costs of staff and support services, costs for implementing the mitigation measures and costs of monitoring. Present these in a table for each budget year. Calculate the cost of the EMP budget as a percentage of the total project budget cost.

[19] The Equator Principles (EPs) are a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making.

This concludes the EMP.

12 TECHNICAL AND KNOWLEDGE GAPS

Provide details of any knowledge gaps that may have occurred as a result of the study.

13 PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

Provide details of public consultation that has been undertaken by the proponent to advise stakeholders of the project and to include their comments in the project design.

Public consultation should occur at least twice during the project assessment. The first should be undertaken after the Scoping Report has been prepared to accommodate any comments in the subsequent EIS. The second public consultation should be undertaken after the Draft EIS has been prepared to allow any comments to be incorporated in the Final EIS.

Provide a table that shows; date of meeting, number attending together with names, title and gender of participants, comments received and response given to the comment.

14 FINDINGS AND RECOMMENDATIONS

Present a summary of the main findings and recommendations of the EIS.

15 CONCLUSIONS

Present a brief conclusion stating that the EIS has addressed the main environmental issues and that there are no other issues that remain unresolved and accordingly the EIS can be implemented as presented.

16 REFERENCES

Submit a list of all references, (books, articles, technical reports and other information sources) cited in the various chapters of the EIS study citing the title of the publication, author, year, source, and publisher.

17 ANNEXES

Attach any data that is essential to support the EIS but is too bulky to be included in the main body of the EIS.

Also include any maps, plans, charts and figures that are too bulky to be included in the main body of the report.

18 COPIES TO BE LODGED.

The proponent is required to provide ten (10) copies of the environmental impact statement during

lodgement of the application to enable the Director of Environment to assess the statement is compliant with *Section* 54 of *Environment Act, 2000.*

Lodge the above submission with:

Director of Environment
Department of Environment and Conservation.
P.O. Box 6601, BOROKO, National Capital District,
Papua New Guinea.
Attention: Executive Director
Environment Protection Division

Maps, plans and diagrams should preferably be presented in colour for ease of interpretation. The report should be presented in PDF format.

An electronic copy of the complete report should also be provided.

18.1 LETTER OF TRANSMITTAL OR COVER LETTER

It is important that the Environmental Impact Statement is transmitted to DEC with a cover letter signed by the responsible company official or its authorised representative (i.e. consultant - engaged by the company to act on its behalf).

If an external consultant is used, the letter must also authorise the consultant to make statements and provide further information on behalf of the company in relation to the application.

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APPENDIX 1: TABLE OF CONTENTS FOR EIS FOR HYDROPOWER PROJECTS

A general Table of Contents for the Environmental Impact Statement (EIS) is provided here. The Table of Contents shall be organized in such a manner as to facilitate the use of the EIS by reviewers and project implementers. EISs for larger projects may have a more detailed Table of Contents than those for smaller projects. Depending on the magnitude and design of the project the Table of Contents may include the following:

ACRONYMS AND ABBREVIATIONS

EXECUTIVE SUMMARY

1. INTRODUCTION TO THE PROJECT
2. BACKGROUND, OBJECTIVES AND JUSTIFICATION FOR THE PROJECT
   - 2.1. Background To The Project
   - 2.2. Project Objectives
   - 2.3. Justification For The Project
   - 2.4. Project Proponents
   - 2.5. Organisation of the EIS Study
3. INSTITUTIONAL AND LEGAL CONTEXT
   - 3.1. Institutions
     - 3.1.1. Institutions With Direct Responsibilities
     - 3.1.2. Institutions With Indirect Responsibilities
   - 3.2. Relevant Legislation, Regulations and Standards
4. PROJECT DESCRIPTION
   - 4.1. Dam And Reservoir
   - 4.2. Intake Structure and Power House
     - 4.2.1. Operation of Powerhouse
     - 4.2.2. Operation of the Reservoir
     - 4.2.3. Project Operation on Downstream Hydrology
   - 4.3. Access And Support Facilities
   - 4.4. Project Location
     - 4.4.1. General Locality
     - 4.4.2. Detailed Location
   - 4.5. Project Construction Details
     - 4.5.1. Personnel Required During Construction
     - 4.5.2. Personnel Required During Operation
5. PROJECT ALTERNATIVES