FINAL REPORT

Nam Ngiep One Power Company

NNP1 Transmission Line from the Main Dam to Vientiane

Initial Environment Examination

February 2016

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EXECUTIVE SUMMARY

The Nam Ngiep 1 Power Company Limited (NNP1PC) is developing the Nam Ngiep 1 Hydropower Project (NNP1) with assistance from the Asian Development Bank (ADB). The distribution of electricity from NNP1 will require the development of a 230 kV transmission line to transmit electricity from the Main Dam site to Nabong collector substation in Vientiane Capital. The transmission line will extend a length of 125 km, with a required 35 m right of way.

An Initial Environmental Investigation (IEE) was undertaken for the transmission line in 2012 by Environmental Research Institute, Chulalongkorn University (ERIC). Since this time, the alignment has been revised based on new information available on the social and environmental constraints surrounding the alignment. The Project Area for the revised alignment includes the alignment right of way (extending 125 km with a width of 35 m) and access roads with a total length of approximately 8 km. This document presents a revised IEE based on the revised alignment, currently available information and comments received from the ADB on the 2012 IEE. This document:

- *identifies the main environmental and social resources of the areas in and adjacent to the proposed transmission line;*
- *identifies the nature of potential adverse impacts that could occur from the construction and operation of the Project; and*
- *outlines mitigation measures to avoid and/or minimize such adverse impacts.*

Preparation of the IEE involved: desktop review of available information, including the 2012 IEE, documentation related to other NNP1 project components, satellite imagery and mapping for the project area; and a two day site reconnaissance visit in January 2014.

Consultation has been undertaken with stakeholders along the transmission line corridor. This has included meetings with to Provincial and District representatives and local villages. The meetings provided an opportunity share (or disclose) information about the transmission line, including potential impacts and proposed management measures, as well as gain feedback from stakeholders. A key part of the consultation process has been to identify existing land uses, infrastructure and culturally significant sites along the transmission line corridor, in order to incorporate this information into the corridor selection process and avoid where possible. Consultation findings have been incorporated into the development of this IEE.

The IEE has been prepared in consideration of the requirements of the Lao PDR Department of Electricity and Ministry of Natural Resources and Environment for the preparation of environmental assessments, as well as in accordance with the ADB Environmental Safeguard Policies.

Baseline Social, Physical and Biological Environments

The proposed transmission line is located on the western bank of the Nam Ngiep river. The northern portion of the alignment is located in a mountainous area, while the southern and western portions are located in the relatively flat Mekong Lowlands.

The area around the proposed transmission line includes 24 villages. These villages share a number of similar characteristics. Houses within these villages tend to be situated alongside the river, in this case the Nam Ngiep, or beside roadways in clusters.

Land cover mapping indicated that approximately two thirds of land within the RoW consists of fallow land (both young and old) and rice paddies. Some areas of agricultural plantations and slash and burn also exist.

Land cover mapping indicated that approximately a third of land within the proposed Project Area is natural habitat, dominated by deciduous forest, with small areas of swamp, bamboo forest, scrub/heath and evergreen forest.

A critical habitat assessment was undertaken to identify if the Project Area provided critical habitat for IUCN listed species, nationally listed species or migratory species. Based on vegetation mapping and consultation with species specialists the assessment identified that the transmission line Project Area is unlikely to be associated with habitat considered to be critical habitat for these priority biodiversity values.

Potential impacts

The IEE identified potential impacts on the social, physical and biological environment for the design, construction and operation phases. The IEE identified the following impacts as requiring management through the design, construction and operation of the Project:

- ***Hydrology*** *– potential impacts to surface flows due to earthworks and in-stream works;*
- ***Water quality*** *– potential degradation of water quality due to erosion and sediment run off, hazardous materials and domestic sewage waste;*
- ***Air quality –*** *potential reduction in air quality due to dust and vehicle emissions;*
- ***Noise and vibration*** *– potential disturbance to people and fauna due to construction noise pollution and ongoing noise emissions from transformers and transmission line;*
- ***Biodiversity*** *- permanent loss of habitat, disturbance and displacement of species, creation of barriers to fauna movement, degradation of habitat due to*

edge effects and fragmentation, and fauna mortality. In general the significance of these impacts to biodiversity and priority biodiversity values was considered to be minor or negligible.

- ***Land Use*** *– temporary and permanent clearing of productive land, and changes to allowable uses of land within the RoW;*
- ***Economy and livelihoods*** *– potential employment opportunities during construction and operation of the Project;*
- ***Damage to property*** *– potential damage to property including houses, farmlands, aquaculture ponds, and irrigation canals;*
- ***Community health and safety*** *– potential increase in risk of disease transmission, road accidents and flood damage during construction, and health risks resulting from electromagnetic radiation, noise and herbicide use during operation;*
- ***Occupational health and safety*** *– risk of accident and injury while working, and risk of disease transmission;*
- ***Culture and customs*** *– potential for social conflict between workers and local communities;*
- ***Physical heritage*** *– potential damage to unidentified heritage items/places; and*
- ***Traffic*** *– potential temporary disturbance to traffic during construction.*

Mitigation measures

Refinement of the transmission line alignment can minimize the impacts to biodiversity, land use and community health and safety, however some risks will remain. Mitigation measures have been develop for implementation during the design, construction and operation phases to further minimize and manage risks to local communities and the environment. The measures set out in the IEE will guide the development of a more detailed Environment and Social Management and Monitoring Plans for the construction phase to be developed by NNP1PC and the construction contractor, prior to the commencement of construction.

To manage the potential for community grievances, NNP1PC have established a grievance redress mechanism (GRM) for the NNP1 Project (including the transmission line). The GRM involves a series of committees including a Village Grievance Committee, District Grievance Committee, and Provincial Grievance Committee. In the instance that the grievance cannot be resolved through the committee structures, redress can be sought through the Court of Law. The GRM has been communicated to stakeholders.

1 INTRODUCTION

The Nam Ngiep 1 Power Company Limited (NNP1PC) is developing the Nam Ngiep 1 Hydropower Project (NNP1) with assistance from the Asian Development Bank (ADB). The distribution of electricity from NNP1 will require the development of a 230 kV transmission line to transmit electricity from the Main Dam site to Nabong collector substation in Vientiane Capital.

An IEE for the Nam Ngiep1 Transmission Line Project (the Project) was compiled by the Environmental Research Institute, Chulalongkorn University (ERIC) in association with The National Consulting Company (NCC) in 2012. Since this time, the alignment has been revised, new information has been obtained, and comments on the previous IEE have been received from ADB. This report presents a revised IEE to reflect the current preferred alignment and available information.

The scope of the Project is the construction of the 230 kV transmission line between the Main Dam site and the Nabong collector substation, and the associated access roads.

Information and data used in this IEE are based on review of available documentation, site visits, regulations, current baseline data available for the project, analysis of geospatial datasets (mapping) and inputs provided by the NNP1PC engineering team.

1.1 PURPOSE OF THE STUDY

The Laos PDR Department of Electricity (DOE) requires electricity development projects to prepare an Environmental Assessment and obtain official approval from the Ministry of Natural Resources and Environment (MONRE) prior to commencing any activities that may impact the environment. The DOE requires the Environmental Assessment to:

- Outline the proposed Project's environmental impacts on physical, biological, socio-economic and cultural environments; and
- Define measures to prevent or mitigate any adverse environmental effects expected from the design, construction, operation and closure of the Project.

In order to achieve this requirement, this report:

- identifies the main environmental and social resources of the areas in and adjacent to the proposed transmission line;
- identifies the nature of potential adverse impacts that could occur from the construction and operation of the Project;

- provides an initial examination of the magnitude, scale, and significance of the identified potential impacts; and
- outlines mitigation measures to avoid and/or minimize such adverse impacts.

1.2 DEFINITION OF THE PROJECT AREA

The transmission alignment is approximately 125 km in length with a required 35 m wide 'right of way' (RoW) to be established. In addition, access roads are required to facilitate the construction and maintenance of the transmission line. For the purposes of this study the Project Area is defined as the area required for the RoW and access roads, as shown on *Figure 2-1*. It is acknowledged that not all of the RoW will be permanently cleared or disturbed given that the infrastructure consists of the establishment of intermittent towers with other clearing for safe operation and maintenance.

1.3 APPROACH

The study consists of three main components:

- A description of the existing environment in the Project area. This involves review of exiting baseline environmental data available associated with the proposed alignment. Particular focus is given to the data and description of baseline conditions that are important to the prediction of impacts and to the determination of measures to avoid and/or minimize anticipated adverse impacts;
- An evaluation of impact levels and feasible mitigation measures. This study used standard methods that follow acceptable EIA procedures for the preliminary evaluation of impact levels for each environmental aspect. Where impacts were quantifiable or had the potential to be observable, measures to prevent or minimize such impacts were identified; and
- Preparation and presentation of the IEE report.

1.4 KEY TERMS

Key terms used in this report are provided in *Table 1-1*.

Table 1.1 Key terms used in document

Term	Meaning
NNP1	The NNP1 Hydropower Project
the Project	The 230kV Transmission Line Project as described in *Section 2* of this report.
Project Area	The area required for the RoW and access roads, as shown on *Figure 2-1.*

1.5 *STRUCTURE OF THIS REPORT*

This report is structured in eleven chapters:

- *Chapter 1* provides an introduction to this document and the Project, including the purpose of this document, approach to the study and the legal and administrative framework governing the Project;
- *Chapter 2* describes the Project, and it is this description that forms the bases of the impact identification;
- *Chapter 3* describes the environmental baseline, including physical, biological and social resources;
- *Chapter 4* identifies potential impacts of the Project during the construction, operation and rehabilitation phases, and outlines measures to mitigate these impacts;
- *Chapter 5* outlines the alternative Project scenarios that have been considered, and the relative environmental and social impacts of these scenarios;
- *Chapter 6* describes the information disclosure and consultation process planned for the Project;
- *Chapter 7* outlines the grievance redress mechanism for the Project;
- *Chapter 8* provides an Environmental Management Plan (EMP) to address the identified impacts;
- *Chapter 9* provides an indicative budget for the implementation of the EMP; and
- *Chapter 10* provides a conclusion and general recommendations.

1.6 *LEGAL AND ADMINISTRATIVE FRAMEWORK FOR ENVIRONMENTAL AND SOCIAL PROTECTION IN LAO PDR*

One of the main principles of the Nam Ngiep 1 Hydropower Project (NNP1) is to ensure that the Project conforms to the environmental and social statutes and policies of the GOL, and relevant local government standards. This IEE has been prepared in conformance with these statutes, policies, directives and procedures.

The Project is also to conform to international treaties to which the Lao PDR is signatory, to standards and safeguard policies of the Asian Development Bank (ADB), and to the Equator Principles. Where there is overlap in GOL and international standards, the most stringent standard will be used. In the case

that a less stringent standard is used, justification will be provided within this document or other relevant documents.

1.6.1 *National Laws And Decrees*

The key laws and decrees relevant to environment assessment and protection issues for NNP1 are:

- The Law on Environmental Protection (1999);
- The Law on Water and Water Resources (1996);
- The Forestry Law (2007);
- The Wildlife and Aquatic Law (2007);
- The Land Law (2003);
- The Electricity Law (2008);
- The Decree on Environmental Impact Assessment (2010);
- The Decree on State Land Lease or Concession (2009);
- The Decree on Compensation and Resettlement of People Affected by Development Projects (2006);
- The Technical Guidelines on Compensation and Resettlement of People Affected by Development Projects; and
- The Decree on the Environmental Protection Fund.

Environmental Protection Law (1999)

The Environmental Protection Law (National Law 02/99) (EPL) was approved by the President on April 3, 1999. This law provides a legal framework for environmental management of development projects. It establishes the framework for unified environmental management with the aim of preserving the environment and making rational and sustainable use of natural resources. The sustainable use of natural resources is to contribute to the national socio-economic development and to the guaranteed health and improved quality of life of the people of Lao PDR. The Ministry of Natural Resources and the Environment (MONRE), previously the Water Resources and the Environment Administration (WREA), which was formerly the Science Technology and Environment Agency (STEA), is responsible for the implementation of EPL. While other ministries issue guidelines for implementing provisions of the EIA and of environmental protection, it is MONRE that is responsible for review of the EIA and that will issue the environmental compliance certificate.

Governmental Decrees, Regulations, and Standards relevant to the EPL are:

- The Implementing Decree of 2002, which provides the legal tool for implementation of the law, and
- The Environmental Management Standard of 2001, which stipulates the minimum environmental standards to develop a project.

MONRE has also developed a set of regulations for conducting the EIA of proposed hydropower projects (2000 and 2001). These regulations and standards establish general impact assessment requirements, including a timing of the EIA in the Project development cycle. They stipulate detailed project screening, initial Environmental Examination and Environmental Impact Assessment requirements, including content and format of reporting, and approval of the report.

Law on Water And Water Resources (1996)

The Law on Water and Water Resources (1996) is intended to assure sustainable water use through policies related to ownership, preservation, use and management of water and water resources. It establishes a basis for classifying water according to use, defining catchments, and setting requirements for EIA for any 'large scale uses', inclusive of construction of water reservoirs for the purpose of irrigation, consumption, and energy production. In this respect the law mandates the requirement for the current EAMP work and should necessitate a review of the Environmental Assessment and Management Plan (EAMP) among the appropriate groups within GOL. The Water Resources Committee under the Prime Minister's Office administers the Water Law and is responsible for the review and evaluation of EIAs related to use of water resources.

Amended Lao Forestry Law (No.06/Na-Dec.2007)

The Amended Forestry Law, No 06/NA (Dec. 2007) stipulates the basic principles, regulations and measures concerning forest conservation, management, and use. It aims to make the forests and forestland a stable source of livelihood and use for the people, by ensuring sustainable preservation of water sources, preventing of soil erosion and maintaining soil quality, conserving plant and tree species and wildlife species, preserving the environment, and contributing to national socio-economic development.

The Amended Forestry Law (2007) confirms that natural forests and forestlands are the property of the national community and that these are centrally managed by the State. The State can grant individuals or organizations the right to plant and own trees. Forests are classified into three general categories: Protection Forest, Conservation Forest (or National Biodiversity Conservation Areas), and Production Forest. Each category of forest is designated a different and distinct zone and area, within which there

can be rich or dense forest, degraded forest, bare forestland and village use forest according to each zoning plan.

Conversion of public forestland to another land use type is only possible when allowed if it is to bring maximum benefits to the nation and to the wellbeing of people and is included in the national socio-economic development plan. Such conversion is only allowed in designated areas. Entities given approval for forestland conversion are responsible for paying fees for technical service, royalties and conversion fees. For temporary conversion such as mining exploitation and other production activities, the land must be restored and trees must be replanted. If the State converts the forestland, which is allocated to individuals or organizations for agreed upon and determined purposes, the State shall compensate according to laws and regulations. For permanent forestland conversion into another land use type for long-term purposes, such as for roads or hydropower construction, the State owns the timber and forest resources that are cut or harvested in those forests or forestlands.

The law stipulates which administrative authorities have the right to approve conversion of degraded forestland that cannot naturally regenerate or of barren forestland. While district, municipal, or provincial authorities can approve conversion of smaller areas of forestland, the conversion of more than 100 ha to 1,000 ha of degraded forestland per activity and of more than 200 ha to 10,000 ha of barren forestland per activity must be approved by the government, through proposals by the National Land Management Authority and agreement by the Ministry of Agriculture and Forestry and the Provincial Agriculture and Forestry Office. The National Assembly Standing Committee must endorse the conversion of forestland greater than those amounts (1,000 ha of degraded forestland or 10,000 ha of barren forestland).

Wildlife and Aquatic Law, No 07/NA (2007)

The Wildlife and Aquatic Law regulates the management, monitoring, conservation, and protection of wildlife and aquatic species in their natural habitats. Wildlife and aquatic species living within the territory of the Lao PDR are considered property of the national community, with the State representing the national community in managing those species. If an individual or organization has permission to raise and reproduce any of these species, it is then considered their own property so long as they abide by the laws and regulations.

Wildlife includes both terrestrial and aquatic life, and all forms of animal life, whether mammals, birds, reptiles, amphibians, or insects. Wildlife is classified into three categories for protection: 1) prohibition, 2) management, and 3) common or general. Whether species are classified as prohibition or management depends upon the level of threat to them (endangered, threatened, rare), the condition of their habitat, and the condition of their regeneration and reproduction. The Ministry of Agriculture and Forestry recommends to the government for consideration and approval the list of

species under the prohibition and management categories. The Ministry of Agriculture and Forestry has authority to include or remove species itself from the list of animals in the common or general category.

Land Law (2003)

The land law was enacted on October 23, 2003. The law determines the management, protection and use of land to ensure its efficient use and to conform with land-use objectives, with other laws and regulations, to contribute to national socio-economic development, and to contribute to the protection of the environment.

Electricity Law (2008)

The Electricity Law No 03/NA dated 8 Dec 2008, requires a license for the generation and transmission of electricity. The Law also requires that:

- EIAs be prepared for at least the larger hydroelectric dams, along with budget estimates for environmental mitigation measures;
- Transmission lines and related activities are done in such a way as to limit any damages to natural environment and people's property; and
- The concessionaire is required to pay compensation for damages to the environment and to the lives and property of people, if any resettlement or other movement of people is required.

Prime Ministerial Decree No. 112/PM on Environmental Impact Assessment (2010)

The 2010 Prime Ministerial Decree No. 112/PM established the procedures and guidelines for conducting Environmental Impact Assessments in Lao PDR. It stipulates the rights of those affected by projects, including their rights of participation. The decree outlines the process, both for WREA (now MONRE) and the developer of projects, of conducting the EIA, preparing environmental management and monitoring plans, social management and monitoring plans, issuing environmental compliance certificates, monitoring compliance with the various plans, and establishing the institutional framework for implementing the EIA of the Nam Ngiep 1 Hydropower environmental and social components of projects, and for hearing and deciding on grievances of affected parties.

Decree on State Land Lease or Concession (2009)

The Decree on State Land Lease or Concession, dated May 25, 2009, establishes the principles, procedures and measures for the leasing or providing concessions of land, for purposes of development for agriculture, industry, tourism, and other activities.

Among the obligations of those leasing or obtaining a concession are that they should not cause damages to the land quality, nor cause negative impacts to the environment or society.

Decree on Compensation and Resettlement of People Affected by Development Projects (2006)

The Decree on Compensation and Resettlement of People Affected by Development Projects defines the principles, rules, and measures to mitigate adverse social impacts and to compensate for damages that may result from involuntary acquisition or repossession of land and of fixed or movable assets, including changes in land use and restrictions to access of community or natural resources, which would affect sources of community livelihood and income. This decree aims to ensure that people affected by a project are compensated fairly and are assisted in ways to improve or maintain their pre-project incomes and living standards, so that they are not worse off than they would have been without the Project.

Technical Guidelines on Compensation and Resettlement of People Affected By Development Project (2005)

Pursuant to Prime Ministerial Decree No. 112/PM, GOL endorsed the Technical Guidelines on Compensation and Resettlement of People Affected by Development Projects, first issued in November 2005. These guidelines were initially adopted under the Decree on Compensation and Resettlement of People Affected by Development Projects in 2006, and have now been endorsed and promulgated as official GOL policy and procedure for the assessment, planning, and mitigation of environmental as well as social impacts from development projects.

These guidelines include detailed procedures for the conduct of public consultation and other participatory processes, to inform affected people of the environmental and social impacts, and to assure their involvement in all aspects of the mitigation and compensation process, from planning to implementation.

Decree on the Environmental Protection Fund (2005)

This Decree defines the principles, rules and procedures for the organization and operation of the Environmental Protection Fund (EPF). The fund is to finance eligible activities that can strengthen environmental protection, sustainable natural resources management, and specifically, biodiversity conservation and community development in Lao PDR. Among the objectives of the EPF are to implement chapter V of the Environmental Protection Law, Article 47 of the Forestry Law, and Article 15 of the Decree to Implement the Law on Water and Water Resources. Sources of funds for the EPF are grants and loans from domestic and foreign entities, State budget, development

projects and other activities, and interest or benefits accrued from investing the EPF endowment.

Key Provisions of Lao PDR Laws and Decrees Pertinent To Environmental Aspects of The NNP1 Project

The table below provides a brief summary of the key provisions of the various laws and decrees of the Lao PDR, as they relate to the environmental components of the Project.

Table 1.2 Key Provisions in the Laws, Decrees and Regulations of the Lao PDR Pertinent to the EIA of the Nam Ngiep 1 Hydropower Project

Law or Decree	Article	Relating to	Content
Constitution of the Lao People's Democratic Republic (1991, amended 2003)	Article 17	Environment in general	"All organisations and citizens must protect the environment and natural resources: land, underground, forests, fauna, water sources and atmosphere."
Environmental Protection Law (1999)	Article 5	Environment in general	Conservation takes priority over mitigation and restoration. Socio-economic development planning must include planning for environmental protection.
	Article 8	EIA Process	MONRE is main agency to issue regulations for EIA. People affected by projects, mass organizations, and local administrations are to be involved in the EIA process.
	Article 10	Responsibility of those engaged in development works	Those engaged in development works must adhere to safeguards, and to standards and regulations issued by GOL agencies.
	Article 14	Responsibility of those engaged in development works	Those engaged in development works must abide by laws on land, forests, water, etc.
	Article 16	Responsibility toward cultural, historical, natural heritage sites	Those engaged in development works must abide by laws and regulations to protect such heritage sites.
	Article 22	Pollution control	All are responsible for control of pollution, and applying technologies appropriate to control such pollution.
	Article 23	Hazardous wastes / emissions	Restrictions to hazardous wastes and means to control such wastes and emissions.
	Article 28	Damage to environment	Those causing damage to environment are responsible for repair through appropriate GOL agencies.

Law or Decree	Article	Relating to	Content
	Article 38, 39	Local environmental management and monitoring	Stipulates responsibilities of local administrations (provinces, municipalities, special districts, districts) to establish environmental management and monitoring units.
	Article 40	Local environmental responsibilities	Stipulates responsibilities of village administrations to follow environmental regulations.
Water and Water Resources Law (1996)	Article 4	Rights to use water resources	Defines rights, obligations, and procedures to gain approval for use of water resources.
	Article 18	Permission for use	Stipulates that medium and large scale uses require feasibility studies, EIAs, and mitigation plans, before permission is granted for use of the resource.
	Article 22	Principles in water resource development management	Stipulates that water resource development must be consistent with national and sector plans, must ensure preservation of the natural beauty of the resources, and must protect against harmful effects of water.
	Article 25	Promotion of Watershed and Water Resource Protection for Hydropower Development	Stipulates that 'hydropower projects must be developed with due concern for environmental protection, flood protection, water supply, irrigation, navigation, fisheries and others."
	Article 29	Water and water resource protection	Requires that water resources be protected from becoming spoilt, polluted, or drying up, and that forest and land resources be protected to help protect the water resources.
Lao Forestry Law (amended 2007)	Article 5	Policy on forest and forest land	The GOL has the policy to preserve, regenerate, and develop forests and forest land to help preserve the environment, water resources, biodiversity, and people's livelihoods.
	Articles 9 to 13	Forest types	Classify the various types of forests according to use, including forests for village use.
	Article 26	Preservation of water resources in forest zones	Stipulates the preservation of water resources in forest zones for those areas where waterways originate and flow, including strict management and regulations to control logging, shifting cultivation, and destructive forest uses.
	Article 70	Conversion of forestland	Stipulates that forestland can be converted to other land type if it brings a high level of benefits to the nation and to livelihoods of the people, and is included in the national development plan.

Law or Decree	Article	Relating to	Content
	Article 71	Types of converted forestland	Stipulates that for uses such as dam construction, the timber and forest resources to be harvested in those areas are property of the State.
Wildlife and Aquatic Law (2007)	Article 31	Use for Household purposes	Allows use by village households of wildlife and aquatic species in the common and general category list in particular seasons or permitted areas, using tools or equipment that do not adversely affect habitats or compromise the species population.
	Article 32	Customary Use	Allows use of wildlife or aquatic species in the common and general category list by village households for "necessary cultural beliefs".
	Article 52	Prohibitions	Prohibits taking of wildlife, including parts of the animals, from their habitats; tormenting wildlife and aquatics; illegal catching, hunting, trading and possession; catching aquatic and hunting in conservation zones, in breeding season, or when pregnant; devastation of habitats and feeding zones.
Land Law (2003)	Article 6	Protection of Land and Environment	Declares that all individuals and organizations are obliged to protect the land from degradation.
	Article 14	Changes in Land Category	Land use can be changed if it does not cause social or environmental harm and if prior approval is obtained from the authorities.
Decree on Land Lease or Concession (2009)	Article 39	Obligation of Person or Legal Entity Who Leases or Obtains Concession	The person or legal entity who leases land or obtains a concession is obligated, among other things, "not to cause any damage to the quality of land and negative impact to the natural environment and the society".
Electricity Law (1997)	Article 6	Environmental Protection	Stipulates the need to assess the impact of electricity enterprises on the natural environment, ecological system, society and wildlife habitats
	Article 13	Feasibility Study	Requires a feasibility study and indicates the contents to be included in such a study.
	Article 14	Environmental Impact Assessment	Requires an environmental impact assessment and indicates the contents to be included in such an assessment
	Article 18	Obligations of Concessionaires	Includes the obligations to protect the environment and to pay compensation for any damage to the environment, or to the lives and property of people, or for resettlement.
	Article 27	Transmission Lines	Installation and construction of electricity transmission lines to be done in ways to limit damage to environment and to people's property

Law or Decree	Article	Relating to	Content
Prime Ministerial Decree No. 112/PM on Environmental Impact Assessment (2010)		Stipulates the need for Environmental Impact Assessment	Stipulates rights of those affected by projects, and need for participation. Outlines the process of conducting the EIA, preparing environmental management and monitoring plans, social management and monitoring plans, issuing environmental compliance certificates, monitoring compliance with the various plans, establishing the institutional framework including grievance procedures.
Decree on Compensation and Resettlement of People Affected by Development Projects (2006)		Establish the procedures for compensation and resettlement for project affected people	Defines the principles, rules, and measures to mitigate adverse impacts and to compensate for damages that may result from involuntary acquisition or repossession of land and of fixed or movable assets, including changes in land use and restrictions to access of community or natural resources.

1.6.2 *International Treaties*

The Lao PDR is party to several major international environmental treaties, which oblige it to abide by conditions of those treaties. Among those potentially relevant to this project are:

Convention on Biological Diversity

The government of the Lao PDR accepted the Convention on Biological Diversity in September 1996. Under this convention, the Lao PDR accepted several obligations, among them the establishment of protected areas, management of those areas, identification of key components of biological diversity, monitoring of those key components, increase public awareness and participatory management of biodiversity, and assessment of proposed projects that could have an adverse impact on biological diversity. The Prime Minister Decree 164 of 1993 to establish National Biodiversity Conservation Areas, the Environmental Protection Law of 1999, the Wildlife and Aquatics Law of 2007, and the Amended Forestry Law of 2007 were all enacted in part to meet the obligations of the Convention on Biological Diversity.

In 2004, the Lao PDR prepared a Biodiversity Strategy to 2020 and Action Plan to 2010. Recognizing the importance of hydropower for national development, the strategy and action plan found that most hydropower projects to date did not take adequate measures to assure protection of biodiversity. Issues of particular concern were that:

- Watershed management and protection is currently inadequate;

- Hydropower development often results in reduced forest cover, wildlife habitats and biodiversity resources;
- Dam construction has a direct impact on fisheries and local income, especially in downstream areas;
- Some hydropower construction has occurred without prior detailed studies;
- The resettlement of the local people can have a direct and indirect impact on biodiversity;
- Dam construction changes the natural water flow; and
- The compensation schemes for lost land and property are not clearly defined according to different scale. (Science, Technology and Environmental Agency, National Biodiversity Strategy to 2020 and Action Plan to 2010, STEA, GOL:2004, p.35)

The report recommends addressing these issues through several options:

- Ensure that hydropower development takes social and environmental concerns into consideration;
- Manage and protect forests in watershed areas;
- Effectively enforce relevant laws and regulations; and
- Ensure that environmental and social impact assessments are effectively applied for hydropower projects. Promote effective and economical energy use, as well as the utilization of renewable energy. (Ibid)

Convention on Climate Change

Having ratified the Convention on Climate Change in January 1995, the Lao PDR is obligated to mitigating greenhouse gas emissions. Of concern to this project are the possible impacts of the reduction of forest area, the emission of greenhouse gasses from organic matter in the reservoir, the development of renewable sources of energy, and the promotion of sustainable forms of agriculture.

Agreement on The Cooperation For Sustainable Development Of The Mekong River Basin

In April 1995, the Lao PDR ratified the Agreement on the Cooperation for Sustainable Development of the Mekong River Basin. This agreement, between the countries of Cambodia, Lao PRD, Thailand and Vietnam, established the Mekong River Commission and formed the basis for the joint management and development of the water resources of the Mekong River and its tributaries.

The four signatory countries agreed "to cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin including, but not limited to irrigation, hydro-power, navigation, flood control, fisheries, timber floating, recreation and tourism, in a manner to optimize the multiple-use and mutual benefits of all riparians and to minimize the harmful effects that might result from natural occurrences and man-made activities." (Article 1)

Key provisions that concern this project are:

- "To promote, support, cooperate and coordinate in the development of the full potential of sustainable benefits . . . and the prevention of wasteful use of Mekong River Basin waters . . . through the formulation of a basin development plan . . ." (Article 2);
- "To protect the environment, natural resources, aquatic life and conditions, and ecological balance of the Mekong River Basin from pollution or other harmful effects resulting from any development plans and uses of water and related resources in the Basin." (Article 3);
- In cases of utilization of waters "On tributaries of the Mekong River, . . . intra-basin uses and inter-basin diversions shall be subject to notification to the Joint Committee." (Article 5, Paragraph A);
- "To cooperate in the maintenance of the flows on the mainstream from diversions, storage releases, or other actions of a permanent nature . . ." (Article 6); and
- "To make every effort to avoid, minimize and mitigate harmful effects that might occur to the environment, especially the water quantity and quality, the aquatic (eco-system) conditions, and ecological balance of the river system, from the development and use of the Mekong River Basin water resources or discharge of wastes and return flows." (Article 7).

Agreement on International Trade in Endangered Species of Wild Fauna And Flora (CITES)

The Lao PDR joined the Convention on International Trade in Endangered Species of Wild Fauna and Flora (or CITES) in March 2004, with it coming into force on 30 May 2004. The Wildlife and Aquatics Law of 2007 includes provisions that meet the obligations of the Lao PDR to CITES.

Inter-Governmental Agreement On Regional Power Trade In The Greater Mekong Sub-Region

The Inter-Governmental Agreement on Regional Power Trade in the Greater Mekong Sub-Region between Cambodia, China, Lao PDR, Myanmar, Thailand and Vietnam sets the framework for electricity development and

trade among the countries of the sub-region. The agreement is based on principles of:

- Cooperation: That issues related to regional interconnection be handled in a spirit of cooperation and mutual benefit, that the Parties have equal rights and obligations, act in solidarity, and refrain from taking advantage of one another;
- Gradualism: That the Parties consider the progressive development of regional electricity trade; and
- Environmentally Sustainable Development: That regional electricity trade is operated within a framework of respect for the environment. (Article 2, Paragraph 2.2).

1.6.3 ADB Environmental Safeguard Policies

Funding for the project is expected from the Asian Development Bank (ADB), and the ADB's Safeguard Policy Statement (SPS) and associated Safeguard Requirements apply to the project. The objectives of the SPS are to avoid, or when avoidance is not possible, to minimize and mitigate adverse project impacts on the environment and affected people, and to help borrowers strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

The Environmental Safeguard Requirements include requirements for:

- environmental assessment as prescribed in ADB's SPS;
- preparation of an Environmental Management Plan (EMP) to manage unavoidable impacts;
- meaningful consultation with affected people;
- establishment of grievance redress mechanisms;
- monitoring and reporting activities;
- planning for unanticipated environmental impacts;
- Biodiversity Conservation and Sustainable Natural Resource Management;
- pollution prevention and abatement;
- health and safety; and
- physical cultural resources.

The NNP1 Project is classified as a Category A project, which requires full environmental assessment of the potential negative and positive impacts and assessment of alternatives, recommended mitigation measures, and participation of the affected people and other stakeholders.

The key environmental concerns of the ADB as noted in its policy that need to be addressed in the NNP1 project EIA are: deforestation and land degradation, biodiversity loss, aquatic resources, water pollution, and climate change.

Of particular relevance to NNP1 are the requirements for Biodiversity Conservation and Sustainable Natural Resource Management. The Safeguard Policy includes requirements for operating in areas of modified, natural and critical habitat, and legally protected areas. The following standards are an extract from the ADB SPS:

A. Modified Habitat

25. In areas of modified habitat, where the natural habitat has apparently been altered, often through the introduction of alien species of plants and animals, such as in agricultural areas, the borrower/client will exercise care to minimize any further conversion or degradation of such habitat, and will, depending on the nature and scale of the project, identify opportunities to enhance habitat and protect and conserve biodiversity as part of project operations.

B. Natural Habitats

26. In areas of natural habitat,[3] the project will not significantly convert or degrade such habitat, unless the following conditions are met:

(i) No alternatives are available.

(ii) A comprehensive analysis demonstrates that the overall benefits from the project will substantially outweigh the project costs, including environmental costs.

(iii) Any conversion or degradation is appropriately mitigated.

27. Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post-project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity.

C. Critical Habitats

28. No project activity will be implemented in areas of critical habitat[5] unless the following requirements are met:

(i) There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.

(ii) The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species[6] or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.

(iii) Any lesser impacts are mitigated in accordance with para. 27.

29. When the project involves activities in a critical habitat, the borrower/client will retain qualified and experienced external experts to assist in conducting the assessment

D. Legally Protected Areas

30. In circumstances where some project activities are located within a legally protected area, in addition to the requirement specified in para. 28, the borrower/client will meet the following requirements:

(i) Act in a manner consistent with defined protected area management plans.

(ii) Consult protected area sponsors and managers, local communities, and other key stakeholders on the proposed project.

(iii) Implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected area.

1.6.4 *Equator Principles*

Private Banks cover a large amount of the financing for international development. Initiated by several of the world's largest banks, the Equator Principles were established to assure that borrowers from the private banks for development projects abide by similar environmental and social standards as those applied by the World Bank, the ADB and other international financial institutions. The Equator Principles incorporate the International Finance Corporation's Environmental and Social Performance Standards. Of particular relevance to the environmental aspects of the NNP1 project are the need and means for biodiversity conservation and sustainable natural resource management, and pollution prevention and abatement. More than 60 of the world's leading banks have adopted the principles, which require them to stop lending if the borrower is found not to abide by the processes.

As with the ADB, projects deemed to have potentially great environmental impact, such as dams, are classified as Category A projects. These are required to have social and environmental impact assessments, adequate consultation with project affected people and local organizations, and adequate

management and grievance mechanisms, similar to those required by the ADB.

Some of the environmental issues of concern in the Equator Principles that relate to the NNP1 project are:

- protection and conservation of biodiversity, including endangered species and sensitive ecosystems in modified, natural and critical habitats, and identification of legally protected areas;
- sustainable management and use of renewable natural resources (including sustainable resource management through appropriate independent certification systems);
- use and management of dangerous substances;
- major hazards assessment and management;
- consideration of feasible environmentally and socially viable alternatives; and
- pollution prevention and waste minimization. (The Equator Principles, July 2006, Exhibit II: Illustrative list of potential social and environmental issues to be addressed in the Social and Environmental Assessment documentation, p.7).

These issues are not considered exhaustive, but indicative of the types of issues to be addressed.

1.6.5 *World Bank Group Environment Health and Safety Guidelines*

The World Bank Group Environment Health and Safety (EHS) Guidelines were developed to define applicable standards for projects involving members of the World Bank Group, however, the guidelines can provide useful guidance to all projects. The EHS Guidelines define performance levels and management measures that are generally considered to be achievable in new facilities by existing technologies at reasonable costs. The EHS guideline for Electric Power Transmission and Distribution identifies the following potential risks associated with transmission line Projects, and provides guidance on the management of these risks:

- Terrestrial habitat alteration, including construction and maintenance, risk of wildfire, avian and bat collisions and electrocutions;
- Aquatic habitat alteration;
- Environmental impacts of electric and magnetic fields;
- Hazardous materials;

- Health and safety risks relating to live power lines, working at heights, electromagnetic fields and exposure to chemicals; and
- Community health and safety risks, including electrocution, electromagnetic interference, noise and ozone, and aircraft interference.

2 DESCRIPTION OF THE PROJECT

2.1 PROJECT OVERVIEW

The 230 kV transmission line for NNP1 will extend for approximately 125 km, connecting the powerhouse at the Main Dam site with the Nabong collected substation. The design will involve approximately 291 towers, based on criteria design of tower ruling spans of 430 m for 230 kV lines.

Many types of linear infrastructure, such as roads and railways, are limited by physical constraints such as steep gradients and wide river crossings; however transmission lines afford considerably more flexibility. Preliminary route selection for the design of transmission lines was based on a review of 1:50,000 scale topographic maps and ground surveys. The consideration and selection of the transmission line route was based on engineering principles together with environmental concerns for the locations of towers, ground clearance and slope, geological condition for foundations and other obstructions. Alternative routes considered are discussed in *Section 5.1*. *Figure 2-1* shows the overall layout of the Project.

2.2 PROJECT COMPONENTS

The following sections outline the components of the Project including the RoW, the transmission line, transmission towers, access roads and worker camps. No quarries will be required, as rocks will be purchased from suppliers and aggregates made by batcher plants. No spoil areas are required as excavated material will be used for backfill and embankments at tower sites. Refer to *Figure 2-1* and *Table 2-2* for the location and dimensions of Project components.

2.2.1 *Right of Way*

During construction, the construction footprint will be confined to within a 35 m wide RoW, except for the construction of external access roads required in remote parts of the RoW. During construction and operation, vegetation below 3.0 m will be retained within the RoW where land is not required for tower footprints or access.

Preliminary route selection for the design of transmission lines was based on a review of 1:50,000 scale topographic maps and ground surveys. The consideration and selection of the transmission line route was based on engineering principles and environmental factors, such as slope, geological condition for foundations and other obstructions. Key aspects considered included:

- For maximum safety, minimum construction cost and effective material use the alignments were created as straight as reasonably possible between the

start and end points of the transmission lines, as well as between tower spans;

- Wherever possible, the alignments were located relatively parallel to an existing road or right-of-way of existing transmission lines, thereby facilitating access for construction, operation and maintenance, and reducing the need for new land clearance and disruption to people;
- Distance from residential areas (in particularly houses and other built up areas) to minimize relocation or resettlement;
- Distance to valuable lands or social, religious or culturally important lands, particularly village forest conservation areas, village cemeteries, and agriculture lands;
- Distance to mature forests and other environmentally sensitive areas, especially the Phou Khao Khoay NBCA, and eco-tourism sites;
- Line reliability (ie. minimal risk of outage and ability to repair); and
- Costs were also considered (ie. through route length minimisation, ease of construction and maintenance).

Based on these criteria, the alignment has undergone a number of revisions as further information on environmental and social constraints has become available. Alternative alignments are outlined in Section *5.1*. The alignment is expected to undergo further refinement following more detailed ecological assessments to be undertaken.

2.2.2 *Transmission Line*

The proposed transmission line comprises 230 kV, 50 Hz, 3 phases, double circuit line on self-supporting lattice steel structures, using 1272 MCM ACSR/GA conductor with one 3/8 inch nominal diameter high strength grade galvanized steel ground wire and one 24-core OPGW. The work for this transmission line includes:

- installation of the tension insulator sets at Gantry and the lead-in to the switchyard equipment at the Nam Ngiep; and
- supply and installation of optical OPGW and joint box for the OPGW at the nearest towers or Gantry at switchyard of the Nam Ngiep Power Plant and Nabong substation.

Ground Clearance

The most severe state for ground clearance of conductors could occur when the conductor's temperature rises to 75°C under still air conditions. For this

Project, the minimum heights of the conductors above ground are specified in *Table 2-1.*

Table 2.1 Minimum Specification for Heights of Conductors

Minimum vertical clearances	High (m)
Streets/highways	10.0
Cultivated areas, ground accessible by vehicles	8.4
Ground accessible to pedestrians only	8.4
Crossing navigable river (above maximum water surface)	11.5
Telecommunication lines	5.2
Distribution lines 33 kV and shield wires	3.5
Power lines	5.8

Side Clearance

For any portion of the transmission line that has another transmission line running parallel to it, side clearance required between two transmission lines shall be:

- Between 115 kV and 230 kV transmission lines 12 + 20 meters from center line to center line;
- Between 230 kV and 230 kV transmission lines 20 + 20 meters from center line to center line;

2.2.3 *Transmission Towers*

Transmission towers for the Project are self-supporting lattice steel structures. Two types of suspension towers will be used, with heights of 46.78 m and 46.18 m. Tension towers will have a height of 46.04 m. The total footprint for tower construction will be approximately 101.9 ha, however during operation the footprint will be limited to 2.4 ha of hardstand area. Plans of the transmission tower designs are shown *in Annex A*.

2.2.4 *Access Roads*

In flat areas of the transmission line, access roads will be provided within the RoW, to minimise the project footprint. In steeper and more remote parts of the RoW external access roads will be required. In particularly, the northern extent of the transmission line has been located in an area of limited access and complex topography to avoid Huay Ngua PPA. A new road will be required in this area to facilitate access to the RoW during operation.

2.2.5 *Worker Camps*

To minimize travel, worker camps will be set up at each tower site during construction. Worker camps will consist of temporary shelter, such as tents.

2.3 PROJECT FOOTPRINT

The total footprint of the above Project components is approximately 441.6 ha. Not all of this area will be modified from its current state. During construction approximately 217.3 ha will be cleared of vegetation and the remaining portion of the footprint will suppress vegetation to 3.0 m. Suppression of vegetation allows for safe clearance for the construction of the transmission line, while retaining substantial ecological value. During operation, land will only be required for tower footprints and access tracks, limiting the amount of cleared land to approximately 69 ha, and allowing retention of low-growing vegetation in approximately 372.6 ha of the RoW.

Table 2-2 provides the approximately dimensions and footprints of Project components. These areas are conservative estimates based on design progress to date, and experience in similar Projects.

Table 2.2 Approximate dimensions and footprints of Project components

Project Component	Temporary Footprint		Permanent Footprint	
	Area (ha)	*Comment*	*Area (ha)*	*Comment*
Total RoW	437.5	35 m width 125 km length	437.5	35 m width 125 km length
• Access road within RoW (dirt or grassed surface)	38.5	5 m width 77 km length[1]	62.5	5 m width 125 km length[1]
• Towers (temporary dirt, permanent hardstand)	101.9	100 m length per tower 35 m width per tower 291 towers	2.4	9 m length per tower 9 m width per tower 291 towers
• Worker camp	72.8	65 m length per tower 35 m width per tower 291 towers	0	Temporary only
• Remaining RoW (vegetation suppressed to 3 m)	224.3	Total RoW footprint, minus cleared areas	372.6	Total RoW footprint, minus cleared areas
Access Roads outside RoW (dirt or sealed road)	4.1	8140 m length 5 m width	4.1	8140 m length 5 m width
Total cleared footprint	217.3		69	
Total vegetation suppression footprint	224.3		372.6	
Total footprint	441.6		441.6	

1. Temporary length is 77 km due to approximately 48 km cleared for construction zones. In practice, length of access road within RoW will be lower, as RoW will not be used for access in steep or mountainous areas, or in areas where access is currently sufficient.

2.4 ASSOCIATED INFRASTRUCTURE

2.4.1 Substation

Nabong substation is an existing substation located approximately 60 km to the north east of the central Vientiane Capital at Ban Nabong, Xaythany District. Nabong substation was designed and constructed to step up

electricity from multiple IPPs from 230 kV to 500 kV for export to Thailand. Currently, Nabong substation and Nabong transmission line is owned, operated and used solely by Nam Ngum 2. The substation will either be upgraded to accommodate input from NNP1, or a new substation will be developed adjacent the existing substation. The option selected will depend on the agreement reached between GoL and Nam Ngum 2. This is discussed further in Section *5.2*.

2.4.2 *Associated 115 kV Transmission Line*

A 115 kV transmission line will be developed to distribute electricity from NNP1 to a substation in Pakxan. The 115 kV line is being developed by Electricite du Laos (EdL) and is outside the scope of the report. However, the 115 kV line is critical to the Project and is considered associated infrastructure.

Prior to the re-routing of the 230 kV line to avoid Huary Ngua PPA (*Section 5.1.1*), the 115 kV line was designed to run parallel to the 230 kV line until branching east to Pakxan. It is not yet confirmed if the 115kV line will also be re-routed to avoid Huay Ngua PPA. When available, a revised project description and timeline for preparation of environmental assessments will be included in a further revision of this document.

2.5 *CONSTRUCTION TIMING*

According to the construction schedule of the Nam Ngiep 1 Hydropower Project, the total construction period of the 230 kV transmission line and its substation will be approximately 30 months.

Figure 2-1 Project Layout

3 DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

3.1 PHYSICAL RESOURCES

3.1.1 Atmosphere

The transmission line is located in the Bolikhamxay Province and Vientiane (municipality), Lao PDR, which is influenced by a Southwestern monsoon climate regime. The Project area is located in a tropical climate. Weather is dominated by monsoons, which divides the year into clearly defined wet and dry periods.

Approximately 70-80% of the annual rainfall occurs during the southwest monsoon from mid-May to late September or early October. The northeast monsoon leads to drier and cooler conditions from early November to March. A hot season commonly lasts from April to early May.

Air temperatures in the project area would be highest in April, with an average daily maximum of 37°C. During the coolest months of December and January, the average daily maximum is 28 to 30°C.

The rainfall records were reviewed for the hydrological study and dam designs. The records of hydrological gauging locations in areas peripheral to the planned basin were evaluated.

Rainfall data was collected from three gauging stations within the basin and another eleven stations from the peripheral areas. Other meteorological data such as air temperature, relative humidity, barometric pressure, solar radiation, sunshine hours, evaporation, and wind velocity were not collected from the gauging stations. According to NNP1PC's Technical Report from 2007, the mean basin rainfall from 1971 to 2000 was assumed to be 1,870mm/year after comparing to the isohyetal map.

The mean rainfall in the Nam Ngiep River basin was lower than that of Pakxan because of the topographical characteristics of the region. According to the meteorological data of Pakxan District (DMH, 2005), the seasonal variation of monthly rainfall follows the general pattern of the Southeast Asia monsoon, with about 90% of rainfall during the six month wet season from May to October. In the dry season from November to April, the monthly precipitation levels are quite low, ranging from 3.7mm to 67.5mm, or about 10% of the annual precipitation for this region.

3.1.2 Topography

The eastern portion of the transmission line running north-south is located adjacent the Nam Ngiep river in mountainous terrain. The western portion of the alignment (running east-west) runs parallel to the Mekong River within the relatively flat Mekong Lowlands (grades of 0 to 1%). Site features found along the proposed route comprise riverbanks, canal and drain banks, road

and rail embankments, and low-lying paddy fields. The lower floodplain land in this area is interspersed with shallow water bodies and in places settlements where tree crops are often grown.

Portions of the proposed transmission line route, which extends from the Ngiep River Powerhouse to the Nabong substation, cross major rivers and streams. These waterways include the Nam San, Nam Ngum, Nam Mang, Nam Jing, and Nam Lo. These rivers and streams are tributaries for the Mekong River. In addition to these waterways, the proposed transmission line traverses a swamp located between Pakxan and Thaphabath.

The elevation of the route ranges between 160 to 290 m above sea level (ASL), with most of the route ranging from 175 to 280 m ASL. The lowest point of the route occurs where the line terminates on the border of Vientiane Province. Seasonal flooding occurs over an estimated 24% of the proposed route, based on levels recorded along the route from the survey, including anecdotal information on flood levels (see *Table 3-1*). Flood level depths of up to 1.5 m can occur in areas along the proposed transmission line. However, the majority of seasonal flooding is estimated to be less than 1 m deep.

Table 3.1 Estimated Seasonal Flooding along the proposed Transmission Line

Transmission Line	Total Line Length	Flood-Prone	
		Length (km)	% of Total Line
230 kV	125 km	25	20

3.1.3 Geology and Landform

The geology along the proposed transmission line routes is characterized as containing Cenozoic alluvial plain deposits, terrace alluvial, pediments, alluvial fans, and floodplains. Surface soils found along the route are reasonably uniform. These soils are mainly classified as the Prateah Lang soil group, characterized by a sandy surface layer with clay or loam subsoil. Soil fertility is often low, with little potential to improve rice yields by more intensive management. The soil is subject to being waterlogged due to the low permeability of the underlying subsoil. These soils can be saturated for up to a week, even after short periods of heavy rainfall. The soil is also subject to drought-like conditions due to the low water holding capacity of the sandy surface soils and the difficulty of root penetration into the heavy subsoil.

Information on soil conditions in the Bolikhamxay and Vientiane Provinces were obtained from the National Agriculture and Forestry Research Institute (NAFRI), and Ministry of Agriculture and Forestry (MAF). These organisations describe the soils in this area as mainly derived from siltstones, and sandstones on an ancient uplifted peneplain, which was heavily dissected by rivers over time. These soils are generally highly weathered, moderately deep (about 1.0 m to 1.5 m or more), and well drained. The soil conditions in Central Lao PDR, as well as in the project area and along the proposed transmission lines, are still in good condition with relatively medium to high

organic matter and available phosphate. This is especially true in the forested areas and agricultural lands that have been recently converted from other types of land use. There are also small areas of limestone outcrops, but these are generally steep with shallow soils, and not widely used for agriculture especially on degraded lands.

The soils in this region, such as Alisols, Acrisols, Luvisols, Lixisols and Cambisols, are generally suitable for rice cultivation and tree plantation, including fruit trees, except on steep slopes where severe erosion can occur after heavy rains. Creation of more permanent agricultural systems (that is, those involving annual cropping on flatlands) would require a combination of practices such as adoption of soil and water conservation measures, use of nitrogen-fixing legumes, and application of manure, compost or other soil amendments. A wide range of perennial crops such as various fruit trees, agricultural and industrial crops, and vegetables can also be grown successfully in this region.

Areas where the transmission line project will pass through generally are flatter lands and contain a considerable amount of vegetation; thus are less prone to erosion. However, surface erosion can occur where most of the vegetation has been removed, either from extensive logging or from slash and burn cultivation.

3.1.4 Surface Water and Groundwater Quality

The Nam Ngiep River originates in mountainous areas of Xieng Khouang province and runs through lowlands to the Mekong River in Bolikhamxay province. Its tributaries (Huay Peun, Huay Ngua, Nam Xao and Nam Tak) within the access road Project area are small compared to Nam Ngiep River.

Surface Water Quality

Water quality data was collected near Ban Hat Gnium (N: 18°39'15.25''; E: 18°39'15.25'') in April and October 2007. Water quality results were assessed against Lao water quality standards and Thai water quality standards, as Thai standards provide a more detailed classification of water quality. The results of the water quality monitoring indicate that the water around Ban Hat Nguim meets the Lao PDR ambient water quality standards. The majority of parameters met the criteria for Class 2 water, which is 'very clean fresh surface water resources used for consumption which requires ordinary water treatment process before use, and is appropriate for conservation of aquatic organisms, fisheries and recreation. The exception is Cadmium, which would require non-detection to be considered Class 2, and was detected with a concentration of less than 0.001mg/L. Water quality standards and results for the 2007 monitoring events are provided in *Table 3-2*.

Table 3.2 Water quality standards and monitoring results at Ban Hat Gnium

Parameters	Unit	Lao PDR Ambient Standards of Water Quality[1]	Thai Water Quality Standards[2]					April 2007	October 2007
			Class 1	Class 2	Class 3	Class 4	Class 5		
Temperature	°C	-	-	-	-	-	-	29.5	25.3
pH	-	5 – 9	-	-	-	-	-	7.09	7.09
Alkalinity	meq/L	-	-	-	-	-	-	0.26	0.14
DO	mg/L	>5.0	-	-	-	-	-	7.21	7.23
BOD_5	mg/L	1.5	n	1.5	2.0	4.0	-	1.4	1.2
Oil and Grease	mg/L	-	-	-	-	-	-	<0.01	<0.01
Turbidity	FTU	-	-	-	-	-	-	17.9	16.2
Suspended solids	mg/L	-	-	-	-	-	-	21.4	22.1
TDS	mg/L	-	-	-	-	-	-	33.1	19.7
Hardness	mg/L	-	-	-	-	-	-	78.0	73.0
Conductivity	µS/cm	-	-	-	-	-	-	60.56	48.9
Phosphate-P	mg/L	-	-	-	-	-	-	0.48	0.10
Total P	mg/L	-	-	-	-	-	-	0.11	0.04
Ammonium-N	mg/L	0.2	n	0.5	0.5	0.5	-	0.05	0.02
Nitrate-N	mg/L	5.0	n	0.5	0.5	0.5	-	0.14	0.21
Total N	mg/L	-	-	-	-	-	-	0.07	0.05
Total coliform	MPN/100	5000 MPN/100 ml	-	5000	20,000	-	-	NA	NA
Fecal coliform	MPN/100	1000 MPN/ml	n	1000	4000	-	-	NA	NA
Cadmium, Cd	mg/L	0.005	n	0.00	0.005	0.005	-	<0.001	<0.001
Mercury, Hg	mg/L	0.002	n	0.002	0.002	0.002	-	<0.001	<0.001
Copper, Cu	mg/L	0.1	n	0.1	0.1	0.1	-	<0.10	<0.10
Iron, Fe	mg/L	-	-	-	-	-	-	0.22	0.20
Manganese, Mn	mg/L	1.0	n	1.0	1.0	1.0	-	0.18	0.11
Nikel, Ni	mg/L	0.1	n	0.1	0.1	0.1	-	<0.10	<0.10
Lead, Pb	mg/L	0.05	n	0.05	0.05	0.05	-	<0.01	<0.01
Zinc, Zn	mg/L	1.0	n	1.0	1.0	1.0	-	<0.02	<0.02
Arsenic, As	mg/L	0.01	-	-	-	-	-	<0.001	<0.001

n naturally

- not indicated

1. Ambient Water Standards of Lao PDR, MONRE, GOL
2. Standard Methods for the Examination of Water and Wastewater recommended by APHA : American Public Health Association, AWWA: American Water Works Association and WPCF : Water Pollution Control Federation.

Green shading indicates that the relevant standards have been complied with.

Groundwater Quality

Groundwater quality at Ban Hat Gnium was not measured during the preparation of the environmental impact assessment (ERIC 2007), as, although there is a well at Ban Hat Gniun, the villagers use it only for disposal of waste,

and do not draw water from the well. Spring water from a gravity-flow system built under Action Contre la Faim (ACF) and the Nam Ngiep River are the main water sources that supplied water to the village.

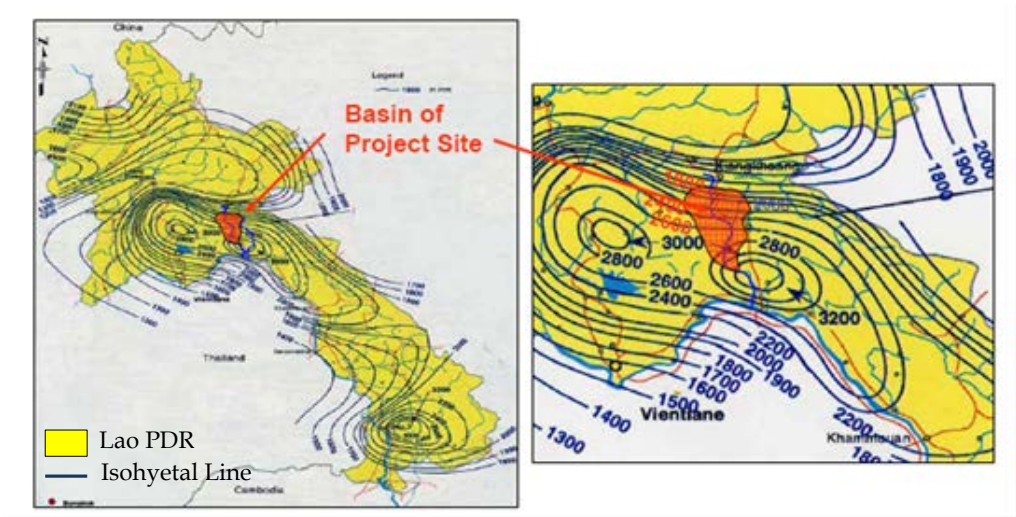
3.1.5 *Seismology*

During the past 20 years, there has been no record of an earthquake in the area exceeding magnitude of 5 (ERIC 2007). It can be concluded that the investigated region is characterized by a geological structure with good stability and that seismic activities in the Nam Ngiep river basin are rare (ERIC 2007). This conclusion is supported by the report on "Lao PDR: Natural Hazard Risks", edited by the OCHA Regional Office for Asia Pacific, issued on 08 March 2007.

3.1.6 *Hydrology*

Based on the isohytel map in ***Figure 3-1***, the mean rainfall for the Project area ranges between approximately 1800 mm/year in the north-eastern and western extremities of the trnamsission line, to as high as 3000 mm/year in the area around Pakxan. The tropical low pressure system, developed in the China Sea and moving along the Mekong Valley, is blocked by high mountains and steep cliffs of the northwestern region. Due to this formation of peaks and high elevation, there is a tendency for storm formations to stall there until the low pressure dissipates.

Figure 3-1 ***Isohyetal map***



Note: Isohyetal lines represent points of equal rainfall.

Based on actual measurements of discharge at the Mouang Mai station over a fourteen year period, the estimated discharge for Nam Ngiep River at Ban Hat Gnium was calculated. The difference between measured discharge and calculated discharge was minimized through a trial-and-error method. This "tank model" methodology and low flow analysis resulted in annual average discharge (1971 to 2000) of 148.4 m^3/s.

3.2 BIOLOGICAL RESOURCES

Biological resources were assessed using a variety of information sources. The full NNP1 Transmission Line Biodiversity Assessment Report, is provided in *Annex C* and a summary is provided in this chapter.

3.2.1 Assessment Methods

The baseline biodiversity values of the transmission line have been determined using a number of information sources including:

- Geospatial datasets including aerial photography and vegetation mapping;
- Desktop literature and other sources;
- Field survey undertaken for the NNP1 Project components; and
- Field reconnaissance visit to identify key biodiversity areas for consideration in refining the alignment.

These sources provide description of vegetation communities, habitats and species that occur in the region surrounding the Project Area, and therefore have potential to occur within the Project Area. The data collated for the purposes of this report can be categorised into two types:

Direct: Species recorded during biodiversity field surveys of NNP1 Project components undertaken during 2013 are considered direct counts. In general the location and details of this data has been recorded and a higher level or certainty can be inferred.

Indirect: Species reported from village surveys or within reports using a more regional study area are considered indirect records. These data sources provide a valuable understanding of the biodiversity of the locality and region however should be afforded further analysis or applicability considered. Data obtained from village surveys can contain errors in some instances, especially when considering identification of species with more challenging diagnostic features.

The reliability of the records has been considered throughout the report and the category of any species records are denoted throughout.

3.2.2 Vegetation

Land Cover

The Lao landscape has historically been dominated by dense forest and, despite more recent clearance, retains significantly more forest coverage than neighbouring countries Thailand, Vietnam and China (Yunnan Province) (Duckworth *et al.*, 1999). The original forests of the Northern-Central Highlands, where the Project Area is located, were predominantly dry

evergreen and mixed deciduous forests. However, shifting cultivation has removed much of the original forest and large areas of grassland, bamboo and other secondary vegetation are now present. Non-timber forest products (NTFPs) such as leaves, shoots, flowers, fruits and bark are used extensively by the Lao people and are of great importance both as a food source and also medicinally and culturally.

Land cover type mapping based on DFRM 2010 forest mapping identifies the dominant landcover types within the Project Area to be deciduous forest and old fallow land, with smaller portions of young fallow land and rice paddies. The land cover types mapped within the Project Area are presented in *Table 3-3*, based on the 35 m wide RoW, and shown in *Figure 3-2*.

Table 3.3 Land cover types within the Project Area

Type (code)	Description	Total within Project Area (ha)
Natural Habitat		**151**
Deciduous forest (DF)	Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Deciduous Forest includes both Upper and Lower deciduous forest types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest.	122
Evergreen forest (EF)	Area dominated by trees where 75% or more of the tree species maintain their leaves all year. Canopy is never without green foliage.	1
Bamboo (B)	Bamboo area where the over storey has a crown cover less than 5%.	6
Scrub, Heath (SR)	This is an area covered with scrub and stunted trees. The soil is shallow and rocky.	2
Swamp (SW)	Areas where the soil is saturated with water. The soil may basically be fertile but the lack of oxygen limits its agricultue or forest capacity. The swamp could have high ecological or environmental value and the flora and fauna may be rich.	7
Modified Habitat		**247**
Agriculture Plantation (AP)	Agricultural plantation currently in use.	7
Old fallow land (OFL)	Land that has been ploughed and tilled and left un-seeded during a growing season.	124
Young fallow land (YFL)	Land that has been recently ploughed and tilled and left un-seeded during a growing season.	68
Rice paddy (RP)	Areas permanently being used for rice cultivation.	53
Slash and burn (SB)	Slash-and-burn is a description of land that has been subjected to an agricultural technique which involves cutting and burning of forests or woodlands to create fields.	4
Unclassified		**8**

Type (code)	Description	Total within Project Area (ha)
Water (W)	The land cover class Water includes rivers, water reservoirs (i.e. ponds and dams for irrigation and hydro power) and lakes. Water reservoirs and lakes with an area of 0.5 ha and rivers should be at least 10m wide to be classified as Water.	3
Shadow (SH)*	Shadow indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	<1
Cloud (CL)*	Cloud indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	4
Other Land (O)	Other land types.	<1
Rock (R)	Rock surfaces.	<1

Figure 3-2 Project Area Land Cover

Vegetation Condition

Vegetation condition based on the NDVI data within the Project Area is divided into four categories. NDVI data identified that:

- The majority of land (94%) is moderate or low condition;
- 5% of the Project Area is high condition, and this is mostly concentrated in the northern segment, from south of Huay Ngua PPA to the Main Dam;
- Approximately two thirds of the Project Area is in moderate condition, and this is evenly distributed throughout the Project Area; and
- Approximately a third of the Project Area is low condition, and this is primarily concentrated in the Pakxan region in the south east.

The representation of these categories within the Project Area is summarised in *Table 3-4* and shown *Figure 3-3*.

Table 3.4 Vegetation Condition in the Project Area

Condition Category (NDVI range)	Area within Project Area (ha)
Impacted (- to 0)	7
Low (0 to 0.4)	159
Moderate (0.4 to 0.6)	212
High (0.6 to 0.8)	25

Figure 3-3 Project Area Vegetation Condition (NDVI)

3.2.3 *Flora Species*

The following sections outline the flora species, diversity and condition identified for Huay Ngua PPA, the resettlement area, the NNP1 Access Road and Phou Khao Kouay NPA.

Huay Ngua PPA

Sampling undertaken during 2013 surveys by TISTR recorded 451 species of vascular plants in the Huay Ngua PPA sampling locations and 410 at the resettlement area sampling locations on the west bank of the Nam Ngiep River. Huay Ngua PPA vegetation is dominated by mixed deciduous forest with some areas of mixed evergreen forest and secondary growth of mixed deciduous forest. Canopy cover was recorded at approximately 60-70 per cent.

Resettlement Area

Resettlement area vegetation is dominated by secondary growth of mixed deciduous forest. Canopy cover was recorded at approximately 40% (TISTR 2013).

NNP1 Access Road

The botanical inventory collected within the disturbance footprint by NUL identified 139 species of vascular plants (Phengsintham 2013) that included one Bryophyta species, nine Pteridophyta species, 102 Dicotyledones species, 25 monocotyledons species and three mushroom species (NUL 2013).

Phou Khao Kouay NPA

The central portion of Phou Khao Kouay NPA contains the lower basins of the Nam Leuk and Nam Mang. This area is predominantly upper dry evergreen forest. This forest has plant families and genera typical for other parts of Southeast Asia, such as the genera Dipterocarpus and Shorea. Mixed deciduous forest is found on lighter, shallow soils. Large stands of coniferous forest, usually monospecific stands of *Pinus merkusii*, grow on shallow, nutrient deficient, sandy soils, particularly in the western portion of the park, where it occurs in association with extensive, fire-climax grasslands.

The dominant species recorded by TISTR in each canopy strata are summarised in *Table 3-5*.

Table 3.5 Dominant Flora Species in survey sites

Canopy class	Dominant species
Resettlement Site Secondary Growth of Mixed Deciduous Forest	
Top canopy (~15m)	*Taliparíti macrophyllum, Peltophorum dasyrachis, Macaanga denticulata, Lepisanthes rubiginosa, Cratoxylum formosum, Aporosa villosa, Chaetocarpus castanocarpus, Maesa ramentacea, Irvingia malayana, Lagerstoemia calyculata.*
Lower canopy (<10m)	Densely covered by seedlings of original forest type, shrubs, climbers and herbs such as *Cleistanthus papyraceus, Ardisia helferiana, Chionanthus velutinus, Connarus semidecandrus, and Amomum biflorum*. The typical species of bamboo found in the area is *Gigantochloa albociliata.*
Access Road (Huay Ngua PPA) Mixed Deciduous Forest	
Top canopy (20-35m)	*Anisoptera costata, Lagerstroemia calyculata, Shorea roxburghii, Irvingia malayana, Alstonia glaucescens, Schima wallichii, Vitex pinnata, Stereospermum fimbriatum*
Middle canopy (10-20m)	*Acronychia pedunculata, Peltophorum dasyrachis, Nauclea orientalis, Microcos tomentosa, Mallotus paniculatus, Gonocaryum lobbianum, Cratoxylum formosum*
Lower canopy (<10m)	*Croton cascarillicdes, Breynia glauca, Ardisia helferiana, Glycosmis pentaphylla, Melicope pteleifolia, Allophylus cobbe, Salacia chinensis*

IUCN Listed Species

A total of 11 plant species listed under the IUCN Red List were recorded during vegetation surveys of the Re-settlement area and Huay Ngua PPA in 2013, the NUL vegetation ground-truthing survey and desktop review of PKK. The species are considered the subject species for the transmission line Project Aea. The IUCN listed species are shown in *Table 3-6* and include:

- one species listed as critically endangered;
- five species listed as endangered; and
- five species listed as vulnerable.

Table 3.6 IUCN Listed Flora Species Reported

Scientific Names	Status	Huay Ngua PPA (TISTR)	Phou Khao Khouy NPA (Indirect)	Re-settlement Site (TISTR)
Dipterocarpus turbinatus	CR	✓		
Afzelia xylocarpa	EN	✓		✓
Anisoptera costata	EN	✓	✓	
Dalbergia oliveri	EN	✓		✓
Dipterocarpus alatus	EN	✓	✓	
Shorea roxburghii	EN	✓		✓
Cycas pectinata	VU	✓		
Dalbergia cochinchinensis	VU	✓		
Hopea odorata	VU	✓		✓
Syzygium vestitum	VU	✓		
Ternstroemia wallichian	VU	✓		

3.2.4 *Fauna Species*

Huay Ngua PPA

A total of 38 terrestrial species of fauna from 19 families, and 31 genera were recorded from the field surveys in 2013 surveys in Huay Ngua PPA by TISTR. Species diversity of animals recorded in this area was low in comparison to other areas surveyed nearby however this is expected to be due to the lack of secondary data, all records were obtained by direct observation during the TISTR field surveys.

The Huay Ngua Provincial Preserved Area Management Plan reports (indirect data) fauna species occurring within the PPA to include wild pig, munjac, clouded leopard (*Pardofelis nebulosa*), civet, flying squirrel as well as Green peafowl (*Pavo muticus*), Hill myna (*Gracula religiosa*), Red junglefowl (*Gallus gallus*) and the Siamese fireback (*Lophura diardi*).

Overall, the TISTR surveys and indirect data reported:

- Nine amphibian species;
- Fifty-nine bird species;
- Twenty-seven mammal species;
- Nine reptile species; and
- Thirty-nine fish species (including twelve species considered to be migratory).

Resettlement Area

Field surveys of the Resettlement area in 2013 found that the area is heavily disturbed as a result of slash and burn activities. There is evidence of some regeneration and secondary growth. Site surveys detected (through interviews with villagers or direct observation) at least 9 mammals species, 24 birds species, 19 reptiles species and 8 amphibian species.

Restricted Species

Species listed as Restricted under the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF includes wild animals and fish which are rare, endangered, high conservation value, and special significance to the economy and national environment.

The 2013 surveys of the Resettlement area and Huay Ngua PPA by TISTR in 2013 (direct data) and indirect data sources identified the following species listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF that may also occur within the transmission line RoW:

- Two mammal species;
- Six bird species;
- One reptile;
- One fish;
- No amphibians.

These species are considered subject species for the transmission line Project Area.

Table 3.7 No. 0360/MAF Restricted Fauna Species Reported

Common Name	Scientific Name	Direct Data	Indirect Data	No. 0360/MAF Status
Mammals				
Leopard	*Panthera pardus*		✓	Restricted
Asiatic golden cat	*Pardofelis temminckii*		✓	Restricted
Bengal slow loris	*Nycticebus bengalensis*		✓	Restricted
Birds				
Great hornbill	*Buceros bicornis*		✓	Restricted
Greater coucal	*Centropus sinensis*	✓	✓	Restricted
Siamese fireback	*Lophura diardi*		✓	Restricted
Silver pheasant	*Lophura nycthemera*		✓	Restricted
Grey peacock-pheasant	*Polyplectron bicalcaratum*		✓	Restricted
Red-breasted parakeet	*Psittacula alexandri*	✓	✓	Restricted
Reptiles				
Reticulated python	*Broghammerus reticulatus*		✓	Restricted
Fish				
	Wallago leeri		✓	Restricted

IUCN Listed Species

Three IUCN Red Listed critically endangered, endangered or vulnerable fauna species were recorded within the Huay Ngua PPA area during 2013 surveys by TISTR while 16 additional species listed as critically endangered, endangered or vulnerable on the IUCN Red List that may occur within the Huay Ngua PPA were identified. Information regarding the PKK identified a number of IUCN Red List species to occur within the national protected area, including ten mammal species (1 critically endangered, 4 endangered and 5 vulnerable).

Table 3.8 IUCN Listed Fauna Species Recorded/Reported

Common Name	Scientific Name	Direct Data	Indirect Data	IUCN Status
Mammals				
Northern white-cheeked gibbon	*Nomascus leucogenys*		✓	CR
Asian wild dog, dhole	*Cuon alpinus*		✓	EN
Asian elephant	*Elephas maximus*		✓	EN
Sunda pangolin	*Manis javanica*		✓	EN
Fishing cat	*Prionailurus viverrinus*		✓*	EN
Phayre's leaf monkey	*Trachypithecus phayrei*		✓	EN
Asian small-clawed otter	*Aonyx cinerea*		✓	VU
Gaur	*Bos gaurus*		✓	VU
Malayan sun bear	*Helarctos malayanus*		✓	VU
Northern pig-tailed macaque	*Macaca leonina*		✓	VU
Clouded leopard	*Neofelis nebulosa*		✓	VU
Bengal slow loris	*Nycticebus bengalensis*		✓	VU
Sambar deer	*Rusa unicolor*			VU
Himalayan black bear	*Ursus thibetanus*		✓	VU
Large spotted civet	*Viverra megaspila*		✓	VU
Birds				
White-winged duck	*Cairina scutulata*		✓*	EN
Green peafowl	*Pavo muticus*		✓	EN
Imperial eagle	*Aquila heliaca*		✓	VU
Reptiles				
Big-headed turtle	*Platysternon megacephalum*		✓	EN
Southeast Asian softshell turtle	*Amyda cartilaginea*		✓	VU
Snail-eating turtle	*Malayemys subtrijuga*		✓	VU
Impressed tortoise	*Manouria impressa*		✓	VU
Indo-Chinese spitting cobra	*Naja siamensis*		✓	VU
Fish				
Giant barb	*Catlocarpio siamensis*		✓	CR
Striped catfish	*Pangasianodon hypophthalmus*		✓	EN
Yellow tail brook barb	*Poropuntius deauratus*	✓*		EN
Thicklipped barb	*Probarbus labeamajor*		✓	EN
Bandan sharp-mouth barb	*Scaphognathops bandanensis*	✓		VU
Jaguar loach	*Yasuhikotakia splendida*	✓		VU

CR = Critically endangered, EN = Endangered, VU = Vulnerable

*Specialist consultation identified potential for unreliable record

3.3 SOCIAL AND CULTURAL RESOURCES

3.3.1 Population

Table 3-9 identifies the 24 villages that are located along the transmission line corridor. It is anticipated that this number will change once the corridor alignment has been confirmed.

These villages presented in *Table 3-9* share a number of similar characteristics. All are predominantly ethnically Lao Loum, the majority group in Lao PDR. Their culture, religious beliefs, practices and livelihoods are typical of Lao Loum.

Table 3.9 Potentially Affected Villages

Province	District	Affected Villages	Total of households	Total of population	No. of affected households	
Bolikhamxay	Bolikhan	1.Hat Gniun	67	371	3	14 households
		2.Houykhoun	358	2,180	4	
		3.Nampa	84	584	7	
	Pakxan	1.Thong Noi	165	839	22	76 households
		2.Thong Yai	86	437	15	
		3.Sanaxay	274	1,156	4	
		4.Anusonxay	390	1,120	33	
		5.Pak Ngiep	137	659	2	
	Thaphabat	1.Xaysavang	87	123	3	73 households
		2.Vuenthat	356	523	14	
		3.Paktuay Tai	126	278	7	
		4.Pakthouay Neu	174	391	7	
		5.Nongkuen	256	342	8	
		6.Sisomxay	275	371	10	
		7.Thabok	364	946	5	
		8.Palai	221	315	5	
		9.Somsaath	121	321	7	
		10. Na	179	462	7	
Vientiane Capital	Pak Ngum	1. Vuenkabao	125	749	1	20 households
		2. Xienglea Na	115	639	8	
		3. Xienglea Tha	237	1,416	4	
		4. Nonh	111	498	4	
		5. Thakokhai	178	378	1	
		6. Nabong	365	456	2	
Total		24	4,851	15,554	183	

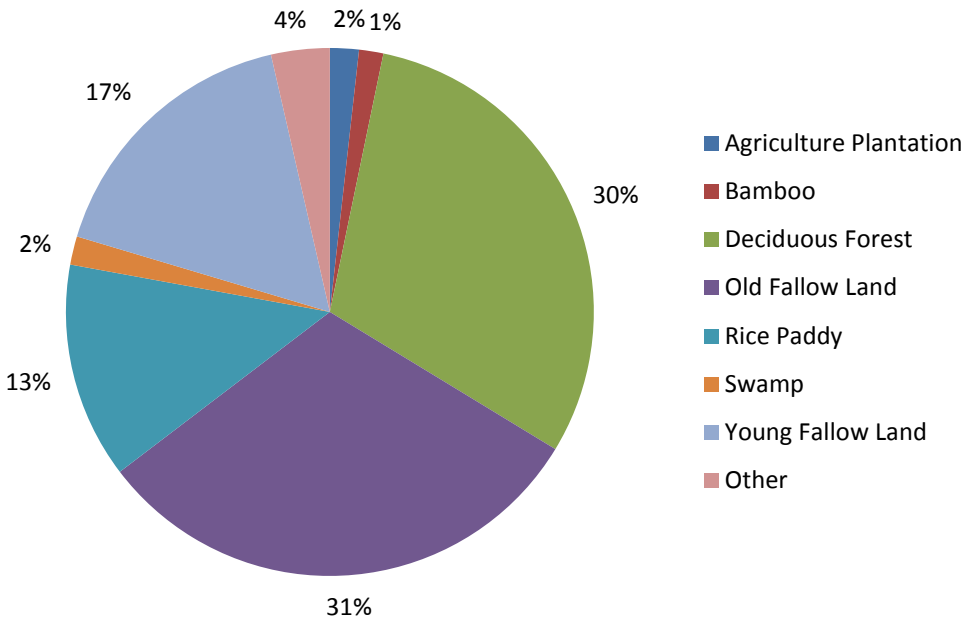
The houses tend to be situated alongside the river, in this case the Nam Ngiep, or beside roadways in clusters. The houses of the Lao Loum are built above ground on wooden posts to cope with seasonal flooding and to allow better

airflow. This style provides space under the house for daytime activities and to keep livestock at night. Most households rely mainly on agriculture for their livelihood, with forest products and fish important secondary sources.

The administrative structure of each village is similar to that of other communities in the country: with a village headman, deputy village headmen, local militias, local police, a branch of the Lao Youth Union, a branch of the Lao Women's Union, and a committee of the Front for Construction.

3.3.2 *Land Use*

A review of land cover mapping identified that almost 50% of land within the Project Area was fallow. The largest productive use at the time land cover mapping was undertaken was land used for rice paddies, (13% of the Project Area). Approximately a third of the Project Area was mapped as supporting natural habitats. Although not specifically used for cultivation, natural habitats may provide resources such as non-timber fiber products and wild-caught food. Ground truthing of land uses in the Project Area will be undertaken prior to construction.



3.3.3 *Livelihood*

Table 3-10 provides an overview of the sources of income in the local villages. This information is based on a field survey with local villagers along the transmission corridor. The main sources income include agricultural and livestock production, followed by small businesses and services. Most households also had more than one source of income, as reflected by the occupations and livelihood systems of local villagers.

Table 3.10 Sources of Income

Sources of Income	District			
	Bolikhan (14 Villages)	*Pakxan (76 Villages)*	*Thaphabat (66 Villages)*	*Pak Ngum (20 Villages)*
	No. of HH	*No. of HH*	*No. of HH*	*No. of HH*
Agricultural Production and Livestock	13	52	61	17
Small Businesses and Services	5	27	16	9
Non-timber Forest Products and Fishing	4	2	5	3
Handicrafts and Small Scale industry	3	2	4	5
Daily Labor	4	43	24	7
Others	3	11	8	2

The relative importance of income from small business operations and handicraft sales is likely because most of the villages within the transmission line corridor are located along major roadways, in particular National Road No. 13 South. This provides access to buyers and markets.

Other sources of income that are often important in rural communities in the Lao PDR, such as NTFPs, were relatively minor by comparison.

3.3.4 *Community Infrastructure*

Table 3-11 provides information on infrastructure in the villages along the transmission corridor. Compared with other villages in the Project area, especially compared with those close or upstream of the dam site, the communities along the transmission line corridor tend to have better infrastructure and services.

Table 3.11 Community Infrastructure

Type of Facility or Infrastructure	Bolikhan 3 Villages	Pakxan 5 Villages	Thaphabat 10 Villages	Pak Ngum 6 Villages
Primary School	3	5	3	6
Lower Secondary School	1	2	4	3
Upper Secondary School	1	1	2	2
Dispensary or Village Clinic	0	1	3	2
Rice Mill	3	4	9	6
Electricity	2	5	9	6
All Weather Road	2	5	9	6
Village Market	2	3	9	6
Public Transport or Bus from Village to Districts/Provinces	2	5	9	6
Factory Nearby	0	3	2	3
Guesthouse	0	2	3	2
Restaurant	1	2	4	3

Type of Facility or Infrastructure	Bolikhan 3 Villages	Pakxan 5 Villages	Thaphabat 10 Villages	Pak Ngum 6 Villages
Garage	1	3	7	6
Communication Network	2	5	9	6
Toilet	3	5	9	6
2-Wheel or Small Tractor	2	5	9	6

The access to better infrastructure may be attributed to proximity of the villages to major roadways, including the National Road 13 South. In addition, feeder roads to the villages are being improved by GOL and are in or will soon be in good condition. Another reason may be the close proximity to the city of Pakxan, a key market and portal to Thailand.

3.3.5 *Archaeology*

There is one significant historic site and tourist attraction located along the transmission line corridor. Wat Prabat Phonsan is located next to National Road No.13 South, in Ban Prabat, Thaphabat District. Important relics/ artefacts at the temple include a model of the footprint of the Lord Buddha, a giant reclining Buddha, and an ancient drum.

4 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Impacts have been identified based on the project as described in *Section 2*. The transmission line alignment will be refined throughout the design process.

In summary, project activities will include:

Construction

- Clearing of vegetation for the RoW;
- Earthworks for installation of the transmission towers;
- Construction of towers and stringing;
- Rehabilitation of RoW areas not required to be permanently cleared; and
- Operation of worker camp.

Operation

- Vehicle travel within the RoW for maintenance activities;
- Maintenance of the RoW, including repairs to transmission lines, and trimming vegetation;
- Presence of roads and bridges; and
- Road maintenance.

4.1 DESIGN AND PRE-CONSTRUCTION STAGE

4.1.1 Hydrology

The following impacts to hydrology may occur during the operational phase, therefore, the below aspects shall also be considered during the design phase:

- The presence of hardstand areas in place of vegetated areas will prevent infiltration and may increase the velocity of surface runoff. Given the small area of hardstand areas (81 m^2 per tower) this impact is expected to be minor; and
- If poorly designed, the presence of bridges (as part of the access roads) has the potential to disrupt streamflows. In particular, restriction of flows may lead to increased upstream flood levels and accelerated erosion due to increased flow velocities. Removal of a beneficial restriction could also lead to increased downstream flows.

Mitigation Measures

- Drainage will be designed to safely convey runoff from developed areas at non-erosive volumes and velocities;
- Bridges and culverts will be designed in accordance with the Best Available Techniques provided in *Annex D*. Measures include: minimizing the use of pylons to retain the existing channel section; operating with a freeboard between the flood level and bridge deck; and avoiding encroachment of bridge abutments into the channel; and
- Construction will be scheduled to occur during the dry season wherever possible.

4.1.2 *Water Quality*

Poorly designed infrastructure layouts, including siting of towers, material stockpiles, worker camps and access roads, can lead to:

- High levels of erosion and sediment run off, which may increase turbidity of surface waters;
- Contaminated run off from waste and hazardous materials storage areas; and
- Leaching of sewage and domestic waste from camp and construction areas.

Mitigation Measures

- Construction in steep areas and watercourse crossings will be minimized wherever possible;
- Adequate waste and materials storage areas will be provided for in the site layout;
- Material stockpiles will be located at least 30 m away from steep slopes, watercourses or drainage paths; and
- Solid and septic waste management systems will be provided.

4.1.3 *Noise*

Noise in the form of buzzing and humming can often be heard around transformers, and may be heard from transmission lines, particularly during rain or fog. These noise emissions do not present any known health risks, but could disturb local residents and fauna.

Mitigation Measures

- Locate RoW away from human receptors and areas of critical habitat for noise-sensitive species.

4.1.4 *Biodiversity*

Inappropriate layout design can lead to unnecessary, avoidable impacts to habitat and species, for example by locating towers, access roads and other infrastructure within protected areas, or natural habitat, where alternatives are available. In addition, inappropriate transmission tower design can present a risk of electrocution to avifauna.

Mitigation Measures

- The design and layout has been planned in consideration of alternative routes to avoid protected areas (refer *Section 5);*
- A flora assessment and other environmental assessments will occur within the RoW and proposed access roads to identify areas of biodiversity value, prior to construction commencing;
- Based on these assessments, refinement of the alignment will minimise tree cutting, protected area disturbance and critical habitat disturbance where possible; and
- Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.

4.1.5 *Land Use*

Inappropriate layout design can lead to unnecessary, avoidable impacts to existing land uses and subsequent impacts to livelihoods.

Mitigation measures

Siting of towers, as well as temporary infrastructure, such as access roads and stockpiles, will minimize the acquisition of productive land. Compensation for the loss of property will be provided to the affected people.

4.1.6 *Community Health and Safety*

Poor siting of transmission lines can impact community health and safety by:

- Locating transmission lines in flight path envelopes, thereby increasing the risk of aircraft collision with overhead powerlines. Power transmission towers can impact aircraft safety through direct collision and interference with radar equipment.

Mitigation Measures

- Transmission lines and towers will be sited outside of known flight path envelopes where possible; and
- If installation is required in flight sensitive areas, buried lines will be used.

4.1.7 *Public Property*

Transmission lines may impact visual amenity, which can be undesirable to residents.

Mitigation Measures

- Powerlines will be sited in consultation with the community, and with due consideration of landscape views;
- Changes to property values due to powerline proximity will be assessed, and appropriate compensation will be provided.

4.2 *CONSTRUCTION STAGE*

4.2.1 *Hydrology*

Impacts to hydrology may include the following:

- Clearing of vegetation may speed the movement of surface run off;
- Earthworks required for tower footprints, access roads, stockpile areas and other infrastructure may alter the flow of surface runoff; and
- Construction of access roads may involve in-stream works, which may alter water flows.

Mitigation Measures

- Wherever possible, construction will occur during the dry season;
- River diversion during in-stream works will be designed with the intent of maintaining water flows within the watercourse. If river diversion is expected to alter flows to an extent that would lower the downstream water level, local people will be informed of changes to water levels, including expected extent and duration of change;
- Earthworks will be undertaken to minimize changes to surface water flows and to avoid collecting standing water.

4.2.2 *Water quality*

Impacts to water quality can occur from erosion and sediment run off, discharge of inadequately treated sewage and domestic waste, and release of hazardous materials. These pollution sources are discussed further below.

Erosion and Sediment

Sources of erosion and sediment run off include:

- Erosion and sediment run off from construction activities that expose or move soil (including clearing of vegetation and earthworks);
- Release of sediment laden effluent during construction, for example drilling wastes; and
- Erosion and sediment released from stream bed and bank disturbance at watercourse crossings required for access roads.

Erosion has the potential to lead to deposition of sediment and increased turbidity of water which can limit photosynthesis, suffocate benthic fauna and more broadly degrade aquatic habitat.

Effluent

Sources of sewage and domestic waste include:

- construction camps, which can discharge litter, sewage, and wastewater containing high levels of nutrients, organic matter, pathogens, oils and heavy metals; and
- concrete batching plants, which if not adequately managed can produce highly alkaline wastewater.

Hazardous Materials

Hazardous materials that may be used in the Project include:

- Paints and solvents;
- Petroleum products such as oils, fuels, and grease;
- Concrete curing and repair compounds; and
- Contaminated waste material.

There is potential for hazardous materials to be released to the environment, particularly during storage and handling, and equipment/vehicle maintenance.

Mitigation Measures

Implementation of appropriate mitigation measures can significantly reduce the impacts of the project on water quality. The following general water quality management measures will be implemented:

Erosion and Sediment

- Clearing and earthworks will be undertaken in the dry season wherever possible to minimize erosion and subsequent release of sediment;
- The period of soil exposure will be minimized by phasing clearing and construction activities, and covering exposed areas (for example by planting fast growing ground cover or covering with riprap, sand bags, erosion mats, bale dikes, mulch, or excelsior blankets) at the earliest time possible. Exposed areas of stream banks will be covered immediately, and preferably be replanted with locally native herbaceous and woody vegetation;
- If in-stream diversion is required during access road construction (e.g. if bridges are required), any diversion infrastructure will be clean and made of suitable materials that will not contribute to turbidity or salinity;
- At watercourse crossings, machinery will operate from stream bank, not the stream channel, whenever practicable with minimal streambed disturbance. All disturbed streambeds will be returned to their original condition or better as soon as possible;
- If vegetation clearing is required on stream banks, vegetation will be cut near or at ground level to leave root mass in the ground. This helps to reinforce soil stability and reduce erosion;
- For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed and maintained until vegetation replanting can occur to stabilise disturbed surfaces;
- Stockpile materials will be located at least 30 m away from steep slopes, watercourses or drainage paths;
- Water quality will be monitored regularly, and if found to exceed standards defined in Annex *B*, additional water quality measures will be implemented.

Effluent

- Prior to operation of concrete batching plants and casting yards, the contractor shall install wastewater treatment systems that have the capacity to treat wastewater to a quality compliant with relevant standards (refer to Annex *B*); and

- Solid and septic system waste management systems will be installed and maintained in good working order.

Hazardous Material

- All fuel and hazardous material storage will be adequately bunded to prevent any spillage problem;
- Only minimal chemicals, hazardous substances and fuel will be stored on site works;
- Whenever feasible, mobile fueling/maintenance units will be used for construction equipment to avoid/reduce on-site fuel/lubricant storage; and
- Discharge of oil contaminated water into the environment is prohibited.

4.2.3 *Air Quality*

Air quality can be impacted by:

- Dust emissions from exposed soils (e.g. due to clearing of vegetation, earthworks);
- Dust emissions from increased traffic on new and existing unsealed roads;
- Dust emissions from transport of soils and materials; and
- Chemical pollutants from fuel combustion for road vehicles and equipment.

Air emissions have the potential to impact the health of workers, as well as flora and fauna (*Section 4.2.5**Error! Reference source not found.***). With appropriate mitigation measures in place, impacts to air quality are expected to be minimized to an appropriate level.

Mitigation Measures

Measures include:

- Restricting vehicle movement to designated access routes;
- Covering all loads;
- Watering exposed surfaces during windy conditions;
- Maintaining the condition of the vehicle fleet;
- Daily monitoring of dust levels through visual inspection; and

- Implementing measures to limit vehicle speeds, particularly around sensitive receptors, for example by installing speed bumps.

4.2.4 *Noise and Vibration*

Operation of construction machinery has the potential to cause noise disturbance to nearby villages, as well as flora and fauna. Noise can also present a health and safety risk to workers.

Noise Impacts

The WHO report entitled "Guidelines for Community Noise" establishes health-based guideline values of noise exposure, for which no adverse effects of community noise exposure on human health would be expected. The report provides guidance on various levels of risk to public health due to noise. This concept allows countries and developers to adopt their own level of noise control, according to affordability and technical feasibility versus public health risks. It is also recommended that community noise exposure should be managed through the use of environmental health impact analyses.

Potential noise impacts associated with construction have been assessed using methodology developed by FTA (Federal Transit Administration, 1995). Noise levels generated from construction equipment are provided in ***Table 4-1***.

Table 4.1 Noise Levels Generated from Construction Equipment

Type of Equipment	Maximum Level (dBA at 50 feet)
1. Grader	85
2. Scrapers	89
3. Bulldozers	85
4. Heavy Tracks	88
5. Backhoe	80
6. Pneumatic Tools	85
7. Concrete Pump	82
8. Crushing Equipment	77

Source: Federal Transit Administration (1995)

Typically, construction equipment operates intermittently, and multiple pieces of equipment can operate simultaneously. In order to model the possible effects from construction equipment at the Project site, a typical scenario in which a grader (85dBA) and a scraper (89 dBA) operate concurrently and continuously in the same area was assessed. The combined sound level of these two pieces of equipment would be approximately 90 dBA at a distance of 50 feet from the construction site.

Noise outputs from grading activities have been investigated, and noise estimates at various distances are provided in ***Table 4-2***. Noise estimates are based on a source level of 90 dBA (measured at 50 feet). Distance attenuation,

molecular absorption, and anomalous excess attenuation were taken into account in the calculation.

Vibration Impacts

Vibration levels from different construction activities must be calculated. Using reference source vibration levels and typical usage factors, peak particle velocities (PPV) must be calculated for construction activities.

Using the method recommended by FTA (Federal Transit Administration, 1995) known as reference vibration amplitude (PPV_{ref}), the vibration produced by the grading activities of a large bulldozer was 0.089 in/s at 25 feet of distance. The vibration was assumed to attenuate over changing distance according to the following equation:

$$PPV = PPV_{ref} \text{ X } (25/\text{distance})^{1.5}$$

Using the above equation and recommended reference amplitude, the estimated vibration amplitude at various distances was calculated and summarized in ***Table 4-2***.

Table 4.2 Estimated Grading-Related Construction Noise in the Project Area*

Distance to Receptor (feet)	Sound Level at Receptor (dBA)	PV (in/S)
25	-	0.08900
50	90	0.03100
100	84	0.01100
200	78	0.00390
400	71	-
500	-	0.00100
600	67	-
800	65	-
1,000	-	0.00035
1,200	60	0.00027
1,500	58	-
2,000	55	0.00012
2,500	52	-
3,000	49	-
4,000	45	-
5,280	41	-
7,500	34	-

The above table is based on the following assumptions:

- Basic sound level drop-off rate: 6.0 dB per doubling of distance
- Molecular absorption coefficient: 0.7 dB per 1,000 feet
- Analogous excess attenuation: 1.0 dB per 1,000 feet
- Reference sound level: 90 dBA
- Distance for reference sound level: 50 feet
- Vibration estimate is based on the vibration of a large bulldozer

Mitigation Measures

The following general measures will be applied to limit impacts from noise and vibrations

- All noise and vibration generating construction equipment shall be operated and maintained to minimize noise emissions, including using appropriate sound dampening equipment and avoiding unnecessary revving and idling of vehicles;
- Construction equipment and vehicles will be subjected to regular inspections to check noise emissions and noise control equipment;
- Stationary noise sources will be positioned as far as practicable from dwellings, worker camps, schools, business and sensitive receptors;
- Hearing protection will be made available for all construction personnel;
- High noise activities, such as blasting, will be carried out only within the hours of 6am to 7pm, and residents should be informed of these activities; and
- The contractor will maintain communication with any schools within 3 km of the Project area, and will avoid high noise activities during school hours.

4.2.5 *Biodiversity*

Anticipated impacts to biodiversity due to construction include:

- Temporary disturbance of habitat in areas required to facilitate construction. Temporary disturbance will mainly be associated with construction areas surrounding tower pads, any required access tracks to tower locations, and temporary stockyards, workers camps and mobile offices;
- Disturbance and displacement of resident fauna due to noise, light and/or vibration as a result of construction activities (excavation, drilling, blasting, clearing, operation of camps, plant and vehicle movement);
- Degradation of habitat due to introduction of alien species and competition with native communities, accidental release of hazardous substances, and the creation of newly disturbed forest edges around the margins of access roads, transmission towers and associated infrastructure;
- Fauna mortality due to vehicle/machinery strike, hunting, poaching and collection for trade due to the creation of access roads within and outside of the RoW;

The biodiversity assessment report (Annex C) assessed the impact of the above items on biodiversity as having minor or negligible significance,

however impacts to IUCN Listed threatened species and nationally listed restricted species was assessed as having moderate significance.

Mitigation Measures

Loss of habitat

- Implement the mitigation measures proposed in relation to hydrology, water quality, air quality and noise and vibration;
- Strict rules against logging outside the approved construction areas and against wildlife hunting and poaching will be imposed on project staff, workers, and all contractors and personnel engaged in or associated with the Project, with penalties levied for anyone caught carrying and using fire arms, or using animal snares and traps, including fines and dismissal, and prosecution under the laws of the Lao PDR;
- The Project owner shall be directly responsible for dissemination to its staff and workers of all rules, regulations and information concerning these restrictions, as well as the punishment that can expected if any staff or worker or other person associated with the Project violate rules and regulations;
- The planned clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing;
- Disturbed areas shall be rehabilitated as soon as possible following construction activities;
- Construction Contractor will establish biological resource management program and management plan to manage the construction activities to be conducted and monitor compliance with relevant permits and environmental regulations in order to prevent potential impacts to terrestrial ecology, in particular, vegetation and wildlife; and
- In natural habitat areas to be cleared, microhabitat features such as hollow logs will be relocated to adjacent natural habitat areas rather than being destroyed where possible.

Disturbance to fauna

- Construction vehicles and machinery will be maintained in accordance with industry standard to minimise unnecessary noise generation;
- Traffic signs will be installed on all roads throughout construction areas depicting speed limits;

- For construction and operation areas requiring night-time lighting, lights will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible; and

- Commitment will be made to raise awareness of values of natural habitat areas to construction work force and make arrangements for restriction of poaching.

Habitat degradation

- Construction and domestic waste will be appropriately stored and disposed of to avoid attracting native and alien species to the construction areas;

- For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed prior to commencement of vegetation clearance or earthworks and maintained until vegetation replanting can occur to stabilise disturbed surfaces;

- Monitoring of erosion and sediment control will be conducted to inspect the proper function of devices;

- Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licensed waste management contractors; and

- Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas.

Fauna mortality

- Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike;

- Commitment will be made to raise awareness of values of natural habitat areas to personnel and arrangements will be made for restriction of poaching and forest product collection; and

- Hunting wild animals will be strictly prohibited to apply for all staff;

4.2.6 *Land Use*

The project will alter land uses by:

- temporarily removing land uses from areas required for access roads, and other temporary infrastructure;

- permanently converting a small area of land to use for lattice towers;

- permanently limiting the types of land uses allowable within the RoW to those compatible with the transmission line, including:
  - prohibiting dwellings;
  - prohibiting growth of vegetation greater than 4.5m;
  - allowing growth of low growing crops, except in areas previously consisting of natural habitat; and
  - opening access to additional land through the creation of new roads.

The changes in land use, and the effects these changes have on communities will vary throughout the Project area. The level of impact will depend on the current level of utilization, availability of alternative resources, and diversity of the local economy.

The scale of land use changes (approximately 217.3 ha of land to be cleared, and 224.3 ha of land limited to vegetation below 3.0m) are not expected to have a significant impact on the social conditions of the surrounding communities.

After approval of the NNP1 by the Lao PDR government, NNP1PC will recheck the RoW and access road alignments and place signs around affected areas to inform the public and to limit the extent of land intrusion for agriculture purposes. Within villages, NNP1PC must reach agreement with the chief of the community and the villagers for infrastructure alignment.

Mitigation Measures

Agriculture productivity in the Project area will be restored as timely and efficiently as possible. The following improvement activities in the Project area should be taken into account.

- Livestock in affected areas will be relocated, where necessary;
- Productive land acquisition for the road alignment will be minimized as far as possible, and where unavoidable, compensation for the loss of property will be provided to the affected people;
- A separate Resettlement Plan will be prepared to address land acquisition and compensation issues, and will be reviewed by the Provincial Resettlement Management and Living Conditions Restoration Committee; and
- In the unlikely event that resettlement is required, the provisions of the Technical Guidelines on Compensation and Resettlement in Development Projects of the Lao PDR concerning resettlement and compensation will be followed strictly.

4.2.7 *Economy and Livelihoods*

Construction of the transmission line and associated infrastructure will provide employment opportunities to local people and may have a positive impact on the local economy and livelihoods. In addition, employment in the Project, and associated training, is expected to improve the skills and experience of local people in construction projects, including an improved working knowledge of health and safety practices.

The impact of productive land acquisition is discussed in Section *4.2.6*.

Mitigation Measures

The following measures should be implemented to maximize the benefits of the project to the economy and livelihoods:

- NNP1PC will carefully manage labor conditions;
- The construction contractor will hire local people during construction where local people have the required skills and experience. It is acknowledged, however, that much of the labor, especially skilled labor, will come from outside the Project area; and
- Training in health and safety and technical areas will be provided to all personnel.

4.2.8 *Damage to Property*

Detailed design of the access road will aim to avoid properties (such as houses, farmlands, aquaculture ponds, and irrigation canals) and community facilities (such as water supply, existing power supply and communication facilities). However, in some cases community infrastructure may be disturbed. This could affect viability of farming practices, water supply, power supply and communication, thereby affecting livelihoods and public attitudes toward the Project.

Mitigation Measures

- When constructing in the vicinity of irrigation and drainage channels, channels will be pegged and marked out to avoid unnecessary disturbance (such as driving over/through channels);
- If irrigation/drainage channels are to be intersected by Project infrastructure, they will be reinstated in the final infrastructure design. For example, if interrupted by a tower pad irrigation channels will be re-routed around the pad; if intersected by an access road, pipes will be installed below ground to maintain flow.

- The contractor shall immediately repair and/or compensate for any damage caused by the project to properties and community facilities.

4.2.9 *Community Health and Safety*

The negative effects on community health and safety during the construction phase may include the following:

- A possible increase in the transmission of communicable diseases (i.e., malaria, dengue fever, diarrhea, HIV/AIDs and STDs, and other endemic diseases) in the Project area. This impact should be minor and most cases prevented if the necessary mitigation and monitoring measures are carried out as detailed in the assessment;

- A possible decrease in the availability of food sources resulting in malnutrition of the local residents due to the requisition of land for the Project activities. However, the probability of this situation occurring is considered to be low as compensation will be provided by NNP1PC to enable residents have an equal or better level of nutrition;

- Naturally occurring floods may move loose construction equipment and materials, potentially causing accident or injury to the community, and damaging property; and

- Risk of vehicle accident due to construction traffic on public roads, as well as Project roads which may be utilised by the public.

The positive impacts on public health may include the following:

- Community development funds from the Project operation could result in greater investment in infrastructure and services such as clean drinking water systems, latrines, health education programs, and mobile clinics.

Mitigation Measures

- A public health education campaign will be provided that addresses: hygiene; disease prevention (including transmission pathways and symptoms of relevant diseases); and basic health promotion. For a rural community with a large number of people living together, public health education would be very helpful in relation to maternal and child health, nutrition, malaria, Japanese encephalitis, intestinal parasitic diseases and some water-borne diseases such as opisthorchiasis and paragonimiasis with vectors and intermediate hosts existing in the area. The Project will cooperate with district and local health authorities in this regard. This will be carried out by the Project's social safeguard staff;

- Impregnated mosquito nets will need to be provided to the Project workers and the general population. The provision of treatment programs and rapid diagnostic testing must also be available in the Project area and will be

implemented in cooperation with health authorities, including volunteer health workers;

- Construction materials and chemicals will be secured and locked down during flooding season.
- Latrines will be provided for each household in the Project area so that villagers have access to clean and safe water as soon as possible, particularly before the construction phase is launched;
- Traffic safety measures will be implemented as described in Section *4.2.13.*

4.2.10 *Occupational Health and Safety*

Construction activities present health and safety risks to personnel, including:

- accident and injury while working;
- spread of transmissible diseases between workers; and
- contraction of disease due to poor sanitation and environmental conditions in work and accommodation areas.

Mitigation Measures

The following measures will be implemented:

- Health Awareness Training will be mandatory for all personnel, and will address both on-the–job safety, and health awareness;
- Clean drinking water will be provided to all camps and work areas;
- Adequate sewage treatment will be provided;
- First aid kits will be readily accessible by workers and first aid teams will be specifically trained and assigned in groups of two to three persons to the different sites; and
- Vector control of mosquitoes and other pests will be managed including by minimizing mosquito breeding habitat and providing mosquito nets and other barriers.

4.2.11 *Culture and Customs*

Possible impacts of the temporary migration of workers and work camp followers into the area include:

- Increased demand on local resources and accommodation;
- Degradation of traditional sites;

- Offence to traditional customs;
- Social conflict between local communities and workers; and
- Increased crime and prostitution.

If these impacts occur, they are likely to be temporary.

Mitigation Measure

- The contractor will consult with local authorities to learn of any traditional practices and rules that need to be followed, and to coordinate in the enforcement of laws and regulations;
- A code of conduct will be established and enforced to reduce the potential for conflict between local residents and migrant workers;
- Any entertainment venues or recreational facilities in the vicinity of the project shall be operated strictly according to the local village values and traditions; and
- Local employment will be prioritised.

4.2.12 *Physical Heritage*

The transmission line has been aligned to avoid direct and visual impacts to the Prabat Phonsan Temple alongside National Road No. 13, which was identified as the only significant site along the transmission line corridor. However, unidentified sites of heritage significance may exist.

Mitigation Measures

The following measures will be implemented to minimize impacts to sites or items of cultural significance:

- ESOs will be trained to identify potential sites or items of cultural significance; and
- If previously unidentified artifacts are identified the contractor will immediately cease operations in the area, and inform the NNP1 Site Manager. The Owner will consult the Head of Village and Culture and Tourism Administration Office to obtain advice regarding the next steps. The contractor will recommence work only after the Culture and Tourism Office has provided official notification accordingly.

4.2.13 *Traffic*

The development of access roads specifically for Project use will limit impacts to traffic. However, transport of equipment and materials from sources to Project roads may increase traffic and the risk of vehicle accidents.

Mitigation Measures

The following mitigation measures will be applied to minimize impacts from construction traffic:

- All roads within the construction area will be signposted to facilitate traffic movement, provide directions to various components of the construction activities and provide safety advice and warnings in Lao and English;
- Traffic speed regulation devices, such as speed bumps, and signage will be installed at sensitive locations including in the vicinity of villages, construction camps, at busy intersections or before the sharp bend, and in areas of high habitat value if necessary;
- Prior to the movement of special loads on public roads, including hazardous materials or large items of including hazardous materials or large items of construction equipment, the ESMMU will be notified. If the ESMMU require additional measures, the reasonable and practical measures will be implemented to ensure that the risk of harm to the community and environment is minimized during transportation of special loads;
- In cases where heavy loads are required to be transported, some segments of roads and bridges may be reinforced to withstand the load; and
- In the event that stringing conductors present a possible risk to traffic temporary barriers (such as bamboo scaffolds) will be constructed across the roads and rivers to protect the public and property.

4.3 OPERATION STAGE

4.3.1 *Water Quality*

Transmission line infrastructure may have the following impacts to water quality during the operational period:

- The presence of hardstand areas (i.e. tower pads) has the potential to impact water quality through the operational phase by reducing infiltration, thereby increasing overland flows carrying pollutants to watercourses. Given the small area of tower pads (100m^2) this impact is expected to be minor;
- Heavily used roads can become contaminated with heavy metals, oils and surfactants that may be released to waterways in surface run-off. Sources of contaminants include tyre wear, brake lining wear and vehicle exhaust. Due to the anticipated low levels of traffic during operation of the transmission line, the risk of contamination from these sources is low; and

- The use of herbicides in RoW maintenance can lead to the release of herbicides into waterways via surface runoff.

Mitigation Measures

- Drainage of hardstand areas will be designed and constructed to retain surface runoff and facilitate infiltration to a level similar to pre-construction flows;

- Vegetation management methods that minimize the application of herbicides will be used (refer to Section *4.3.4*); and

- Store and handle pesticides to minimize escape to the environment, for example by storing in a location with appropriate containment measures and implement groundwater supply wellhead setbacks for pesticide application and storage.

4.3.2 *Air Quality*

Operation and maintenance can affect air quality by:

- The emission of ozone from transmission lines when in active corona, however ozone emitted from transmission lines is not known to carry any health risks[1]; and

- Air pollution due to burning of vegetation for RoW management.

Mitigation Measures

Vegetation will not be burnt for maintenance. Mechanical method will be used to trim tall and encroaching vegetation.

4.3.3 *Noise*

Noise in the form of buzzing and humming can often be heard around transformers, and may be heard from transmission lines, particularly during rain or fog. These noise emissions do not present any known health risks, but could disturb local residents and fauna.

Mitigation Measures

- Where locating the RoW near human receptors and areas of critical habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.

[1] World Bank Group (2007) EHS Guidelines: Electric Power Transmission and Distribution

4.3.4 *Biodiversity*

Anticipated impacts to biodiversity during operation include:

- Permanent loss of 65 ha of habitat, and modification of 373 ha of habitat within the corridor footprint;
- The RoW may interrupt the continuity of forest habitat, as vegetation heights will be limited to below 3 m, however the maintenance of vegetation in the understorey and midstorey is likely to continue to allow arboreal species to move throught the landscape;
- Disturbance and displacement of resident fauna due to noise as a result of electricity transmission, and noise and light as a result of maintenance activities;
- During operation, mortality of avifauna (birds and bats) may occur due to collision with the transmission line and electrocution. Avian collisions could occur in large numbers if lines are located in daily flyways, or if avifauna are travelling during low light conditions.
- Fauna mortality due to hunting, poaching and collection for trade due to the creation of access roads within and outside of the RoW.

Mitigation Measures

<u>Habitat Loss and Degradation</u>

- Within the RoW, vegetation trimming will be restricted to that required to safely operate the transmission line. Groundcover and midstorey vegetation will be retained wherever practicable;
- The Project shall implement landscaping and re-vegetation after completion of construction in suitable areas; and
- Vegetation management during the operation phase will minimise the use of herbicides by using mechanical pruning methods and providing appropriate training to maintenance personnel.

<u>Fauna Mortality</u>

- Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike;
- Commitment will be made to raise awareness of values of natural habitat areas to personnel work force and arrangements will be made for restriction of poaching and forest product collection;
- Hunting wild animals will be strictly prohibited; and

- Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.

4.3.5 *Land Use*

Operation of the project will limit the availability of land use in the RoW by:

- Prohibiting growth of trees greater than 4.5 m; and
- Prohibiting burning of crops (such as rice straw or plant residue).

Mitigation Measures

Compensation for loss of productivity due to the Project will be paid during the construction phase.

4.3.6 *Economy and Livelihoods*

Ongoing maintenance of the RoW, particularly vegetation management, can provide employment to local residents.

Mitigation Measures

- Local people will be employed for suitable roles wherever possible; and
- Appropriate health and safety measures will be undertaken to protect all Project personnel, as described in Section *4.3.8*.

4.3.7 *Community Health and Safety*

The presence and operation of transmission lines presents health and safety risks to the public. These include:

- Potential for aircraft collision with overhead powerlines. Power transmission towers can impact aircraft safety through direct collision and interference with radar equipment.
- Potential health impacts due to exposure to electromagnetic radiation. Studies have shown that the electromagnetic field strengths for 230 kV transmission lines at 30m are as low as or lower than that of common household appliances.[1] However, it is the constant exposure to the electromagnetic force that is of concern. Health issues associated with constant exposure include depression and migraine headaches. There is also a possible (although not confirmed) increased risk of childhood leukaemia from exposures greater than 0.4mG. The electromagnetic

[1] From http://www.who.int/peh-emf/about/WhatisEMF/en/index3.html

radiation from transmission lines is lower than 0.4mG when 60m from the centre line for 230 kV lines.[2]

- Noise in the form of buzzing and humming can often be heard around transformers, and may be heard from transmission lines, particularly during rain or fog. These noise emissions do not present any known health risks, but could disturb local residents;

- Overhead transmission line conductors and high frequency currents can create radio noise. Although these are generally designed to limit noise outside of the RoW periods of rain may increase this effect and affect radio reception in nearby residential areas;

- Toxicity of herbicides used in maintenance of RoW, which may come into contact with residents through air, water or direct contact with vegetation;

- Uncontrolled forest fires as a result of inadequate management of vegetation in the RoW; and

- Electrocution due to contact with high voltage electricity, or items (such as tools, vehicles or ladders) in contact with high voltage electricity.

Mitigation Measures

<u>Air craft collision</u>

- Transmission lines and towers will be sited outside of known flight path envelopes where possible and if installation is required in flight sensitive areas, buried lines will be used (Section *4.2.8*); and

- Air traffic authorities will be consulted prior to construction.

<u>Electromagnetic Radiation</u>

- Site transmission lines and other high voltage equipment away from residential properties and areas of high human occupancy (e.g. schools);

- Evaluate potential exposure levels and assess against the standards provided in *Annex B*;

<u>Noise</u>

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[2] See Stakeholder Advisory Group on ELF EMFs (SAGE), First Interim Assessment: Power Lines and Property, Wiring in Homes, and Electrical Equipment in Homes, pp. 43-52. This report calculated the distance according to the standard transmission lines in the UK, of 30 meters for 110 and 123 kV lines, and 60 meters for 275 kV lines, which are considered equivalent to the 115 kV and 230 kV lines of this project.

- Where locating the RoW near human receptors and areas of critical habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.

Toxicity

- The use of herbicides will be minimized through the integrated vegetation management approach described in Section *4.3.4;*
- If application of herbicides is unavoidable, application will not occur during windy or rainy weather; and
- The measures outlined in Section *4.3.1* to minimize impacts of herbicides on water quality will be implemented.

Forest Fires

- Thinning and slashing will be scheduled to avoid the fire season;
- Vegetative debris will be disposed of in locations that do not increase the fire risk; and
- Fuel breaks will be established to slow the progress of fires and allow firefighting access.

Electrocution

- Signs and barriers will be installed to prevent access to high voltage areas; and
- Grounding conducting objects will be installed near transmission lines.

General

- Development (for example construction of homes, shops etc) within the RoW will be strictly prohibited.

4.3.8 Occupational Health and Safety

Hazards relevant to Project personnel include:

- Exposure to EMF at levels higher than those experienced by the general public;
- Electrocution due to contact with high voltage electricity or items in contact with high voltage electricity (such as tools, vehicles or ladders);
- Working at height on towers;
- Exposure to herbicides and PCBs.

Mitigation Measures

Electromagnetic fields

- An EMF safety program will be developed prior to operation which: identifies potential levels of exposure; provides training for all workers; delineates zones appropriate for public access and those restricted to appropriately trained workers; defines measures to limit exposure time, such as through work rotation; and provides personal monitoring equipment for workers.

Electrocution

- Transmission lines will be deactivated and grounded prior to work on, or near, transmission lines;
- Live work will only be conducted by trained workers;

Working at heights

- Fall protection measures will be implemented including provision of appropriate fall protection equipment, training in use of equipment, training in climbing techniques, and rescue of fall-arrested workers;
- All equipment, including hoisting equipment, power tools and tool bags, will be properly rated and maintained;

Exposure to chemicals

- Appropriate personal protective equipment (such as gloves and safety glasses) will be supplied to all personnel handling herbicides or potentially contaminated materials;
- Training will be provided to all personnel in the appropriate application, hygiene and safety requirements for the use of herbicides.

5 ANALYSIS OF ALTERNATIVES

As described in *Section 2*, the purpose of the Project is to transmit electrical power from the Main Dam site to the Nabong collector substation in Vientiane. A number of alternative route alignment scenarios were considered to fulfill this purpose in a financially and technically feasible way, and with minimum environmental and social impact. This included consideration of alternative route alignments and two alternative substation layouts.

Considerations in the selection of alternatives included:

- Reliability of power transmission, by minimizing the risk of line outage and maximizing opportunities to rapidly repair the line if damage occurs;
- Avoidance of significant environmental features, such as protected areas or other forest areas of biodiversity value;
- Avoidance of significant socioeconomic features, such as large settlements, villages, houses, businesses, other infrastructure and industry; and
- Cost effectiveness, including efficient design and minimizing the route length, construction access and maintenance access points.

In addition, options for substation layout exist. The selected option, however, will depend upon agreement between Government of Laos and the current substation operator, Nam Ngum 2. Substation options are described in Section *5.2*.

5.1 ALTERNATIVE ROUTE ALIGNMENTS

The transmission line has undergone a number of route alignment changes since pre-feasibility studies based on changes in the environment and social conditions of the region and the availability of additional information as environmental investigations progress. *Table 5-1* summarizes the changes to the alignment since pre-feasibility assessments in 2002. Section *5.1.1* provides further detail on the changes to the alignment from the route described in the 2012 IEE.

Table 5.1 Alignment adjustments 2002 - 2014

Alignment Version	Description
Prefeasibility route (November 2002)	Intersected areas of mixed forest and two residential areas. Avoided Wat Ptabat Phansane Temple.
EGAT route (August 2007)	Avoided areas of mixed forest, residential areas and Wat Ptabat Phansane Temple. EGAT route was found to intersect area frequently used by elephant herd.
Initial IEE route (February 2011)	Avoided areas of mixed forest, residential areas, Wat Ptabat Phansane Temple and area frequently used by elephant herd. Huay Ngua PPA was established in 2010, and initial IEE route was found to intersect the PPA.
IEE V1 route (January 2014)	Alternative routes considered, and alternative that avoided Huay Ngua PPA was selected.

Alignment Version	Description
Source: NNP1PC 2013	

5.1.1 *Alternative Alignments Following Initial IEE*

The original route alignment was designed prior to the gazette of Huay Ngua PPA. The original route alignment was studied in the initial IEE (ERIC 2012), however following the creation of the PPA, it was identified that the original alignment traversed the PPA. For this IEE, new alternative routes to avoid the PPA were considered. The base alignment considered in this report is referred to as the Eastern Alignment. The alternative considered, which avoids Huay Ngua PPA by remaining on the west bank of the Nam Ngiep River, is referred to as the Western Alignment.

- Eastern Alignment: the alignment runs along the east bank of Nam Ngiep, adjacent an existing access road that intersects Huay Ngua PPA, then from south of Huay Ngua PPA runs parallel to the EDL transmission line route.

- Western Alignment (the option examined in this IEE): the alignment remains on the west bank of Nam Ngiep, avoiding Huay Ngua PPA, and rejoins the original alignment south of Huay Ngua PPA. The gradient on the west bank is steep.

An analysis of considerations with respect to vegetation and habitats for the two alignments was carried out in the NNP1 Transmission Line Biodiversity Assessment Report (Appendix F). The analysis split each route into five different segments, with each segment analyzed for its potential impact to the habitat type and land condition. The results indicated that, overall, the Western Alignment traverses less natural habitat and contains a higher proportion of low condition vegetation in comparison to the Eastern Alignment.

Based on the assessment of the cost, constructability, reliability and environment and social impacts provided in *Table 5-2*, the Western Alignment was considered the preferred option, and is the option examined in this IEE.

Table 5.2 ***Comparison of environment and social impacts, and feasibility of Proposed Road and Alternative Route***

Consideration	2012 Alignment	Eastern Alignment	Western Alignment (subject of this IEE)
Length/cost	Approx. 125 km. Mitigation cost to be considered.	Approx. 136 km (+11km). Higher cost due to long distance.	Approx. 124 km (-1km). Equivalent cost to original budget.
	Poor	Poor	Good

Consideration	2012 Alignment	Eastern Alignment	Western Alignment (subject of this IEE)
Constructability / operability	Aligned in intermountain area with moderate slope, and accessibility with some distance from the existing access road.	Aligned in intermountain area with moderate slope, and easy accessibility adjacent to the existing access road.	Aligned in intermountain area with steep slope, and difficult accessibility away from the existing access road.
	Good	Excellent	Fair
Reliability	A certain distance from NNP River. High reliability due to alignment located in intermountain area with moderate slope.	A certain distance from NNP River. High reliability due to alignment located in intermountain area with moderate slope.	Must avoid the flooded area because of close to NNP River. Must avoid possible landslide area due to rather steep slope.
	Excellent	Excellent	Good
Environmental impact	Impacts on PPA with longer length. Tree cutting and bush clearance are required.	Impacts on PPA with shorter length. Tree cutting and bush clearance are required. Traverses more natural habitat than Western Alignment.	No impacts on PPA Tree cutting and bush clearance are required. Traverses less natural habitat and more low condition vegetation than the Eastern Alignment.
	Fair	Good	Excellent
Social impact	No residential area.	Passing close to Thahuea village.	No residential area.
	Excellent	Poor	Excellent
Evaluation	Fair	Good	Good

Figure 5-1 Alternative alignments considered prior to 2012 IEE (Source: NNP1PC 2013)

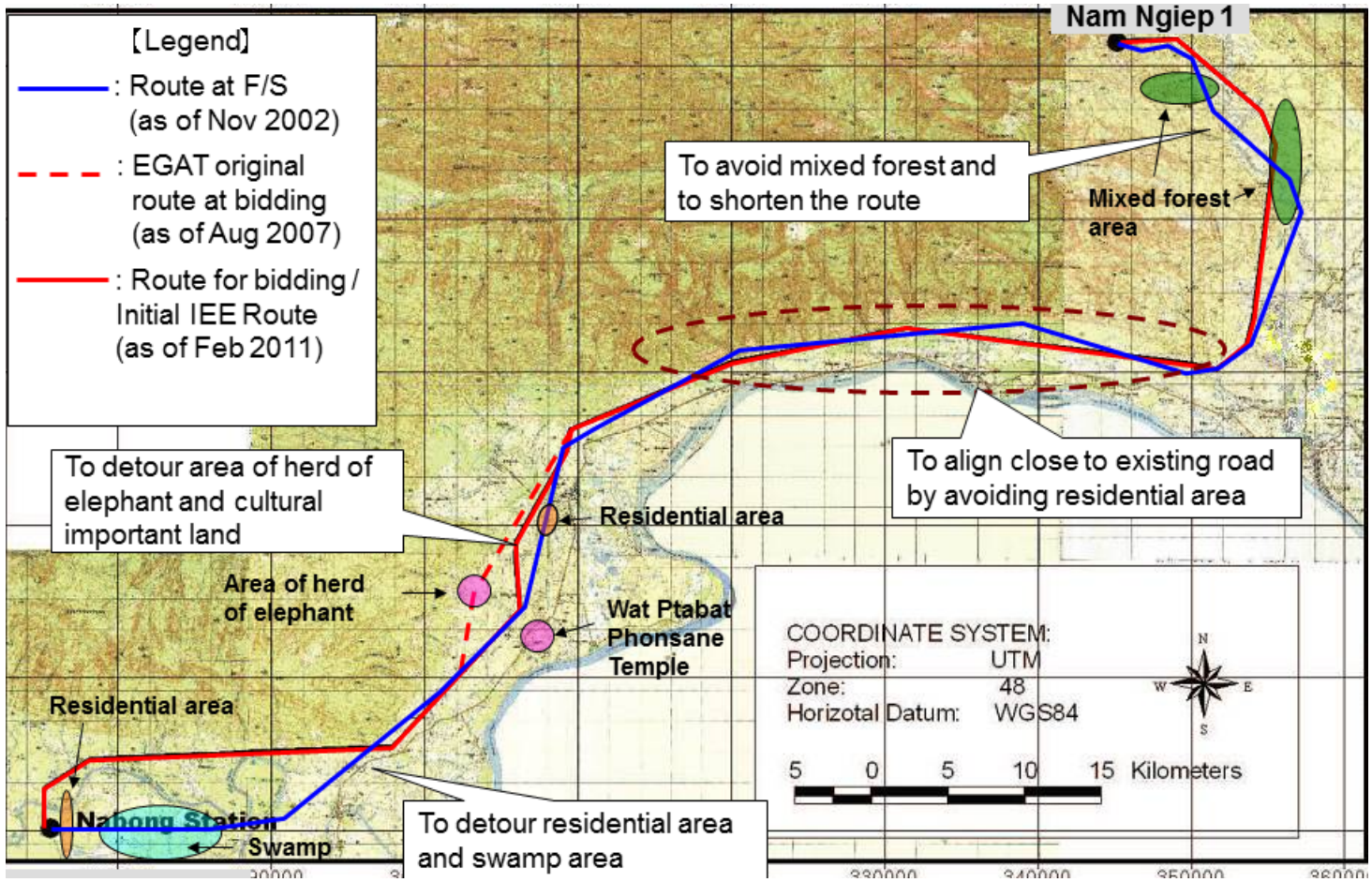


Figure 5-2 Alternative alignments following 2012 IEE

5.2 *SUBSTATION LAYOUT ALTERNATIVES*

Nabong substation was designed and constructed for collective use, i.e. for collection of electricity generated by multiple IPPs. From the substation, electricity is stepped-up from 230 kV to 500 kV and exported to Thailand by 500 kV Nabong transmission line. Nabong substation and Nabong transmission line should be embedded into the Lao National Grid System. Currently, Nabong substation and Nabong transmission line is owned, operated and used solely by Nam Ngum 2. The transmission line is operated at 230 kV, although has been designed for 500 kV.

There are two options for the use of Nabong Substation by NNP1PC:

- **Option 1 -** Once other IPPs, including Nam Ngiep 1, are accepted to sell electricity by EGAT, ownership of Nabong substation and Nabong transmission line would be transferred from Nam Ngum 2 to the Government of Laos. The substation would then be expanded and upgraded (by installing additional transformers) to allow other IPPs to connect. The transmission line would then be operated at 500 kV. In this option, Nabong substation, including transformers, and Nabong transmission line should be shared by all interconnected IPPs.

- **Option 2 –** If asset transfer is not successful, GoL will need to construct a second substation adjacent the existing Nabong substation to enable NNP1PC to interconnect to Nabong transmission line. In this option, a new substation would be constructed very close to the existing Nabong substation. Based on the collocation of the two substations, the environmental impacts of both options are considered equivalent, with the only difference being a requirement for an extra few hundred metres of 500 kV transmission line to interconnect the existing Nabong transmission line downstream of Nabong substation.

The option selected will depend on the agreement reached between GoL and Nam Ngum 2.

Public consultation has played a key role in development of the Project, and will continue to play an important in its implementation.

The goal has been to ensure opportunities exist for stakeholders to be involved in Project design, including potentially affected people. More specifically, the objectives are to:

- Ensure that stakeholders concerns are incorporated in the Project design and implementation;
- Increase stakeholder awareness and familiarity with the Project;
- Ensure transparency in the decision-making process; and
- Enhance the potential benefits by directly involving relevant stakeholders.

These objectives are being met through a comprehensive public consultation and disclosure process, which has been ongoing for a number of years. This has included:

- Sharing relevant Project information at the earliest stages of the Project;
- Providing on-going opportunities to input to the Project; receiving feedback from Project stakeholders; and
- Utilising outputs from the consultation process to inform the Project design, including proposed management measures and corresponding management plans.

In terms of the transmission line corridor, disclosure of the alignment and discussion of potential impacts and proposed management measures has occurred. This has been done through a variety of engagement activities - as outlined in *Table 6-1*.

Table 6.1 Public Meetings

Stakeholder Group	Date	Consultation Activity
Stakeholders including international financial institutions, MONRE, GOL organizations and agencies, general public, and NGOs	May 2011	Consultation and discussion at Hom District
	July 2011	Technical workshop and site visit to proposed resettlement site by MoNRE
Provincial Level: Bolikhamxay, Vientiane, and Xieng Khouang Province representatives	April 2008	Consultation and discussion at Bolikhamxay Province
	April 2008	Consultation and discussion at Xieng Khouang Province
	April 2008	Consultation and discussion at Vientiane Province

Stakeholder Group	Date	Consultation Activity
	April 2012	Consultation and discussion at Vientiane, Xieng Khouang and Bolikhamxay Provinces
District Level: Bolikhan, Pakxan, Hom, and Thathom District representatives	January 2008	Public consultation at Bolikhan District
Zone 3 villages, including villagers and village authorities	July 2011	Household and village survey at Ban Hatsaykham
	September 2011	Consultation meeting at Ban Hatsaykham

The consultation activities have helped to identify potential impacts, including impacts to significant historical/ archaeological sites, such as the Wat Prabat Phonsan. The result has been a realignment of the transmission line corridor in order to minimise the potential impacts.

However, as the transmission corridor alignment has recently changed additional consultation will be required. This engagement will be undertaken once the alignment has been confirmed and will provide an opportunity to disclose the revised alignment.

7 GRIEVANCE REDRESS MECHANISM

The Project has the potential to affect the interests of thousands of people, which may result in differences in perception and expectations. These differences may lead to conflicts between potentially affected persons (PAPs), including individuals, households or groups in the communities, on the one hand, and the government, the developer, and those hired to implement the Project on the other. A grievance redress mechanism (GRM) has therefore been established to achieve the following objectives:

- Promote productive relationships with local communities and identify community concerns through consultation, disclosures, participatory planning and decision making (as described in *Section 6*) with PAPs in order to prevent grievances wherever possible and maximize environmental and social benefits;
- Address and resolve differences or grievances associated with the Project through established GRM procedures, as outlined in the following sections.

The GRM will address all grievances raised by PAPs across the Project, including a grievances raised by stakeholders located along the transmission line corridor.

7.1 GRIEVANCE REDRESS PROCEDURE

The GRM, in the first instance, seeks to resolve disagreements or stakeholder concerns before they evolve into grievances. This is done through ongoing engagement with stakeholders throughout the Project, particularly the PAPs. The resulting informal negotiations and discussions will be conducted in a transparent manner and will be appropriately documented. This includes agreements that are reached, which will be voluntarily signed by all parties involved in the negotiation.

In cases where concerns or conflicts cannot be resolved through consultation and / or discussions, the GRM has established a hierarchy of grievance committees and procedures to receive and resolve grievances. These committees and procedures are summarized below.

Stages and timeframes associated with the GRM procedures are as follows:

- Stage 1: PAPs will register grievances on any aspect of compensation, relocation or unaddressed losses with the Village Grievance Committee. The Village Grievance Committee will organize a meeting within 15 days from the date of formal receipt of the grievance with the complainants to resolve the issue using its traditional methods of conciliation and negotiation; the meeting will be held in a public place and will be open to other PAPs and villagers to ensure transparency. The report on the decision of the Village Grievance Committee must be in writing and must be signed by all members of the committee. If any members of the committee dissent from the opinion of the majority, those members can note their dissent as part of the report of the decision. The aggrieved party and the Project representatives should also sign and indicate their agreement or disagreement with the decision.

- Stage 2: If either the PAP or the Company is not satisfied with the decision of the Village Grievance Committee, or if the Project does not abide with the decision of the Village Grievance Committee, an appeal can be made directly by the Project or by the PAP, or by the Village Grievance Committee on behalf of the PAP. Other persons or organizations, such as local NGOs, mass organizations like Lao Women's Union, or other representatives of the PAP, can ensure that the appeals are forwarded to the District Grievance Committee. The District Grievance Committee will keep a public log of all claims and grievances it receives, including a summary of the decisions made, and must also make public all reports on the decisions made by the committee. The meeting of the District Grievance Committee will be held in a public place, no more than 20 days from the date of formal receipt of the grievance. Representatives from the Company must be available to provide any necessary information to the committee on entitlements, compensation rates, mitigation measures, and any other relevant information concerning the grievance. The report on the decision of the District Grievance Committee must be in written and must be signed by the members of the committee.

- Stage 3: If the PAP is still not satisfied with the decision of the District Grievance Committee or if the Project does not abide by the decision of the District Grievance Committee, an appeal can be made to the Provincial Grievance Redress Committee. The Provincial Grievance Redress Committee will examine and consider the complaint or grievance in consultation with representatives of MONRE and the Company within 20 days after filing the complaint.

- Stage 4: If the PAP is still not satisfied with the decision of the Provincial Grievance Redress Committee, or in the absence of any response within the stipulated time, the grievance can be submitted to the Court of Law by the PAPs or a representative of a non-profit organizations or the Village Grievance Committee on behalf of the PAPs or at the request of the Project.

The Court of Law will follow up with the relevant authorities to make the final and binding decision.

- Stage 5: In case that the Project is found responsible for negligence, the Project will cover in full all administrative and legal fees incurred by the PAPs in the GRM process at the district, provincial and MONRE levels and in the Court of Law. Complaints and grievances concerning impacts during construction will be considered up to and for no more than one year after the official date of completion of construction.

7.2 ESTABLISHMENT OF GRIEVANCE REDRESS COMMITTEES

The GRM procedures will be managed by a hierarchy of grievance redress committees, comprising the members outlined in *Table 7-1*.

Table 7.1 Grievance Redress Committee Members

Committee	Committee Members
Village Grievance Committee	• The village head (chairperson); • Representatives of local village authorities; • Village elders; and • Representatives from community organizations, including the Lao Women's Union.
District Grievance Committees	• Representative of the District Authority (chairperson); • Local village leader(s)/ head(s); • Representatives from the PAPs, other than village leader(s)/head(s); • Local village elders and/or other local community organizations, including the Lao Women's Union; • Representatives from local not-for-profit organizations; and • Representatives from the Project team.
Provincial Grievance Redress Committee	• Representative of the provincial authority. This individual will become the chairperson; • Representatives from the provincial or district authority' • Representatives from the PAP (eg a representative from a village directly affected by the Project); • Representatives from community organizations, including the Lao Women's Union; • Representatives from a local not-for-profit organization; and • Representatives from the Project team.

The various committees will be established prior to commencement of the Project, in particular the resettlement activities. This will be done by making a formal request to the GOL for the relevant authorities in each province to establish the Provincial and District Grievance Committees. The District

Grievance Committees will be given the authority to establish Village Grievance Committees in villages affected by the Project.

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 INSTITUTIONAL ARRANGEMENT

8.1.1 Project Institutional Arrangement

During the pre-construction and construction stage of the transmission line, a specific project's Environmental and Social Team will be established. It is obligated to entail the appointment of new teams and responsibilities as follows:

- Environmental Management Office (EMO); and
- Social Management Office (SMO)

Both offices would be established as the Environmental and Social Division (ESD), managed by the ESD Manager who is responsible for the environmental and social implementation of Environmental Management Plan (EMP) on the site during construction stage. The ESD Manager would be supported by a Deputy Managing Director, Environment and Coordination.

Table 8-1 defines the roles and responsibilities of the Environment and Social Team, and an overview of the Project's management structure and environmental incorporation between the owner and the construction contractor is shown in ***Figure 8-1***.

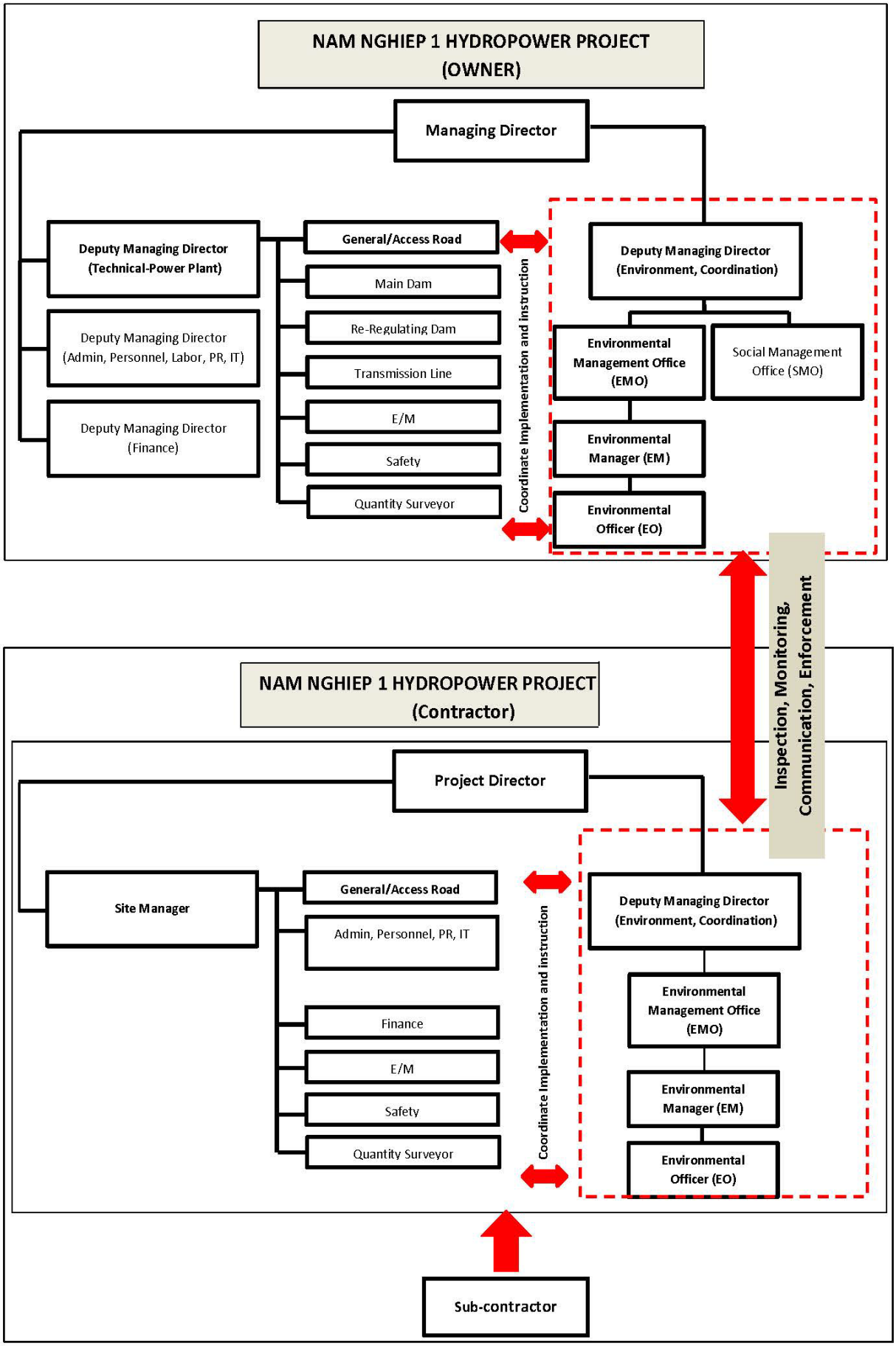
Table 8.1 Roles and Responsibilities for implementation of EMP

Role	Responsibilities
Deputy Managing Director (Environment, Coordination)	• Guide the development of an Environment and Social Management and Monitoring Plan for the Construction Phase (ESMMP-CP) based on the impacts and mitigation measures defined in the IEE; • Have a working understanding of legal environmental obligations of the Project, and the requirements of the ESMMP-CP; • Implement the ESMMP-CP; • Confine the construction site to the demarcated area; • Provide adequate resources and capabilities to implement and maintain the ESMMP-CP; • Verify that sufficient funds are available to properly implement the ESMMP-CP; • Monitor site activities on a regular basis for compliance; • Conduct internal audits of the construction site against the ESMMP-CP; • Rectify transgressions through the implementation of corrective action; and • Submit periodic monitoring reports to ADB.

Role	Responsibilities
Environment Manager and Environmental Officers	• Develop the Project ESMMP-CP based on the impacts and mitigation measures defined in the IEE; • Have a working knowledge of the environmental impacts, mitigation measures and recommendations of the ESMMP-CP; • Supervise and provide budget for monitoring activities. • Verify that sufficient funds are available to properly implement the ESMMP-CP. • Review and approve the SS-ESMMP-CPs; • Act as main point of contact between the GOL authorities and the Project on environmental issues; • Review and improve method statements for environmental aspects prior to work starting; • Verify that tender documents and civil works contracts include the Project ESMMP-CP and specify requirement for preparation and implementation of construction SS-ESMMP-CP; • Identify environmental and health and safety competence requirements for all staff, including contractor personnel, working on the project and facilitate delivery of environmental training; • Monitor construction performance to verify that appropriate control measures are implemented to comply with the ESMMP-CP; • Recommend corrective action for any environmental non-compliance incidents on the construction site, and provide advice and liaison with the construction teams to ensure that environmental risks are identified and appropriate controls are developed; • Compile a regular report addressing environmental performance progress and any non-compliance issues to relevant parties, including submitting semi-annual monitoring reports to ADB through the ESD; • Provide the data and information to the lenders' environment specialist tasked to audit the environmental performance of the completed access road. This data and information include the approved ESMMP-CP, SS-ESMMP-CPs, proof of delivery of training program, environmental monitoring reports, engineer's logbook, records of compliance check, contractor's report on environmental performance and incidents, environmental register of all incidents that occurred on the site during construction. • Inform affected parties of any changes to the construction program. The contact numbers of the EO shall be made available to the affected parties. This will ensure open channels of communication and prompt response to queries and claims; • Establish an environmental grievance redress mechanism that is acceptable to ADB, to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the Project's environmental performance; and • Liaise and cooperate with GOL authorities responsible in arranging for adequate meeting and reporting to GOL authorities on a regular basis.
Construction Contractor	• Recruit a qualified Environmental Officer on a full-time basis to manage compliance with contractual environmental obligations and implementation of the SSESMMP-CP; • Develop and implement the Construction Contractor's Environmental Management Plan (Construction Contractor's EMP) and SSESMMP-CPs to comply with Project commitments (i.e. Owner's EMP and ESMMP-CP); • Plan and direct construction activities to minimize environmental impacts and comply with environmental management procedures, license and approval requirements;

Role	Responsibilities
	• Verify the implementation of all applicable mitigation measures defined in the SSESMMP-CP during construction of road, bridges and culverts, and associated facilities; • Liaise with EMO to facilitate implementation of environmental mitigation measures; • Provide adequate resources to implement the Construction Contractor's ERM and SSESMMP-CP; • Implement routine inspection and monitoring program, including undertaking the contractor's weekly environmental monitoring; • Implement a process of corrective and preventive action for non-compliance identified through internal and external inspections and audits; • Implement additional environmental mitigation measures where monitoring or other observations indicate opportunities for improved environmental management; • Submit monthly reports to ESD/EMO on the implementation of environmental mitigation measures and environmental monitoring results; • Maintain an environmental register which keeps a record of all incidents which occur on the site during construction and report environmental incidents to Owner; • Manage safety of construction workers and local people during construction; • Receive and manage complaints from the public in accordance with the GRM; and • Facilitate the restoration of community facilities and provision of temporary canals/irrigation channels to avoid disruption of water supply to farmlands.
All Project personnel	• Protecting the environment by implementing relevant aspects of the EMP and ESMMP-CP

Figure 8-1 Project Institutional Structure



8.1.2 *Government of Lao PDR Institutional Arrangement*

The GOL will establish the national level organizations responsible for setting policy and directions, supervising and monitoring the development of the Project. The project will provide resources so that these organizations can effectively monitor the implementation of the Project's environment and social management programs.

The roles of the GOL at the national level will be provided through the Joint Steering Committee (JSC) and the Ministry of Natural Resources and Environment (MONRE) as the primary supervisory and monitoring body. A Secretariat of the JSC will include key government agencies and organizations involved in the environmental and social components of the Project, specifically EdL, the Department of Environmental and Social Impact Assessment (DESIA) of MONRE, the Department of Energy Business (DEB) of the Ministry of Energy and Mines, and the Resettlement Management Unit (RMU) established for this project.

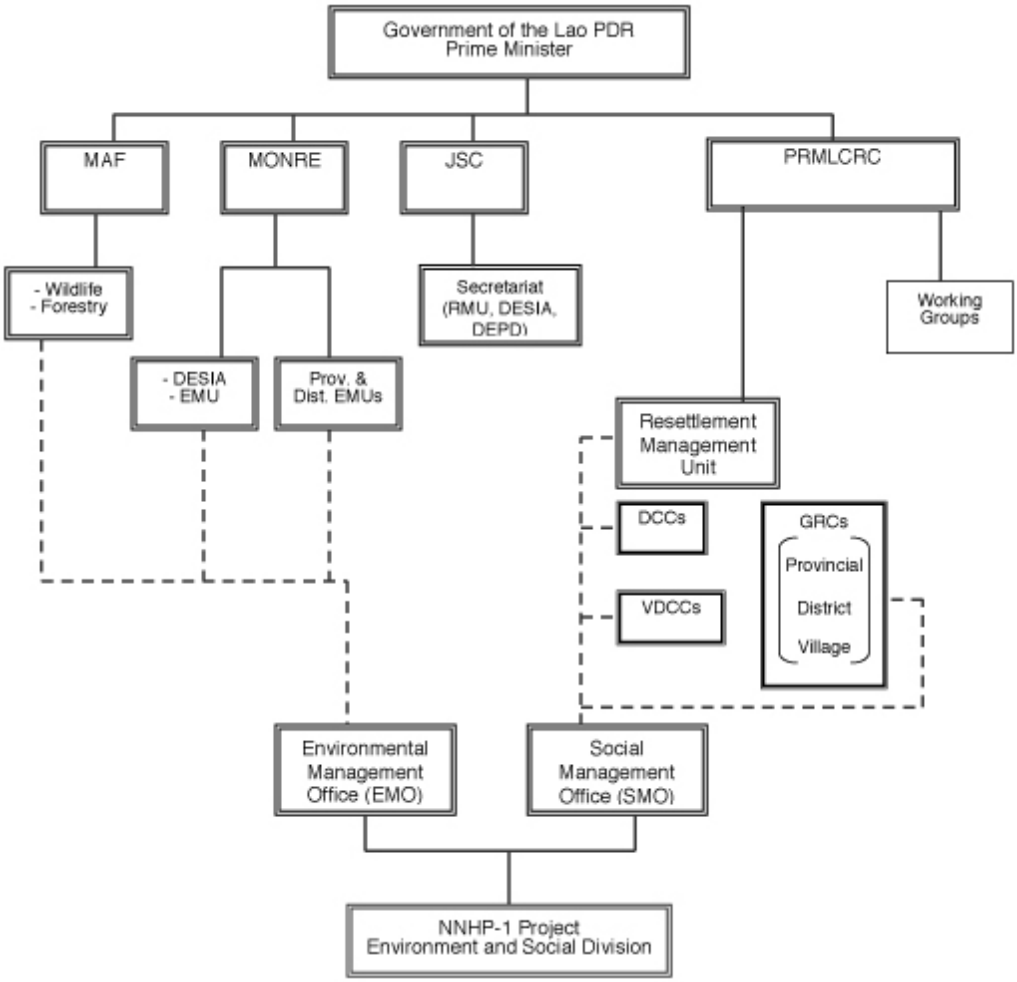
An Environmental Management Unit (EMU) will be established in MONRE to oversee monitoring of the project. Environmental components will be carried out by relevant government agencies in MONRE and in the Ministry of Agriculture and Forestry (MAF). Provincial and District EMUs will be established, consisting of the heads of the relevant government offices for the various environmental aspects of the Project.

A Provincial Resettlement and Living Restoration Committee (PRLRC) has been established to be the lead organization in approving policies and plans, entitlements, and activities, and supervising and monitoring the implementation of social measures, including resettlement, and to provide the mechanism for public involvement, for decisions on compensation, and for the expression and resolution of grievances.

A Resettlement Management Unit (RMU) will be established by the PRMLCRC to coordinate the work of the government in resettling the most severely affected people in the project area, together with the technical assistance, financial support, and related work of the project developers through the Project's Environment and Social Division.

Figure 8-2 shows the relationship between the Project institutional structure and the relevant departments of the GoL.

Figure 8-2 Relationship between Project team and GoL



8.2 ENVIRONMENTAL MEASURES

Environmental management for the Project aims to minimize the negative impacts of the transmission line construction and at the same time, enhance the positive and beneficial impacts.

Table 8.2 presents the mitigation measures of transmission line construction. These mitigation measures are an overview only, based on the potential impacts identified in this IEE. Prior to construction, an Environment and Social Management and Monitoring Plan for the Construction Phase (ESMMP-CP) will be prepared which provides further detail on the implementation of the environmental management. The ESMMP-CP will include a series of sub-plans specific to environmental themes identified in this IEE.

Prior to construction, the construction contractor will develop a suite of Site-Specific ESMMPs which address specific segments of the RoW, based on site conditions (e.g. proximity to villages, waterways and natural habitats).

Table 8.2 Environmental Management Measures

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Design and Pre-construction Phase						
Hydrology	If poorly designed, the presence of bridges has the potential to disrupt stream flows.	• River diversion and bridges will be designed to maintain pre-construction flows, including by designing the bridge to: minimize the use of pylons to retain the existing channel section; operate with a freeboard between the flood level and bridge deck, avoid encroachment of bridge abutments into the channel.	Bridges and in-stream works	At commencement of design phase	Civil Engineers	Deputy Managing Director (EC)
Hydrology	Creation of hardstand areas can increase the velocity of surface run off and lead to erosion.	• Drainage will be designed to safely convey runoff from developed areas at non-erosive volumes and velocities.	All hardstand areas.	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Water Quality	Poor siting of towers, material stockpiles, worker camps and access roads, can lead to: • High levels of erosion and sediment run off, which may increase turbidity of surface waters; • Contaminated run off from waste and hazardous materials storage areas; and • Leaching of sewage and domestic waste from camp and construction areas.	• Construction in steep areas and watercourse crossings will be minimized. • Adequate waste and materials storage areas will be provided for in the site layout. • Material stockpiles will be located at least 30 m away from steep slopes, watercourses or drainage paths. • Solid and septic waste management systems will be planned for in the design process.	All construction areas	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Noise	Noise from transmission lines could disturb people if sited near villages or other areas of frequent	• Refine transmission line route to avoid villages and critical habitat for noise-sensitive species.	Transmission line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Biodiversity	Loss of natural and modified habitat due to vegetation clearing	• A habitat/flora assessment will be undertaken within proposed transmission line route and proposed access roads to identify areas of natural habitat and locations of threatened flora species. • The design and layout plan will be prepared to minimise tree cutting and to avoid any identified areas critical habitat and threatened flora. • A transmission line route was selected to avoid intersecting Huay Ngua PPA.	All construction areas	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Biodiversity	Some residual impacts will not be able to be avoided through the measures outlined in this EMP. These impacts are to be offset.	• Implement the recommended offset package outlined in the Biodiversity Offset Design Report (ERM 2013).	Offset areas designated in Biodiversity Offset Design Report (ERM 2013)	Beginning in design phase.	Deputy Managing Director (EC)	Deputy Managing Director (EC)
Biodiversity	Bird and bat mortality due to electrocution	• Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.	Transmission Line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Land Use	Inappropriate layout design can lead to unnecessary, avoidable impacts to existing land uses and subsequent impacts to livelihoods.	• Locations of infrastructure, including permanent infrastructure, will be selected to minimize the acquisition of productive land as far as practicable. • A compensation process will be developed and compensation will be provided for the loss of property during the construction phase.	All areas to be acquired.	Beginning in design phase.	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Community Health and Safety	Potential for aircraft collision, or interference with radar equipment.	• Transmission lines and towers will be sited outside of known flight path envelopes where possible; and • If installation is required in flight sensitive areas, buried lines will be used.	Transmission Line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Community Health and Safety	Potential health impacts due to exposure to electromagnetic radiation.	• Site transmission lines and other high voltage equipment away from residential properties and areas of high human occupancy (e.g. schools). • Evaluate potential exposure levels and assess against the	Transmission Line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		standards provided in Annex *B*.				
Public Property	Transmission lines may impact visual amenity, which can be undesirable to residents.	• Powerlines will be sited in consultation with the community, and with due consideration of landscape views. • Changes to property values due to powerline proximity will be assessed, and appropriate compensation will be provided.	Transmission Line	Beginning in design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Construction Phase						
Capacity of Personnel	Project workers fail to implement EMP due to lack of understanding and competencies in environmental skills and awareness.	• Development and provision of environmental induction and regular training for all workers. • A training register containing details and name of training session; date of training session; list of attendees; and signatures and name of trainer will be properly maintained. • The key messages of each training session will be communicated to workers via poster and leaflet form in proper language. In addition, posters will be displayed prominently in construction work camps and construction areas and leaflets will be distributed to staff on a regular basis.	Training and Induction Centre	Prior to personnel commencing work	EM/EO	Deputy Managing Director (EC)
Hydrology	Naturally occurring flooding may cause a risk to the Project, and the presence of construction equipment and materials may exacerbate the risk to surrounding communities. Since the flood flow is fast and high volume, loose materials and equipment might get swept downstream and potentially cause some damage to structures and harm local people.	• A Flood Response Plan will be prepared and communicated as part of the Training and Awareness Program. • Construction materials and chemicals will be secured and locked down during flooding season. • If stream diversion, or flow inhibition is required during in-stream works, the construction contractor must understand the emergency flood plan, and be aware of increased waterway capacity in order to release the excess volume of water.	All construction areas	Wet season	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Hydrology	Temporary diversion of rivers for in-stream works (potentially required for access road construction) impacting hydrology, aquatic biota, and potentially access of villagers to water resources.	• If river diversion is expected to alter flows to an extent that would lower the downstream water level, local people will be informed of changes to water levels, including expected extent and duration of change.	Construction site - watercourses	Prior to river diversion	CC	EM/EO
Hydrology	Earthworks required for tower footprints, access roads, stockpile areas and other infrastructure may alter the flow of surface runoff.	• Earthworks will be undertaken to minimize changes to surface water flows, and to avoid collecting standing water.	All earthwork sites	Prior to and during earthworks	CC	EM/EO
Water Quality (Erosion and Sediment)	Erosion and sediment run off from construction activities that expose or move soil. Release of sediment laden effluent during construction, for example drilling wastes.	• Clearing and earthworks will be undertaken in the dry season to minimize erosion and subsequent release of sediment; • The period of soil exposure will be minimized by phasing clearing and construction activities, and covering exposed areas (for example by planting fast growing ground cover or covering with riprap, sand bags, erosion mats, bale dikes, mulch, or excelsior blankets) at the earliest time possible. Exposed areas of stream banks will be covered immediately, and preferably be replanted with locally native herbaceous and woody vegetation. • For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed and maintained until vegetation replanting can occur to stabilise disturbed surfaces; • Stockpile materials (excavated soil, quarry materials etc.) will be located at least 30 m away from steep slopes, watercourses or drainage paths. • Sediment trap will be installed in between the stream and the stockpile to control runoff where necessary.	All construction areas	Throughout construction	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		• Water quality will be monitored regularly, and if found to exceed standards defined in Annex *B*, additional water quality measures will be implemented.				
Water Quality (Erosion and Sediment)	Erosion and sediment released from stream bed and bank disturbance during instream works (for example watercourse crossings of access roads).	• If vegetation clearing is required on stream banks, cut vegetation near or at ground level to leave root mass in the ground. This helps to reinforce soil stability and reduce erosion. • If in-stream diversion is required during bridge construction, any diversion infrastructure must be clean and made of suitable materials that will not contribute to turbidity or salinity. • At watercourse crossings, machinery will operate from stream bank, not the stream channel, whenever practicable with minimal streambed disturbance. All disturbed streambeds will be returned to their original condition or better as soon as possible. • Water quality will be monitored regularly, and if found to exceed standards defined in Annex *B*, additional water quality measures will be implemented.	Watercourse crossings.	During bridge construction	CC	EM/EO
Water Quality (Erosion and Sediment)	Sediment runoff from material stockpiles, including soil stockpiles during earthworks.	• Soil removed and stockpiled during earthworks will be stabilized and constructed with smooth slopes and free drainage patterns. • Stockpile materials will be located at least 30 m away from steep slopes, watercourses or drainage paths. • Ridges may be created on topsoil stockpiles to provide for the moisture retention to assist re-growth and slow runoff. • Sediment trap or other measure will be established to capture sediment runoff. • Sediment or retention ponds will be installed to receive leaching from the spoil at the end of the drainage lines prior to discharge to the watercourse.	Material stockpiles.	Throughout use of spoil and borrow area.	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Water quality (Effluent)	Pollution in effluent from construction sites (point source).	• Prior to operation of concrete batching plants and casting yards, the contractor shall install wastewater treatment systems that have the capacity to treat wastewater to a quality compliant with relevant standards (refer to Annex *B*); and • Wastewater from site activities such as concrete cutting, drilling or excavation will be appropriately treated prior to discharge. • Sediment or retention ponds will be installed to receive drainage water and runoff water from plant before discharge. • Discharge will be immediately stopped if the quality is not compliant with requirements. • Spill respond kit will be provided to prevent spilling and contamination	All construction areas.	During construction	CC	EM/EO
Water Quality (Effluent)	Deterioration in surface water quality when effluent from worker camps untreated.	• Solid and septic system waste management systems will be installed and maintained in good working order. • Septic tanks will be installed to treat domestic wastewater generated from camp. • To avoid water pollution caused by the rubbish and waste, regular waste collection will be provided. • Separate wastewater from runoff water drainage. • Sediment or retentions ponds will be installed to receive runoff water from worker camp before being discharge off-site. • Effluent water monitoring program will be routinely conducted and sampling locations, parameters specified in applicable standards will be identifies.	Worker Camps	Throughout operation of worker camp	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Water Quality (Hazardous Materials)	There is potential for hazardous materials (including paints and solvents, petroleum products, concrete curing and repair compounds, and contaminated wastes) to be released to the environment, particularly during storage and handling, and equipment/vehicle maintenance.	• Hazardous materials will be stored in the suitable storage location such as close area, bund, water trap with open-close valve. • Only minimal chemicals, hazardous substances and fuel will be stored on site works. • Whenever feasible, mobile fueling/maintenance units will be used for construction equipment to avoid/reduce on-site fuel/lubricant storage. • Hazardous waste will be disposed of according to the most appropriate best practices. Discharge of hazardous wastes (including contaminated water) to the environment is prohibited. • Any release of hazardous material will be cleaned up as soon as practicable.	Refuelling sites, hazardous material storage areas.	Throughout construction period.	CC	EM/EO
Air quality	Dust emissions from exposed soils, transport of materials and increased traffic.	• Restricting vehicle movement to designated access routes; • Covering all loads; • Watering exposed surfaces during windy conditions; • Daily monitoring of dust levels through visual inspection; and • Implementing measures to limit vehicle speeds, particularly around sensitive receptors, for example by installing speed bumps. • All vehicles will be washed or cleaned before leaving the site, when appropriate. . • Stockpiles will be located to avoid wind dispersion of dust. • Blasting will be avoided in windy conditions.	All construction areas	Throughout construction period	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Air quality	Chemical pollutants from road vehicles and equipment.	• Vehicles and equipment will be regularly maintained and serviced in accordance with manufacturer's specifications. • All vehicles engines will be switched off when stopped, and vehicles will not be left idling. • Air quality will be monitored near villages. • Air monitoring program will be routinely conducted and sampling locations, parameters specified in applicable standards will be identified. • PPE for emission protection will be provided to all workers working in activities generating emission and any workers who requests PPE.	Vehicles and all construction areas where vehicles and equipment are operating	Throughout construction period	CC, EM/EO	EM/EO
Noise and Vibration	Increased noise and vibration levels may disturb local residents and fauna, and can present a risk to personnel.	• All noise and vibration generating construction equipment shall be operated with appropriate sound dampening equipment. • Construction equipment and vehicles will be subjected to regular inspections to check noise emissions and noise control equipment. • Stationary noise sources will be positioned to avoid impacts to sensitive receptors. • Hearing protection will be made available for all construction personnel and required for personnel working in areas with noise above 80dB. • High noise activities, such as blasting, will be carried out only within the hours of 6am to 7pm, and residents should be informed of these activities. • The contractor will maintain communication with any schools within 3 km of the Project area, and will avoid high noise activities during school hours.	All construction areas	Throughout construction period	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Biodiversity	Loss of natural and modified habitat due to vegetation clearing	• Strict rules against logging outside the approved construction areas and against wildlife hunting and poaching will be imposed on project staff, workers, and all contractors and personnel engaged in or associated with the Project, with penalties levied for anyone caught carrying and using fire arms, or using animal snares and traps, including fines and dismissal, and prosecution under the laws of the Lao PDR; • The Project owner shall be directly responsible for dissemination to its staff and workers of all rules, regulations and information concerning these restrictions, as well as the punishment that can expected if any staff or worker or other person associated with the Project violate rules and regulations; • The planned clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing; • Disturbed areas shall be rehabilitated as soon as possible following construction activities; • Construction Contractor will establish biological resource management program and management plan to manage the construction activities to be conducted and monitor compliance with relevant permits and environmental regulations in order to prevent potential impacts to terrestrial ecology, in particular, vegetation and wildlife; and • In natural habitat areas to be cleared, microhabitat features such as hollow logs will be relocated to adjacent natural habitat areas rather than being destroyed where possible.	All construction areas	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Terrestrial Biodiversity	Degradation of habitat	• The measures outlined in this document relating to hydrology, water quality, air quality and noise and vibration, will be implemented. • Construction and domestic waste will be appropriately stored and disposed of to avoid attracting native and alien species to the construction areas; • For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed prior to commencement of vegetation clearance or earthworks and maintained until vegetation replanting can occur to stabilise disturbed surfaces; • Monitoring of erosion and sediment control will be conducted to inspect the proper function of devices; • Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licensed waste management contractors; • Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas; • Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas.	All construction areas.	Throughout construction period.	CC, EM/EO	EM/EO
Terrestrial Biodiversity	Fauna mortality	• Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike; • Commitment will be made to raise awareness of values of natural habitat areas to personnel and arrangements will be made for restriction of poaching and forest product collection; • Hunting wild animals will be strictly prohibited to apply for all staff;	Rules apply to all personnel in any location while working for the Project.	Throughout construction period.	CC, EM/EO	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		•				
Terrestrial Biodiversity	Disturbance to fauna behaviour	• Construction vehicles and machinery will be maintained in accordance with industry standard to minimise unnecessary noise generation; • Traffic signs will be installed on all roads throughout construction areas depicting speed limits; • For construction and operation areas requiring night-time lighting, lights will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible; and • Commitment will be made to raise awareness of values of natural habitat areas to construction work force and make arrangements for restriction of poaching.	All construction areas.	Throughout construction period.	CC, EM/EO	EM/EO
Terrestrial Biodiversity	Impacts to threatened species	• General biodiversity measures contribute to the conservation of threatened species. In addition: • If threatened flora species are identified within the Project Area, these will be specifically managed within the Biodiversity Action Plan and replanting or propagation may be appropriate. • The training and awareness program will highlight the threatened species with potential to occur in the Project Area to further discourage hunting.	All construction areas.	Throughout construction period.	CC, EM/EO	EM/EO
Terrestrial Biodiversity	Some residual impacts will not be able to be avoided through the measures outlined in this EMP. These impacts are to be offset.	• The recommended offset package outlined in the Biodiversity Offset Design Report (ERM 2013) will be implemented.	Offset areas designated in Biodiversity Offset Design Report (ERM 2013)	Beginning in design phase.	Deputy Managing Director (EC)	Deputy Managing Director (EC)
Aquatic Biodiversity	Degradation of habitat	• Water quality and hydrology measures will be implemented.	All construction areas, and specific measures for	Throughout construction period.	CC, EM/EO	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
			bridges.			
Aquatic Biodiversity	Mortality	• Fishing and using of illegal fishing gear anywhere along the river will be prohibited.	Rules apply to all personnel in any location while working for the Project.	Throughout construction period.	EM/EO	Deputy Managing Director (EC)
Land Use	Removal of productive land (temporary and permanent)	• Livestock in affected areas will be relocated, where necessary; • Productive land acquisition for the road alignment will be minimized as far as possible, and where unavoidable, compensation for the loss of property will be provided to the affected people; • A separate Resettlement Plan will be prepared to address land acquisition and compensation issues, and will be reviewed by the Provincial Resettlement Management and Living Conditions Restoration Committee.	Construction areas within productive or privately owned land.	Prior to commencement of construction in each area.	EM/EO	Deputy Managing Director (EC)
Land Use	Potential for resettlement of individual families or communities.	• In the unlikely event that resettlement is required, the provisions of the Technical Guidelines on Compensation and Resettlement in Development Projects of the Lao PDR concerning resettlement and compensation will be followed strictly.	Acquired land and resettlement site	Prior to construction	EM/EO	Deputy Managing Director (EC)
Economy and Livelihoods	Construction of the transmission line and associated infrastructure will provide employment opportunities to local people.	• NNP1PC will carefully manage labor conditions. • The construction contractor will hire local people during construction where local people have the required skills and experience. • Training in health and safety and technical areas will be provided to all personnel.	All construction areas.	Prior to and during construction.	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Damage to Property	Potential disturbance of/damage to property and community facilities.	• When constructing in the vicinity of irrigation and drainage channels, channels will be pegged and marked out to avoid unnecessary disturbance. • If irrigation/drainage channels are to be intersected by Project infrastructure, they will be reinstated in the final infrastructure design. For example, if interrupted by a tower pad irrigation channels will be re-routed around the pad; if intersected by an access road, pipes will be installed below ground to maintain flow. • The contractor will immediately repair and/or compensate for any damage caused by the project to properties and community facilities.	All construction areas.	As required.	CC	EM/EO
Community Health and Safety (Disease)	Possible increase in disease transmission.	• A public health education campaign will be provided, addressing: hygiene, disease prevention (including transmission pathways and symptoms of relevant diseases) and basic health promotion. The program will be designed and implemented in consultation with district and local health authorities. • Impregnated mosquito nets need will be provided to the local communities. Treatment programs and rapid diagnostic testing will be provided in cooperation with health authorities, including volunteer health workers. • Latrines will be provided for each household in the Project area so that villagers have access to clean and safe water as soon as possible and preferably prior to commencement of construction.	Villages and households	Prior to and during construction phase.	Deputy Managing Director (EC)	Deputy Managing Director (EC)
Community Health and Safety (Flood)	Naturally occurring floods may move loose construction equipment and materials, potentially causing accident or injury to the community, and damaging property.	• Construction materials and chemicals will be secured and locked down during flooding season.				

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Occupational Health and Safety (Accident and Injury)	Potential for accident and injury during construction.	• A Health and Safety program will be developed and implemented which includes an initial safety induction for all employees, on-going safety awareness and an incident reporting system. • First aid kits will be readily accessible by workers and trained first aid teams will be assigned to work sites.	All construction areas	Throughout construction period.	CC	EM/EO
Occupational Health and safety (Disease)	Health Risks due to lack of health and sanitation conditions through disposal of sewage on open land which may cause mosquito nuisance, water borne diseases, etc. Chances of spread of sexually transmittable diseases, including AIDS.	• Toilet facilities and sewage treatment systems will be installed at worker camps prior to use. • First aid equipment/facilities will be provided at worker camps and work areas. • Education and awareness programs will be provided addressing disease prevention and treatment. • Mosquito wire screen and net will be installed at high use areas, including offices, canteens and bedrooms. • Hygienic drinking water will be provided.	Worker camp and all construction areas	Throughout construction period.	CC	EM/EO
Health and Safety – community and personnel (UXO)	UXO events result in injury or death, and causes serious loss and destruction of property.	• A UXO survey will be undertaken following finalization of alignment, and UXO clearance will occur for the construction area. • All construction activities will occur within the UXO clearance boundary.	All construction areas	Prior to construction	Owner	GOL's representative
Health and Safety – community and personnel (Geology)	Landslide and rock movement may be induced, particularly along steep slopes around the construction site along riverbank, borrow areas, spoil disposal areas and quarry.	• The potential for and monitoring of landslides and rock movements around the Project site will be investigated during construction. • If there are any sections along the access road that may have landslide and rock movement problems, the construction contractor will address the problem before further construction. • Routine inspection of the construction areas will be undertaken.	Steep areas	Throughout construction period	CC, Owner	Owner

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Culture and Customs	Temporary migration of workers may influence local cultural and create social tension.	• The contractor will consult with local authorities to learn of any traditional practices and rules that need to be followed, and to coordinate in the enforcement of laws and regulations. • A code of conduct will be established and enforced to reduce the potential for conflict between local residents and migrant workers; • Any entertainment venues or recreational facilities in the vicinity of the project shall be operated strictly according to the local village values and traditions.	Applicable to all personnel while at worker camp and in villages.	Throughout construction period	CC, Owner	Owner
Physical Heritage	Increase in adverse impacts on cultural heritage and archaeological sites found in areas where access road is under construction.	• Construction activities will be undertaken in such manner as to avoid any physical effect on known sites of cultural or religious significance. • ESOs will be trained to identify potential sites or items of cultural significance. Construction workers will be trained in the appropriate reporting and communication procedures to be followed if they identify any potential sites or items and the importance of implementing these procedures • The Owner will employ a head of village who is familiar with cultural resources. • The following steps will be implemented in the event that previously unidentified artifacts are identified: i. The contractor shall immediately cease operations on road section where artifacts/archaeological finds are unearthed and immediately inform NNP1 Site Manager. ii. The Owner will consult the Head of Village and Culture and Tourism Administration Office to obtain advice regarding the next steps. • The contractor to recommence work only after the Culture and Tourism Office has provided official notification accordingly.	All construction areas.	Throughout construction period.	EM/EO	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Traffic and access	Hazards associated with the traffic movement in working areas during construction phase leading to property/equipment damage and injury to workers or nearby villagers.	• Transportation schedules will be arranged to avoid peak hours of road usage. • Traffic signs will be installed for all roads throughout construction areas. • Relevant traffic regulations will be implemented throughout construction areas. • Traffic speed regulation devices, such as speed bumps, and signage will be installed at sensitive locations including in the vicinity of villages, construction camps, at busy intersections or before the sharp bend, and in areas of high habitat value if necessary. • Prior to the movement of special loads on public roads, including hazardous materials or large items of including hazardous materials or large items of construction equipment, the ESMMU will be notified. If the ESMMU require additional measures, the reasonable and practical measures will be implemented to ensure that the risk of harm to the community and environment is minimized during transportation of special loads; • In cases where heavy loads are required to be transported, some segments of roads and bridges may be reinforced to withstand the load. • In the event that stringing conductors present a possible risk to traffic temporary barriers (such as bamboo scaffolds) will be constructed across the roads and rivers to protect the public and property.	All Project roads and public roads.	Throughout construction	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Operation Phase						

Water Quality	The use of herbicides in RoW maintenance can lead to the release of herbicides into waterways via surface runoff.	• Vegetation management methods that minimize the application of herbicides will be used (refer to 'Vegetation Management' below); and
		• If the use of herbicides is required:
		  • Personnel will be trained on the safe and efficient application of herbicides;
		  • Herbicides will be applied in accordance with the manufacturer's directions and published reports on minimum effective dose;
		  • Herbicides will be applied using methods to avoid unintentional drift or runoff. For example, herbicides will not be applied on windy days.
		  • Herbicides will not be applied within 50 m of watercourses or drainage lines.
		• Herbicides will be stored and handles to minimize escape to the environment, including:
		  • Storing in a room with appropriate spill containment measures;
		  • Siting storerooms away from water resources and well heads; and
		  • Handling and disposing of storage containers as hazardous waste.
			RoW and herbicide storage locations.	Throughout maintenance period.	Maintenance Contractor	EM/EO

Air Quality	Air pollution due to burning of vegetation for RoW management.	• Vegetation will not be burnt.	All roads in Project site	Throughout operation period.	Maintenance Contractor	EM/EO
Noise	Noise pollution from transmission lines may disturb local residents and fauna.	• Where locating the RoW near human receptors and areas of natural habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.	Transmission line within 1 km of natural habitat or villages.	Prior to operation.	Maintenance Contractor	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit

Biodiversity (Vegetation Management in RoW)	Degradation of habitat for RoW maintenance.	• The Project shall implement landscaping and re-vegetation using locally native species after completion of construction for any areas not required to be permanently cleared.
		• Vegetation management will aim to maintain low growing vegetation and only remove vegetation that may interfere with transmission line operation.
		• Trees greater than 3 m will be pruned.
		• Tall-growing tree species and invasive species will be selectively removed to encourage growth of low-growing native species.
		• If further ecological surveys identify endangered and critically endangered species that may breed in and around the RoW, maintenance activities will be scheduled to avoid breeding and nesting seasons for these species.
		• Clearing in riparian areas will be minimized. Vegetation removal within 10m of watercourse banks will be undertaken by hand to avoid the use of machinery in riparian areas.
		• The use of herbicides will be minimized by:
		  • Using mechanical weed control and pruning methods;
		  • Provide invasive species identification training to maintenance personnel to minimize application of unnecessary herbicides; and
		  • Using animals to graze areas where access needs to be maintains.
			RoW	Throughout maintenance period.	Maintenance Contractor	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Terrestrial Biodiversity	Fauna mortality	• Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike. • Commitment will be made to raise awareness of values of natural habitat areas to personnel work force and arrangements will be made for restriction of poaching and forest product collection. • Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.	All roads in Project site, and training at induction and training location.	Throughout operation period	EM/EO	Deputy Managing Director (EC)
Terrestrial Biodiversity	Potential increased levels of hunting due to improved access to areas surrounding RoW.	• Strict rules against logging (other than required maintenance activities) and wildlife hunting and poaching will be imposed on all personnel engaged in or associated with the Project. Penalties will be levied for anyone caught carrying and using fire arms, or using animal snares and traps, including fines and dismissal, and prosecution under the laws of the Lao PDR. • Commitment will be made to raise awareness of values of natural habitat areas to construction and operation work force and arrangements will be made for restriction of poaching and forest product collection. • The Biodiversity Offset Plan will consider improved enforcement and security of offset areas.	Rules apply to all personnel in any location while working for the Project. Offset areas discussed in Biodiversity Offset Plan.	Throughout operation period.	EM/EO	Deputy Managing Director (EC)
Economy and Livelihoods	Ongoing maintenance of the RoW, particularly vegetation management, can provide employment to local residents.	• Local people will be employed for suitable roles wherever possible. • Appropriate health and safety measures will be undertaken to protect all Project personnel, as described in Section *4.3.8*.	RoW	Throughout maintenance period.	Maintenance contractor	EM/EO
Community Health and Safety	Aircraft collision, electromagnetic radiation, noise	• These impacts will be mitigated through appropriate siting of infrastructure. Refer to measures outlined for Design and Pre-Construction Phase.	Refer to measures outlined for Design and	Refer to measures outlined for Design and Pre-	Refer to measures outlined for Design and Pre-	Refer to measures outlined for Design and

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
			Pre-Construction Phase.	Construction Phase.	Construction Phase.	Pre-Construction Phase.
Community Health and Safety	Exposure to herbicides.	• The use of herbicides will be minimized. • If application of herbicides is unavoidable, application will not occur during windy or rainy weather. • The measures outlined under 'Vegetation Management' will be implemented. • Only herbicides that have been manufactured under license and approved by the appropriate authority in accordance with the Food and Agriculture Organization's International Code of Conduct on the Distribution and Use of Pesticides will be used.	RoW	Throughout maintenance period.	Maintenance contractor	EM/EO
Community Health and Safety	If vegetation within the RoW is uncontrolled, the transmission line could ignite a forest fire.	• Thinning and slashing will be scheduled to avoid the fire season. • Vegetative debris will be disposed of in locations that do not increase the fire risk. • Fuel breaks will be established to slow the progress of fires and allow firefighting access.	RoW	Throughout maintenance period.	Maintenance contractor	EM/EO
Community Health and Safety	Electrocution due to contact with high voltage electricity or items in contact with high voltage electricity (such as tools, vehicles or ladders).	• Signs and barriers will be installed to prevent access to high voltage areas. • Grounding conducting objects will be installed near transmission lines.	RoW	Throughout operation period.	Maintenance contractor	EM/EO

Occupational Health and Safety	Exposure to EMF at levels higher than those experienced by the general public.	• An EMF safety program will be developed prior to operation which:
		  • identifies potential levels of exposure;
		  • provides training for all workers;
		  • delineates zones appropriate for public access and those restricted to appropriately trained workers;
		  • defines measures to limit exposure time, such as through work rotation; and
			Transmission Line	Throughout operation period.	Operator	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		• provides personal monitoring equipment for workers.				
Occupational Health and Safety	Electrocution due to contact with high voltage electricity or items in contact with high voltage electricity (such as tools, vehicles or ladders)	• Transmission lines will be deactivated and grounded prior to work on, or near, transmission lines. • Live work will only be conducted by appropriately trained workers.	Transmission Line	Throughout operation period.	Operator	EM/EO

Occupational Health and Safety	Working at height on towers.	• Fall protection measures will be implemented including:
		  • provision of appropriate fall protection equipment,
		  • training in use of equipment and climbing techniques, and
		  • rescue of fall-arrested workers.
		• All equipment, including hoisting equipment, power tools and tool bags, will be properly rated and maintained.
			Transmission Line	Throughout operation period.	Operator	EM/EO

Occupational Health and Safety	Exposure to herbicides and PCBs.	• Appropriate personal protective equipment (such as gloves and safety glasses) will be supplied to all personnel handling herbicides or potentially contaminated materials; • Training will be provided to all personnel in the appropriate application, hygiene and safety requirements for the use of herbicides.	RoW	Throughout operation period.	Operator	EM/EO
Rehabilitation Phase						
Hydrology	Changes to topography required for the construction phase can affect hydrology.	• Construction areas not required for operation or maintenance of the transmission line will be rehabilitated. • Rehabilitation areas will be graded to provide proper drainage and blend with natural contour with the land.	All construction areas.	Areas are to be rehabilitated as soon as they are no longer required for construction or operation.	CC, EM/EO	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Terrestrial Biodiversity	Loss or degradation of habitat	• Landscaping and re-vegetation will be undertaken after completion of construction using native species where possible, and based on advice provided by a suitably qualified botanist/ecologist; • Following grading, rehabilitation areas will be vegetated using plants native to the area, suitable for the site condition, and beneficial to wildlife. • Following abandonment, all yards, offices, and construction buildings, including concrete footings and slabs, will be removed from the site. • Where applicable, the following agencies will be consulted to determine the recommended plant species composition, seeding rates, and planting dates: Department of Natural Resources and Environment, Department of Agriculture and Rural Development. • Grasses, forbs, shrubs, and trees appropriate for site conditions and surrounding vegetation will be included in the plant list. Species chosen for a site will be matched for site drainage, climate, shading, resistance to erosion, soil type, slope, aspect, and vegetation management goals. Wetland and riparian species will be used in re-vegetating disturbed wetlands. Upland re-vegetation shall match the plant list to the site's soil type, topographic position, elevation, and surrounding natural communities.	All construction areas no longer required	Areas are to be rehabilitated as soon as they are no longer required for construction or operation.	CC, EM/EO	Deputy Managing Director (EC)

8.3 *ENVIRONMENTAL MONITORING*

Monitoring is an integral part of the environmental management system as it:

- verifies the implementation of environmental mitigation measures, in compliance with environmental management plans, contractual obligations and regulatory requirements;
- Identifies and measures impacts of Project activities;
- Identifies opportunities for corrective action.

The initial monitoring program based on the impacts and mitigation measures defined in this IEE is provided in *Table 8.3*. An updated monitoring program will be provided in the ESMMP-CP.

Monitoring in the construction period can be categorized in the following:

- At Contractor level, monitoring to ensure on a day to day basis that mitigation measures are fully implemented with construction activities, and that results observed comply with the contractual obligations and Contractor's SS-ESMMP;
- At Owner level, routine inspections to ensure that monitoring results provided by the Construction Contractor are corrected, to provide the necessary environmental coordination and interface with the Contractors, and to provide a comprehensive picture of the current environmental situation and efforts at site level.

8.3.1 *Monitoring and Inspection by Construction Contractor*

The Construction Contractor will employ suitably qualified inspectors, who will conduct routine inspections to evaluate compliance with commitments defined in the Construction Contractor's SSESMMP-CP.

Results of field observations, including documenting compliance or non-compliance, will be reported on standard forms to enable observations to be recorded in a consistent manner.. The information can be entered into the database that will be used to track the status of and allow analysis of non-compliance situations.

Monitoring activities will include verification of implementation of mitigation measures defined in the SS-ESMMP, as well as water quality, air quality, noise and vibration and biological monitoring. For ambient air, noise and water quality, sampling and analysis shall be carried out relying on certified equipment and/or laboratory.

8.3.2 *Monitoring and Inspection by Owner*

The Inspector or EO of the Owner will visit and inspect each of the construction sites at the frequency defined in the monitoring plan below. Information collected during each visit will be reported on a standard form, which provides a checklist of issues to control, depending on the degree of compliance or non-compliance observed. The Inspector or EO of the Owner may join inspection with Construction Contractor and relevant agencies e.g. GOL, and as agreed in order to observe and follow up any event or significant issues that have been reported. Visits to a site will be increased if the site presents a higher environmental risk potential.

Monitoring activities will include verification of implementation of mitigation measures defined in the ESMMP-CP, as well as water quality, air quality, noise and vibration and biological monitoring. For ambient air, noise and water quality, sampling and analysis shall be carried out relying on certified equipment and/or laboratory.

8.3.3 *Internal Audit*

Regular audits shall be carried out by internal auditors with the following experience:

- Expertise in environmental science and technology;
- Expertise in the technical and environmental aspects of construction phase of the project;
- Expertise in environmental law and regulation;
- Expertise in environmental management systems; and
- Expertise in auditing process.

The auditor will initiate scheduled audits of construction activities and the Construction Contractor's organization against the requirements established in the Contract Documents and the ESMMP-CP.

Internal Audits will be carried out every six months. Non-compliance identified during audits will be subject to corrective action.

8.3.4 *External Audit*

GOL's representative will regularly audit the Owner's management system and construction activities to verify compliance with contractual obligations. It is the responsibility of the Owner to provide available documentation, information and data requested by the auditor.

Non-compliance identified during audits will be subject to corrective action. The audit report will be submitted to the Owner for action.

Table 8.3 Environmental Monitoring Program

Environmental Aspect/Area to be concerned	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
				Implementing Unit	Monitoring Unit	
Design Phase						
Hydrology	Drainage will be designed to safely convey runoff from developed areas at non-erosive volumes and velocities.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Hydrology	Bridge design to maintain hydrology	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Water Quality	Design to avoid works in watercourses, riparian areas and on steep slopes.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Water Quality	Locate material stockpiles at least 30m away from steep slopes and watercourses.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Water Quality	Provide for solid, liquid and hazardous waste storage and treatment in design of construction areas and worker camps.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Hydrology	Flood Response Plan prepared to address the risk of flash flooding. This plan should be provided to all construction personnel.	Audit adequacy of Flood Response Plan	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Noise	Refine transmission line route to avoid villages and critical habitat for noise-sensitive species.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Biodiversity	A habitat/flora assessment will be undertaken within proposed transmission line route and proposed access roads.	Audit adequacy of assessment.	Once following assessment.	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Biodiversity	Design and layout plan to minimise tree cutting and protected area disturbance where possible.	Audit design and layout. Examine design and contract documents to confirm sufficient protection of biodiversity.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Biodiversity	Transmission line design provides sufficient clearance to minimize risk of electrocution of birds and bats.	Audit design.	Once.	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Biodiversity	Implement the recommended offset package outlined in the Biodiversity Offset Design Report (ERM 2013).	Verify progress of offset program.	Quarterly	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Land Use	Locations of infrastructure, including permanent infrastructure, will be selected to minimize the acquisition of productive land as far as practicable.	Verify that alternative alignments have been considered to minimize impact to productive land.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Land Use	A compensation process will be developed and compensation will be provided for the loss of property during the construction phase.	Verify that landowners have been compensated for loss of property and impacts to productivity.	Monthly until all compensation is paid.	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Community Health and Safety	Transmission lines and towers will be sited outside of known flight path envelopes where possible; and if installation is required in flight sensitive areas, buried lines will be used.	Verify that transmission lines are designed to avoid impacts to aircraft.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Community Health and Safety	Site transmission lines and other high voltage equipment away from residential properties and areas of high human occupancy (e.g. schools). Evaluate potential exposure levels and assess against the standards provided in Annex *B*.	Verify that transmission lines are located to produce exposure levels below those defined in Annex *B*.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Community Health and Safety	Preparation of flood response plan.	Verify flood response plan has been prepared.	Once prior to commencement of construction	Deputy Managing Director (EC),	Deputy Managing Director (EC),	Project office

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
				environmental consultant	environmental consultant	
Public Property	Powerlines will be sited in consultation with the community, and with due consideration of landscape views. Changes to property values due to powerline proximity will be assessed, and appropriate compensation will be provided.	Verify that suitable consultation has occurred and landholders have been compensated where necessary.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Construction Phase						
Capacity of personnel	Provision of training and education.	Review training register to verify mandatory training has been attended.	Monthly	CC	EMO	Human Resources Office
Hydrology	Construction materials and equipment secured during flood season.	Visual verification that materials and equipment are secured.	Weekly during flood season.	CC	EMO	All construction areas.
Hydrology	Inform local people of changes to water levels due to in-stream works.	Construction contractor to record instances of changes to downstream water levels, and record contact with community representatives. Records to be verified.	Monthly.	CC	EMO	In stream works.
Hydrology	Earthworks undertaken to minimize changes to surface flows.	Visual verification of completed earthworks following rain events.	Once per construction area.	CC	EMO	All areas where earthworks are undertaken.
Water Quality (Erosion and Sediment)	Undertake clearing and earthworks in dry season.	Verification of construction schedule.	Monthly.	CC	EMO	All construction areas.
Water Quality (Erosion and Sediment)	Minimize period of soil exposure.	Verification of construction schedule.	Monthly.	CC	EMO	All construction areas.
Water Quality (Erosion and Sediment)	Installation of erosion and sediment control devices.	Visual verification.	Weekly	CC	EMO	All construction areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Water Quality (Erosion and Sediment)	Appropriate location of stockpile materials.	Visual verification.	Weekly	CC	EMO	All construction areas.
Water Quality (Erosion and Sediment)	Water quality monitoring.	Measurement of parameters defined in Annex *B*.	Monthly	CC	EMO	Water quality monitoring locations (to be defined following definition of final alignment).
Water Quality (Erosion and Sediment)	During works in riparian areas: avoid vegetation clearing, and if unavoidable, cut vegetation near or at ground level; machinery to operate from stream bank, not channel; and any diversion infrastructure must be clean.	Visual verification.	Once at each area of in-stream/riparian work.	CC	EMO	Watercourses.
Water Quality (Erosion and Sediment)	Stockpile management measures, including stabilization, drainage, righting and sediment traps.	Visual verification of stockpile stabilization, distance from watercourses and drainage paths and installation of sediment traps.	Monthly	CC	EMO	Stockpiles
Water Quality (Effluent)	Installation of wastewater treatment systems and sediment retention ponds. Provision of spill response kit.	Visual verification that systems are installed and in good working order, and that spill response kit is available. .	Monthly	CC	EMO	All construction areas.
Water Quality (Effluent)	Installation of solid and septic waste management systems. Installation of sediment and retention ponds.	Visual verification that systems are installed and in good working order	Monthly	CC	EMO	All construction areas.
Water Quality (Effluent)	Monitoring of effluent water quality.	Monitoring of parameters listed in Annex *B*.	Monthly	CC	EMO	All construction areas.
Water Quality (Hazardous	Appropriate storage and disposal of hazardous materials. Appropriate spills	Visual verification of appropriate storage and disposal. Verification that	Monthly	CC	EMO	All construction areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Materials)	clean up.	there are no unattended spills or leaks.				
Air quality	Daily monitoring of dust levels.	Visual assessment of dust level and implementation of further dust suppression if required.	Daily	CC	EMO	All cleared/exposed work areas.
Air quality	Dust suppression, including restricting vehicle movement to designated access routes; covering all loads; watering exposed surfaces during windy conditions; vehicle speed limits; cleaning of vehicles; avoiding blasting on windy days.	Visual verification that mitigation measures are implemented.	Weekly	CC	EMO	All cleared/exposed work areas.
Air quality	Vehicles switched off when stopped. PPE for emission protection provided to all workers working in activities generating emissions.	Verification of sample of vehicles and work areas.	Weekly	CC	EMO	Throughout construction area.
Air quality and Noise and Vibration	Regular maintenance of vehicles and equipment.	Review of vehicle and equipment log books to verify maintenance.	Quarterly	CC	EMO	All cleared/exposed work areas.
Noise and Vibration	Use of sound dampening equipment. Hearing protection available to personnel.	Visual verification of use of appropriate sound dampening equipment on machinery and use of hearing protection by all personnel in areas with noise over 80dB.	Monthly	CC	EMO	Throughout construction area.
Noise and Vibration	High noise activities carried out between 6am and 7pm, and not during schools days.	Verify monthly based on daily reports.	Monthly	CC	EMO	Throughout construction area.
Terrestrial Biodiversity	Vegetation clearing areas clearly marked. Microhabitat features relocated. Weed and pest management measures.	Visual verification of demarcation of clearing areas, and restriction of clearing to within defined area. Visual verification of relocation of microhabitat feastures, and	Weekly	CC	EMO	Throughout construction area.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
		implementation of weed and pest management measures.				
Terrestrial Biodiversity	Delivery of training and awareness.	Discussion with sample of personnel to determine level of understanding of biodiversity values and management measures.	Monthly	CC	EMO	Throughout construction area.
Land Use	Compensation provided for loss of land and reduction in productivity of land.	Review of compensation cases to identify progress.	Monthly until all cases finalized.	EMO	EMO	Affected land.
Economy and Livelihoods	Employment of local people.	Verification of the number of local people employed, and identification of additional local employment opportuntiies.	Quarterly.	CC	EMO	NA
Damage to Property	Irrigation and drainage channels pegged and marked when working in vicinity.	Visual verification.	Weekly.	CC	EMO	Drainage channels in construction area.
Damage to Property	Irrigation and drainage channels reinstated in final design.	Visual verification.	Once, at completion of construction around each drainage channel.	CC	EMO	Drainage channels in construction area.
Community Health and Safety (Disease)	Delivery of public health campaign. Provision of mosquito nets, latrines and malaria treatment programs.	Review of implementation of public health program.	Monthly	EMO	EMO	Villages
Community Health and Safety (Flood)	Construction materials and chemicals will be secured and locked down during flooding season.	Visual verification of secured items.	Weekly during rainy season.	CC	EMO	All construction areas.
Occupational Health and Safety (Accident and Injury)	A Health and Safety program will be developed and implemented which includes an initial safety induction for all employees, on-going safety awareness and	Verify implementation of Health and Safety program.	Monthly	CC	EMO	All Project areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
	an incident reporting system.					
Occupational Health and Safety (Accident and Injury)	First aid kits will be readily accessible by workers and trained first aid teams will be assigned to work sites.	Visual verification of availability of first aid kits.	Monthly	CC	EMO	All Project areas.
Occupational Health and safety (Disease)	Toilet facilities and sewage treatment systems will be installed at worker camps prior to use. Mosquito wire screen and net will be installed at high use areas, including offices, canteens and bedrooms.	Verification of provision of toilet facilities, sewage systems, mosquito screens.	Once at establishment of worker camp.	CC	EMO	Worker camps.
Occupational Health and safety (Disease)	Clean drinking water will be provided.	Monitor drinking water quality.	Monthly	EMO	EMO	Worker camps.
Occupational Health and safety (Disease)	Education and awareness programs will be provided addressing disease prevention and treatment.	Verification of delivery of education and awareness program.	Monthly	EMO	EMO	Worker camps.
Health and Safety – community and personnel (UXO)	A UXO survey will be undertaken following finalization of alignment, and UXO clearance will occur for the construction area. All construction activities will occur within the UXO clearance boundary.	Verification of UXO clearance.	Once, prior to commencement of construction.	EMO	EMO	All Project areas.
Health and Safety – community and personnel (Geology)	Monitoring of potential of landslides and rock movement.	Inspection of stability of steep slopes within, and in vicinity of construction areas by a qualified engineer.	Quarterly, and monthly during rainy season.	EMO	EMO	Steep slopes.
Culture and Customs	A code of conduct will be established and enforced to reduce the potential for conflict between local residents and	Supervisors to monitor employee behavior throughout construction period.	Ongoing	CC	EMO	All Project areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
	migrant workers.					
Physical Heritage	Cease work if previously unidentified artifacts are identified.	Review cases of artifact detection and verify that action was taken in accordance with chance finds procedure.	Quarterly	CC	EMO	All Construction areas.
Traffic and access	Abide by traffic rules; appropriate road barriers applied to separate public traffic from construction areas.	Visual verification of driver behavior and road safety devices.	Monthly	CC	EMO	All Construction areas.
Operation Phase						
Water Quality	Herbicide application to minimize unintentional drift or runoff to watercourses.	Visual verification that herbicides are applied in accordance with mitigation measures defined in EMP.	Once during each maintenance period	EMO	EMO	RoW
Water Quality	Storage of herbicides with sufficient containment to avoid release to the environment.	Visual verification that herbicide storage prevents release to the environment.	Quarterly	EMO	EMO	Herbicide storage areas.
Noise	Where locating the RoW near human receptors and areas of natural habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.	Monitoring of noise level at nearest residences, and a sample of natural habitat areas.	Quarterly.	EMO	EMO	Villages and natural habitat monitoring locations.
Biodiversity	Vegetation trimming will be restricted to that required to safely operate the transmission line. Use of herbicides minimised. Speed limits of 40 km/hr enforced.	Verify that mechanical and manual methods of vegetation management are being utilised where practicable, and that vegetation trimming is minimized.	At each vegetation management event.	EMO	EMO	RoW
Biodiversity	Training and awareness program delivered.	Discussion with a sample of personnel to determine level of understanding.	Quarterly	EMO	EMO	RoW
Community Health	Only herbicides that have been	Verify type of herbicides used.	Quarterly.	EMO	EMO	Herbicide

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
and Safety	manufactured under license and approved by the appropriate authority in accordance with the Food and Agriculture Organization's International Code of Conduct on the Distribution and Use of Pesticides will be used.					storage areas.
Community Health and Safety	Management of vegetation to limit fire risk.	Visual verification that: • Vegetation is not encroaching RoW and does not exceed 4.5 m height; • Fuel breaks are maintained; • Vegetative debris is disposed of in a location/manner that does not increase fire risk.	Quarterly	EMO	EMO	RoW
Community Health and Safety	Signs and barriers will be installed to prevent access to high voltage areas. Grounding conducting objects will be installed near transmission lines.	Visual verification of installation of signs and barriers, and grounding conducting objects.	Quarterly	EMO	EMO	RoW
Occupational Health and Safety	Implementation of fall protection measures.	Visual verification of the use of fall protection measures, and use of properly rated and maintained equipment.	Quarterly	EMO	EMO	RoW
Occupational Health and Safety	Appropriate personal protective equipment (such as gloves and safety glasses) will be supplied to all personnel handling herbicides or potentially contaminated materials; Training will be provided to all personnel in the appropriate application, hygiene and safety requirements for the use of herbicides.	Visual verification of use of personal protective equipment.	At each maintenance period.	EMO	EMO	RoW
Rehabilitation Phase						

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Hydrology	Rehabilitation areas will be graded to provide proper drainage and blend with natural contour with the land	Visual verification of proper contouring and drainage.	Once, following completion of rehabilitation.	EMO	EMO	RoW
Biodiversity	Re-vegetation after completion of construction using locally native species.	Visual verification of tower sites following construction.	Once, or weekly until achieved, at each tower site following construction.	EMO	EMO	Tower sites

9 INDICATIVE BUDGET FOR IMPLEMENTATION OF THE EMP

The budget provided in *Table 9-1* covers the implementation of, and compliance with, NNP1PC's environmental obligations for transmission line construction and operation. The budget includes environmental monitoring undertaken by NNP1PC (both internally and outsourced). The budget is indicative only, and NNP1PC may fund any additional measures required from changes to the ECC, EMP, ESMMP-CP and ESMMP-OP; or other measures required to prevent or mitigate impacts to the environment which for any reason were not included in the initial budget.

Implementation of environmental controls during construction is the responsibility of the construction contractor. A budget for environmental measures implemented by the construction contractor will be provided in the contractor's EMP.

Table 9.1 Indicative EMP budget (Figures in US$)

Items	Tasks	Expenses	Labour
Implementation of EMP			
Design Phase			
Hydrology	Drainage Control Bridge Design Flood Response Plan	$8,000	$10,000
Biodiversity	Habitat Protection	$15,000	$18,000
Construction Phase			
Capacity of Personnel	Environmental Induction Training Preparation of Posters and Leaflets Provision of PPE	$5000	$20,000
Hydrology	Securing of hazardous materials Re-contouring of Quarries and barrow pits	$5000	$20,000
Water Quality and Erosion	Sediment and Erosion Control Controls for preventing spillage and clean-up of hazardous materials Septic Tank installation Design for Management of rubbish and waste	$35,000	$60,000
Air quality	Watering of exposed soil surfaces Washing and cleaning of vehicles	$30,000	$15,000
Noise and Vibration	Inspections of vehicles Provision of PPE	$5,000	$5000
Geology	Monitoring of landslides	$1000	$5000

Items	Tasks	Expenses	Labour
UXO	UXO Clearance	$15,000	$35,000
Hazardous management	Storage and handling of hazardous waste	$5000	$5000
Terrestrial Biodiversity	Training and Awareness Inspection of vehicles Wildlife protection procedure Speed signage Marking of habitats for retention	$10,000	$18,000
Cultural heritage and archaeology	Training and Awareness Employment of Head of Village Inspections for artifacts	$5000	$10,000
Health and safety	Construction of toilet facilities Sewage Treatment Awareness Program Mosquito Control Drinking Water First Aid equipment	$35,000	$15,000
Traffic and access	Education and Awareness Traffic signs	$15,000	$10,000
Operation Phase			
Air Quality	Road watering	$25,000	$5000
Terrestrial Biodiversity	Education and awareness on fauna strike Inspection of vehicles for fauna trafficking	$4000	$7500
Rehabilitation Phase			
Topography and Hydrology	Rehabilitation of disturbed areas Removal of all equipment and buildings	$150,000	$10,000
Terrestrial Biodiversity	Replanting of disturbed areas with native species	$15,000	$10,000
	SUB TOTAL	**$165,000.00**	**$20,000.00**
Environmental Monitoring Program (Calculated over the life of the project)			
Design Phase			
Hydrology	Confirm details of design specifications	$1000	$10,000
Terrestrial Biodiversity	Audit Design layout		$2500
Construction Phase			0
Capacity of Personnel	Review training register during weekly site audit		$15,000
Hydrology	Audit of Flood Plan during weekly site audit		$15,000

Items	Tasks	Expenses	Labour
Water Quality	Audit of planning documentation Water quality monitoring Audit of sediment and erosion control measures	$18,000	$15,000
Air quality	Audit of dust control measures during weekly site audit	$5000	$5,000
Noise and Vibration	Noise control monitoring	$5000	$15,000
Geology	Geologist/engineer inspection		$5000
UXO	Audit of UXO clearance		$5000
Hazardous management	Audit of hazardous materials storage and waste		$5000
Terrestrial & Aquatic Biodiversity	Audit of clearance works Confirm vehicle inspections		$15,000
Health and safety	Audit hygiene and PPE adherence by all personnel		$15,000
Traffic and access	Audit use of signage and traffic controls		$15,000
Operation Phase			0
Air Quality	Daily dust audit		$25,000
Terrestrial and aquatic Biodiversity	Audit of clearance works Confirm vehicle inspections		$25,000
Rehabilitation Phase			0
Topography and Hydrology	Audit of slope stability by geologist/engineer		$5000
Terrestrial Biodiversity	Audit of vegetation establishment and removal of plant and equipment/buildings/waste		$20,000
	SUB TOTAL	**$29,000**	**$212,500.00**
	TOTAL	**$419,000**	**$463,000**

10 CONCLUSION AND RECOMMENDATION

This IEE was prepared based on preliminary route alignment and assessment of alternatives, and has been assessed using information collected during biodiversity and social assessment for the NNP1 Project as well as other desktop sources.

This document provides a description of the baseline social and environmental conditions, a discussion of potential impacts and measures to minimize and mitigate those impacts. The document also introduces the Grievance Redress Mechanism and Consultation Process.

The IEE identified risks to the environment and local communities, including impacts to biodiversity, water quality, traffic and community health and safety. Management actions outlined in this document will be refined and developed further into the appropriate ESMMP-CP documentation that will be implemented to avoid and minimize the identified impacts. In the case of biodiversity, including threatened species, some impacts may be unavoidable and these will be offset through the approach provided in the BODR.

Annex A

Plans of Transmission Tower

Annex B

Environmental Standards

DRINKING WATER QUALITY STANDARDS

Lao PDR current standards for drinking water of the Lao PDR are provided below for reference.

Table B.1 Bacteriological Parameter

Parameters	*Units*	*Concentration*
Faecal Coliform	*MPN/100ml*	*0*
Total Coliform	*MPN/100ml*	*<2.2*
Entero virus	*MPN/100ml*	*0*

Source: Refer to CA - Annex C– Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Bacteriological Parameters

Table B.2 Physical-Chemical Parameters

Parameters	**Symbol**	**Unit**	**Maximum Concentration**
Aluminium	Al^{3+}	mg/l	0.2
Ammonia	NH_3	mg/l	1.5
Chloride	Cl^-	mg/l	250
Copper	Cu^{2+}	mg/l	2.0
Iron	Fe^{2+} and Fe^{3+}	mg/l	<1
Manganese	Mn^{2+}	mg/l	0.5
Sodium	Na^+	mg/l	250
Sulphate	SO_4^{2-}	mg/l	250
Hydrogen Sulphide	H_2S	mg/l	0.1
Conductivity	EC	µS/cm	<1,000
Total dissolved solids	TDS	mg/l	600
Sodium Chloride	NaCl	mg/l	300-350
pH	pH	-	8.5
Temperature	T	^0C	35
Hardness	-	mg/l	300

Parameters	Symbol	Unit	Maximum Concentration
Turbidity	-	NTU	<10
Taste and Odour	-	-	Acceptable
Colour	-	TCU	5
Residual Chlorine (if Chlorine disinfection is used)	Cl_2	mg/l	<0.2

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Physical-Chemical Parameters.

Table B.3 Health Significant Chemical Parameters

Parameters	Symbol	Unit	Maximum Concentration
Antimony	Sb^{3+}	mg/l	0.005
Arsenic	As^{3+}	mg/l	0.01-0.05
Barium	Ba^{2+}	mg/l	0.7
Boron	B	mg/l	0.50
Cadmium	Cd^{2+}	mg/l	0.003
Chromium	Cr	mg/l	0.05
Cyanide	CN^-	mg/l	0.07
Fluoride	F^-	mg/l	1.5
Lead	Pb	mg/l	0.01
Mercury	Hg	mg/l	0.001
Nitrate	NO^-_3	mg/l	50
Nitrite	NO^-_2	mg/l	3
Selenium	Se	mg/l	0.01

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Health Significant Chemical Parameters

Table B.4 Priority Parameters

Parameters	Symbol	Unit	Maximum Concentration
Iron	Fe	mg/l	<1
Manganese	Mn	mg/l	<0.5
Arsenic	As	mg/l	<0.05
Fluoride	F^-	mg/l	<1.5
Nitrate	NO_3^-	mg/l	50
Nitrite	NO_2^-	mg/l	3
Nitrite Nitrogen	NO_2^-N	mg/l	1
pH	pH	-	6.5-8.5
Coliform	-	MPN/100ml	0
Conductivity	EC	µS/cm	1000
Residual Chlorine (if Chlorine disinfection is used)	Cl_2	mg/l	0.2
Total Hardness	-	mg/l	<300
Turbidity	-	NTU	<10
Taste and Odour	-	-	Acceptable

Source: Refer to CA - Annex C – Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Priority Parameters

GROUNDWATER QUALITY STANDARDS

Lao PDR current standards for groundwater are provided below for reference.

Table B.5 Volatile Organic Compound

No.	Substances	Unit	Maximum Concentration
1	Benzene	mg/l	0.005
2	Carbon Tetrachloride	mg/l	0.005
3	1,2-Dichloroethane	mg/l	0.005
4	1,1-Dichloroethylene	mg/l	0.007
5	Cis-1,2-Dichloroethylene	mg/l	0.070

No.	Substances	Unit	Maximum Concentration
6	Trans-1,2-Dichloroethylene	mg/l	0.1
7	Dichloromethane	mg/l	0.005
8	Ethylbenzene	mg/l	0.7
9	Styrene	mg/l	0.1
10	Tetrachloroethylene	mg/l	0.005
11	Toluene	mg/l	1
12	Trichloroethylene	mg/l	0.005
13	1,1,1 Trichloroethane	mg/l	0.2
14	1,1,2 Trichloroethane	mg/l	0.005
15	Total Xylenes	mg/l	10

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.9 Groundwater Quality Standards

Table B.6 Heavy Metals

No.	Substances	Unit	Maximum Concentration
1	Cadmium	mg/l	0.003
2	Hexavalent Chromium	mg/l	0.05
3	Copper	mg/l	1
4	Lead	mg/l	0.01
5	Manganese	mg/l	0.5
6	Nickel	mg/l	0.02
7	Zinc	mg/l	5
8	Arsenic	mg/l	0.01
9	Selenium	mg/l	0.01
10	Mercury	mg/l	0.001

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.9 Groundwater Quality Standards

Table B.7 Pesticides

No.	Substances	Unit	Maximum Concentration
1	Chlordane	mg/l	0.0002
2	Dieldrin	mg/l	0.00003
3	Heptachlor	mg/l	0.0004
4	Heptachlor Epoxide	mg/l	0.0002
5	DDT	mg/l	0.002
6	2,4-D	mg/l	0.03
7	Atrazine	mg/l	0.003
8	Lindane	mg/l	0.0002
9	Pentachlorophenol	mg/l	0.001

Source: Refer to CA - Annex C – Appendix 2 Standard, 1.9 Groundwater Quality Standards

Table B.8 Other Parameters

No.	Substances	Unit	Maximum Concentration
1	Benzo[a]pyrene	mg/l	0.0002
2	Cyanide	mg/l	0.2
3	Polychlorinated biphenyls	mg/l	0.0005
4	Vinyl Chloride	mg/l	0.002

Source: Refer to CA - Annex C – Appendix 2 Standard, 1.9 Groundwater Quality Standards

GROUNDWATER QUALITY STANDARDS FOR DRINKING PURPOSES

Lao PDR's current standards for groundwater for drinking purposes are provided below for reference.

Table B.9 Physical Parameters

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
				Suitable	Maximum
Physical	Colour	-	Platinum-	5	15

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
			Cobalt (Pt-Co)		
	Turbidity	-	JTU	5	20
	Total solids	TS	mg/l	≤600	1,200

Source: Refer to CA - Annex C – Appendix 2 Standard, 1.10 Groundwater Standards for Drinking Purposes

Table B.10 Chemical Parameters

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
				Suitable	Maximum
Chemical	Acidity	pH	-	7.0-8.5	6.5-9.2
	Iron	Fe(ii), Fe(iii)	mg/l	≤0.5	1
	Manganese	Mn^{2+}	mg/l	≤0.3	0.5
	Copper	Cu^{2+}	mg/l	≤1.0	1.5
	Zinc	Zn^{2+}	mg/l	≤5.0	15
	Sulphate	SO_4^{2-}	mg/l	≤200	250
	Chloride	Cl^-	mg/l	≤250	600
	Fluoride	F^-	mg/l	≤0.7	1
	Nitrate	NO_3^-	mg/l	≤15	45
	Total Hardness as $CaCO_3$	Total $CaCO_3$	mg/l	≤300	500
	Non-carbonate hardness as $CaCO_3$	Non $CaCO_3$	mg/l	≤200	250
	Arsenic	As^{3+}, As^{5+}	mg/l	None	0.05
	Cyanide	CN^-	mg/l	None	0.1
	Lead	Pb^{2+}	mg/l	None	0.05
	Mercury	Hg	mg/l	None	0.001
	Cadmium	Cd^{3+}	mg/l	None	0.01
	Selenium	Se(iv)	mg/l	None	0.01

Source: Refer to CA - Annex C – Appendix 2 Standard, 1.10 Groundwater Standards for Drinking Purposes

Table B.11 Bacteria Parameters

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
				Suitable	Maximum
	Coliform bacteria	Coliform	MPN/100 ml	<2.2	<2.2
Bacteria	E. coli bacteria	E. coli	MPN/100 ml	None	None
	Standard plate count	-	Colonies/ml	≤500	-

Source: Refer to CA - Annex C – Appendix 2 Standard, 1.10 Groundwater Standards for Drinking Purposes

AMBIENT SURFACE WATER QUALITY STANDARDS

Deviation from these standards will only be allowed with the prior written approval of MONRE on a case by case basis, where the Company is able to demonstrate to MONRE's reasonable satisfaction that such deviation is caused by the inherent nature of the Nam Ngiep river or by the initial impoundment of the reservoir during the appropriate period as approved by MONRE. In applying for MONRE's approval, the Company shall clearly specify and justify all parameters, the proposed temporary standards for such parameters and the period during which such temporary standards are proposed to be in force together with appropriate monitoring plans and proposed steps promptly to address and resolve any failure to meet temporary standards. For the avoidance of doubt, the Company remains at all times responsible for Adverse Impacts related to approve deviations from the Ambient Water Quality Standards caused by the initial impoundment.

Table B.12 Ambient Surface Water Quality Parameter

Parameters	Units	Standard
pH		5-9
Dissolved Oxygen	mg/l	>6.0
BOD_5	mg/l	1.5
COD	mg/l	5.0
Nitrogen as nitrate ($N\text{-}NO_3$)	mg/l	5.0
Nitrogen as ammonia ($N\text{-}NH_3$)	mg/l	0.2

Parameters	Units	Standard
Sulfate	mg/l	500
Total coliform bacteria	MPN/ml	5,000
Total faecal coliform	MPN/ml	1,000
Phenols	mg/l	0.005
Arsenic (As)	mg/l	0.01
Cadmium (Cd) $CaCO_3 \leq 100$ mg/l	mg/l	0.005
Cadmium (Cd) $CaCO_3 \geq 100$ mg/l	mg/l	0.05
Chromium (VI) (Cr^{6+})	mg/l	0.05
Copper (Cu)	mg/l	0.1
Cyanide	mg/l	0.005
Lead (Pb)	mg/l	0.05
Mercury (Hg)	mg/l	0.002
Nickel (Ni)	mg/l	0.1
Zinc (Zn)	mg/l	1.0
Manganese (Mn)	mg/l	1.0
Alpha ¬Radioactivity	Becquerel/l	0.1
Beta ¬ Radioactivity	Becquerel/l	1.0
Total Organochlorine	mg/l	0.05
DDT	mg/l	1.0
Alpha-BHC	mg/l	0.02
Dieldrin	mg/l	0.1
Aldrin	mg/l	0.1
Heptachlor and Heptachlor Epoxide	mg/l	0.2
Endrin	mg/l	0

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.11 Ambient Surface Water Quality Standards

EFFLUENT STANDARDS

The Company is responsible for compliance with applicable effluent standards. This applies to all effluents and runoff from project activities, facilities, installations as well as discharges from resettlement sanitation and drainage.

Selected standards are listed below. All other parameters shall comply with the Lao National Standards and IFC Guidelines whichever is stricter.

Deviation from these standards will only be allowed:

1. with the prior written approval of MONRE, and in circumstances where the Company and its contractors have applied an appropriate waste water treatment system used by international construction contractors in Lao PDR and applicable to the construction site or
2. if the water from any project activities does not have an adverse effect on the existing water quality or
3. to the extent that the deviations are present as a result of the existing water quality.

Table B.13 Effluent Standards

Parameters	Units	Guidelines
pH		**6-9**
Biochemical Oxygen Demand -BOD	mg/l	**30**
Chemical Oxygen Demand -COD	mg/l	**125**
Total suspended solids	mg/l	**50**
Oils and grease	mg/l	**10**
Phenol	mg/l	**0.5**
Cyanide	mg/l	**0.1**
Ammonia -N	mg/l	**10**
Total Nitrogen	mg/l	**10**
Total phosphorus	mg/l	**2**
Residual chlorine	mg/l	**0.2**
Total coliforms	MPN/100ml	**<400**
Temperature increase	°C	**<3**
Arsenic	mg/l	**0.1**

Parameters	Units	Guidelines
Cadmium	mg/l	**0.05**
Chromium	mg/l	**0.1**
Copper	mg/I	**0.3**
Fluoride	mg/l	**20**
Iron	mg/l	**2**
Lead	mg/l	**0.2**
Mercury	mg/l	**0.002**
Nickel	mg/l	**0.5**
Selenium	mg/l	**0.1**
Silver	mg/I	**0.5**
Sulfides	mg/l	**1**
Zinc	mg/l	**0.5**
Total Toxic metals	mg/l	**5-10**

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.13 Effluent Standards

NOISE STANDARDS

Noise emission and ambient noise levels shall be in compliance with the Lao National Environmental Standard for noise as provided below for reference.

Table B.14 Noise Standards

Standards Method of Measurement	Standards Method of Measurement
Maximum Sound Level (L_{max}) should not exceed 115 dB(A)	Maximum Sound Level (L_{max}) should not exceed 115 dB(A)

Source: Refer to Agreement on the National Environmental Standards of Lao PDR, 2009

Table B.15 Noise Standards for Other Places

Type of Area	Standard Value in dB(A)		
	6.00-18.00	18.00-22.00	22.00-6.00
Quiet areas: hospitals, libraries, treatment places, kindergarten and schools	50	45	40
Residential areas: hotels and houses	55	55	45
Commercial and service areas	70	70	50
Small industrial factories located in residential areas	70	70	50

Source: Refer to Agreement on the National Environmental Standards of Lao PDR, 2009

AIR STANDARDS

Air emission and ambient air levels shall be in compliance with the Lao National Environmental Standard for ambient air quality standard as provided below for reference.

Table B.16 Ambient Air Quality Standards

Parameters	Symbol	Average Time Unit: mg/m³					Method of Measurement
		Hour			1 month	1 year	
		1 hr	8hr	24 hr			
Carbon monoxide	CO	30	10.26	-	-	-	Non dispersive infrared detection

Parameters	Symbol	Average Time Unit: mg/m³					Method of Measurement
Nitrogen dioxide	NO_2	0.32	-	-	-	-	Chemiluminescene method
Sulphur dioxide	SO_2	0.78	-	0.30	-	0.10	UV Fluorescence (1hr, 24hr, 1yr) or Pararosaniline (1hr, 4hr)
Total suspended Particulate	TSP	-	-	0.12	-	0.05	Gravimetric
Particulate Matter less than 10 microns	PM-10	-	-	0.12	-	0.05	Gravimetric or Beta Ray or Taper Element Oscillating Microbalance or Dichotomous
Ozone	O_3	0.20	-	-	-	-	Chemiluminescence or UV Absorption Phoptometry
Lead	Pb	-	-	-	1.5	-	Atomic Absorption Spectrometer

Source: Refer to Agreement on the National Environmental Standards of Lao PDR, 2009

VIBRATION STANDARD

The vibration standard was not mentioned in the Lao PDR national standard and international standard guideline. Therefore, to compare the results of measuring in construction activities of the Project such as blasting plant and quarry, the guideline for vibration standards from Mining and Quarry in Thailand is proposed in Table A3.8.1.

Table B.17 Vibration from Mining and Quarry Standard

Frequency (Hertz)	Velocity (mm/s)	Displacement (mm)
1	Not Exceed 4.7	Not Exceed 0.75
2	Not Exceed 9.4	Not Exceed 0.75
3	Not Exceed 12.7	Not Exceed 0.67
4	Not Exceed 12.7	Not Exceed 0.51
5	Not Exceed 12.7	Not Exceed 0.40
6	Not Exceed 12.7	Not Exceed 0.34
7	Not Exceed 12.7	Not Exceed 0.29
8	Not Exceed 12.7	Not Exceed 0.25
9	Not Exceed 12.7	Not Exceed 0.23

Frequency (Hertz)	Velocity (mm/s)	Displacement (mm)
10	Not Exceed 12.7	Not Exceed 0.20
11	Not Exceed 13.8	Not Exceed 0.20
12	Not Exceed 15.1	Not Exceed 0.20
13	Not Exceed 16.3	Not Exceed 0.20
14	Not Exceed 17.6	Not Exceed 0.20
15	Not Exceed 18.8	Not Exceed 0.20
16	Not Exceed 20.1	Not Exceed 0.20
17	Not Exceed 21.4	Not Exceed 0.20
18	Not Exceed 22.6	Not Exceed 0.20
19	Not Exceed 23.9	Not Exceed 0.20
20	Not Exceed 25.1	Not Exceed 0.20
21	Not Exceed 26.4	Not Exceed 0.20
22	Not Exceed 27.6	Not Exceed 0.20
23	Not Exceed 28.9	Not Exceed 0.20
24	Not Exceed 30.2	Not Exceed 0.20
25	Not Exceed 31.4	Not Exceed 0.20
26	Not Exceed 32.7	Not Exceed 0.20
27	Not Exceed 33.9	Not Exceed 0.20
28	Not Exceed 35.2	Not Exceed 0.20
29	Not Exceed 36.4	Not Exceed 0.20
30	Not Exceed 37.7	Not Exceed 0.20
31	Not Exceed 39.0	Not Exceed 0.20
32	Not Exceed 40.2	Not Exceed 0.20
33	Not Exceed 41.5	Not Exceed 0.20
34	Not Exceed 42.7	Not Exceed 0.20
35	Not Exceed 44.0	Not Exceed 0.20
36	Not Exceed 45.2	Not Exceed 0.20
37	Not Exceed 46.5	Not Exceed 0.20

Frequency (Hertz)	Velocity (mm/s)	Displacement (mm)
38	Not Exceed 47.8	Not Exceed 0.20
39	Not Exceed 49.0	Not Exceed 0.20
40	Not Exceed 50.8	Not Exceed 0.20

Note: Pollution Control Department (PCD), Ministry of National Resources and Environment, Thailand.

ELECTRIC AND MAGNETIC FIELD EXPOSURE LIMITS

Table B.18 Exposure Limits for General Public Exposure to Electric and Magnetic Fields

Frequency	Electric Field (V/m)	Mangetic Field (μT)
50 Hz	5000	100
60 Hz	4150	83

Source: International Commission of Non-Ionizing Radiation Protection, cited in World Bank Group (2007) *Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution.*

Table B.19 Occupational Exposure Limits for Electric and Magnetic Fields

Frequency	Electric Field (V/m)	Mangetic Field (μT)
50 Hz	10,000	500
60 Hz	8300	415

Source: International Commission of Non-Ionizing Radiation Protection, cited in World Bank Group (2007) *Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution.*

Annex C

Transmission Line Biodiversity Assessment Report

Annex D

Best Available Techniques