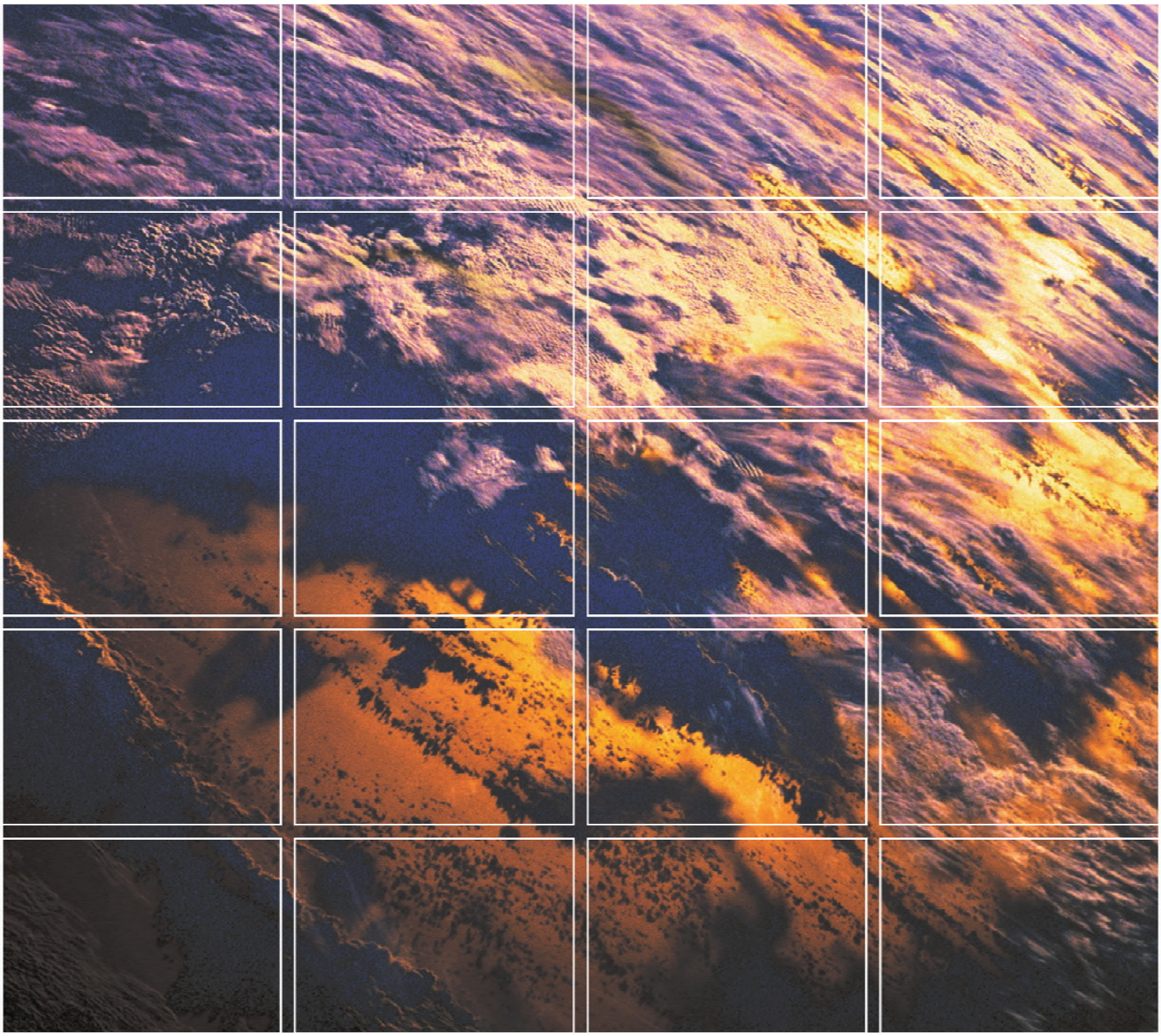
Appendix C

Cumulative Impact Assessment (CIA) Report



Nam Ngiep 1 Hydropower Project

Cumulative Impact Assessment *(CIA)* Report

NAM NGIEP 1 POWER COMPANY LIMITED

May 2014

0200749

www.erm.com

The world's leading sustainability consultancy

ERM

FINAL REPORT

NAM NGIEP 1 POWER COMPANY LIMITED

Cumulative Impact Assessment *(CIA)* Report

May 2014

Reference 0200749

For and on behalf of
ERM-Siam Co., Ltd.

Reviewed by: David Nicholson

Signed: 

Position: Principal Consultant – Biodiversity Lead

Approved by: Cristina Pellegrino

Signed: 

Position: IAP Partner

Date: 22 May 2014

CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

ERM has prepared this Cumulative Impact Assessment (CIA) for the Nam Ngiep 1 Power Company (NN1PC) following a request by the Asian Development Bank to prepare this assessment. The purpose of the assessment is to better understand the impacts of past and future actions on the Nam Ngiep River and watershed.

This current CIA document is based on the principles outlined in the following documents:

- *the U.S. Council on Environmental Quality (CEQ) implementing the National Environmental Policy Act (NEPA) (US EPA 1999);*
- *International Finance Corporation Performance Standards 1 and 6 (IFC 2012);*
- *IFC's Draft (External Peer Review) – Cumulative Impact Assessment Guidance Note for Private Sector in Emerging Markets (ESSA & IFC 2012); and*
- *ADB Safeguard Policy Statement (2009).*

There is currently very little quantitative data available for other projects upon which to make an informed CIA for the Nam Ngiep watershed. Nonetheless, some other RFFAs for which impact assessments have been completed contain qualitative discussion of impacts.

An analysis of available information on seven other proposed hydro-electric power (HEP) and mining development Projects in the area and various other reasonably foreseeable future actions (RFFA) was undertaken for this CIA. Impacts from this Project and each of the RFFAs were considered on the VECs identified for the Project:

- *VEC 1: Terrestrial biodiversity and habitats*
- *VEC 2: Aquatic biodiversity and habitats*
- *VEC 3: River flows and water quality*
- *VEC 4: Ecosystem services*

The analysis was mostly qualitative as little quantitative data was available for other projects.

The creation of reservoirs will inundate some terrestrial environments across the watershed however as the nature of the existing impacts is such that the valley floors are already exploited for agriculture and have been largely cleared, the impacts on these environments through inundation along will not be as large as the increased pressure on available resources from increased human populations.

The creation of reservoirs and barriers (i.e. dam walls) along water courses such as will occur for this Project and the potential six other HEPs and mining developments in the area has the potential to greatly alter the aquatic ecology of the Nam Ngiep River as a whole with some impacts on the Mekong River. There could potentially be

an increase in abundance of fish species adapted to lacustrine environments with those requiring migration and/or fast-flowing waters likely to decline.

An increase in construction activity and improvements to infrastructure in the region are both likely to lead to an increase in the human population in the area. This will likely negatively impact on terrestrial and aquatic resources as more people require agricultural and subsistence products from the arable land and forest areas.

The NNP1 Project has prepared a comprehensive environmental assessment and has responded with a similarly comprehensive suite of mitigation and management measures, including biodiversity offsetting. These measures are not matched by other current and future RFFAs within the watershed.

In relation to biodiversity offsets, the achievement of no-net-loss on biodiversity values by the NNP1 Project enables a positive contribution to management within the watershed. Without a biodiversity offset, biodiversity values would be lost and not adequately compensated through management measures. It is likely that there would be an ongoing decline in biodiversity values within the watershed, including for species such as L. striolatus and the White Cheeked Gibbon. Conservation initiatives proposed for the biodiversity offset area will be aimed at ensuring the persistence of these species in the landscape.

This will contribute to the improvement in biodiversity values within the watershed, reducing the chances of further and continued loss of biological resources. The NNP1 Project can therefore be considered as positive to the biological environment in the longer term.

To manage cumulative impacts, management actions should be implemented at the planning and operational stage to protect the environment. These practices should focus on: watershed management activities to coordinate development activities; environmental flow regimes for HEPs; sediment and erosion control; assessment and management of biodiversity using the mitigation hierarchy; requirements for biodiversity offsetting and watershed management activities to coordinate effective management of water allocations and resources.

1 INTRODUCTION

1.1 THE CUMULATIVE IMPACT ASSESSMENT CONCEPT

Assessment of cumulative impacts builds from the assessment of the direct/indirect impacts of the Project undertaken during the Environmental Impact Assessment (EIA: ERM, 2014) process and within the Initial Report (ERM 2013a). The results of the direct/indirect assessment are considered in combination with other past, present, and reasonably foreseeable future actions potentially affecting resources and receptors.

The ultimate goal of this analysis is to capture the total effects of many actions over time from past, existing and realistically future actions or Projects that may be inadvertently missed by evaluating each action individually. To encourage informed decision making we assess the relative contribution of the Project and other related projects to the overall cumulative effects. The Cumulative Impact Assessment (CIA) describes the additive or combined result of the alternatives as they potentially interact with actions external to the Project and other past, existing and realistically future projects. It is critical to focus the CIA on meaningful cumulative impact issues, rather than on all conceivable impact relationships.

1.2 LIMITATIONS

In order to deliver a comprehensive CIA, quantitative data is required on the Project and the other reasonably foreseeable future actions (RFFAs). Currently there is very little quantitative data available for other (RFFAs) upon which to make an informed CIA for the Nam Ngiep watershed. However, some other RFFAs for which impact assessments have been completed contain qualitative discussion of impacts. For this reason, the CIA process for the Nam Ngiep watershed is constrained to providing an overview of the likely cumulative impacts and mitigation measures available to limit environmental impact.

2 METHODOLOGY

2.1 APPROACH

The CIA was developed in reference to guidance outlined in the following documents:

- the U.S. Council on Environmental Quality (CEQ) implementing the National Environmental Policy Act (NEPA) (US EPA 1999);
- International Finance Corporation Performance Standards 1 and 6 (IFC 2012);
- IFC's Draft (External Peer Review) – Cumulative Impact Assessment Guidance Note for Private Sector in Emerging Markets (ESSA & IFC 2012); and
- ADB Safeguard Policy Statement (2009).

Consistent with the IFC's Draft (External Peer Review) – *Cumulative Impact Assessment Guidance Note for Private Sector in Emerging Markets,* this CIA report focusses on the identified Valued Environmental and Social Components (VECs) (ESSA & IFC 2012). VECs are environmental and social attributes that are considered important in assessing risk (ESSA & IFC 2012).

The VECs identified as a result of the literature review described in *Section 3.1* are:

- VEC 1: Terrestrial biodiversity and habitats
- VEC 2: Aquatic biodiversity and habitats
- VEC 3: River flows and water quality
- VEC 4: Ecosystem services

Discussion of these VECs is provided in *Section 3.1* framed in terms of the parameters:

- Known or suspected impacts by the project and RFFAs;
- Known cumulative impact issues in the region; and
- Concerns generally recognized as important on the basis of scientific concerns.

2.2 *INVESTIGATION AREAS*

In order to satisfy the assessment requirements, a number of locations were assessed for baseline biodiversity values. Within this report the following terminology applies:

- Study area – the area encompassing all areas assessed for biodiversity values where includes the Project area (***Figure 4.1***) and Nam Ngiep watershed where originally covers three provinces; Vientiane, Bolikhamxay and Xieng Khouang provinces. However, the GOL has recently announced the establishment of the new province, Xaysomboon Province.

- Project area – the area potentially directly and indirectly affected by the NNP1 Project. This includes the footprint of disturbance of the various components.

- Temporal boundary area – the area potentially directly and indirectly affected by the Project in a given life cycle (27 years) where is the downstream of Nam Ngiep River covering two provinces; Bolikhamxay and Vientiane.

The location of the investigation areas is shown in ***Figure 4.1***.

3 INFORMATION SOURCES

3.1 LITERATURE REVIEW

Key documents used to inform this CIA include:

- *Nam Ngiep 1 Hydropower Project Environmental Impact Assessment (EIA) Draft Report*, Prepared by Environmental Research Institute (ERI), Chulalongkorn University, 2012.
- *Nam Ngiep 1 Hydropower Project Environmental Impact Assessment (EIA) Updated Version Report*, Prepared by ERM-Siam Co., Ltd., January 2014.
- *Nam Ngiep 1 Hydropower Project Social Impact Assessment Report*, prepared by Sriburi *et al.* for the Kansai Electric Power Company Inc., May 2012.
- *Nam Ngiep 1 Hydropower Project Biodiversity Baseline Report,* prepared by ERM for KANSAI Electric Power Co., INC., September 2013.
- *Nam Ngiep 1 Hydropower Project Resettlement Technical Review Final Report*, prepared by ERM-Siam, Co Ltd. for the Kansai Electric Power Company Inc., May 2013.
- *Lao: Nam Ngiep 1 Hydropower Project, Draft Initial Environmental Examination (IEE),* Prepared by The Kansai Electric Power Company, Inc., EGAT International Company, Ltd. And Lao Holding State Enterprise for the Asian Development Bank, January 2012.
- *Power System Development Plan for Lao PDR: Final Report, Volume C: Project Catalogue*, Prepared for Lao People's Democratic Republic, Ministry of Industry & Handicrafts, Department of Electricity and World Bank by Maunsell Limited 2004.
- *Nam Phouan Hydropower Project: Environmental and Social Impact Assessment*, Prepared by Velcan Energy, and Lem Consultants, September 2012.
- *Nam Ngiep 2 Hydropower Project Final Environmental Impact Assessment Report,* Prepared by NCC Environmental Assessment Team, February 2010.
- *National Statistics Centre of the Lao PDR*. Lao Department of Statistics NSC (2007).

3.2 *BIODIVERSITY SURVEY (THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR))*

In order to supplement the available information (above), field investigations were undertaken in March and July 2013 by the Thailand Institute of Scientific and Technological Research (TISTR) to collect data representative of wet and dry season biodiversity conditions.

The surveys incorporated detailed assessments that included forest and vegetation cover survey and assessment, wildlife survey and assessment, and aquatic ecology survey and assessment.

Survey was undertaken at four of the investigation areas that include:

- The Project area (main dam site and reservoir, re-regulation dam site, resettlement site/lower Nam Ngiep);
- Upper Nam Ngiep River;
- Upper and lower Nam Xan River; and
- Huay Ngua provincial protected area.

Further surveys were also undertaken by Dr Maurice Kottelat and Mr Terry Warren regarding fish species within the Nam Ngiep River in late 2013 and early 2014. A specialist primate survey was also undertaken in the Nam Ngiep watershed by Dr Phavianh Phiaphalath in early 2014. Reference to these specialist studies is also contained in this report.

3.3 *VILLAGE AND MARKET SURVEYS*

Two field visits were conducted by ERM and sub consultants in February and July 2013. The first visit included engagement with key government and non-government officials to understand current land use and tenure as well as use and threats to biodiversity in the Nam Ngiep River watershed and potential offset sites. In addition, village and market surveys were undertaken. These were used to gather data on the utilisation of ecosystem services by project affected people (PAP), including the use of threatened flora and fauna. The village surveys included focus group discussions and in-depth interviews with relevant community representatives (e.g. hunters, gatherers); while the market surveys involved visual review and informal discussions with stall operators.

The second field visit in July 2013 focussed on understanding and assessing the ecosystem services in the potential offset sites as well as community acceptance of the proposed offset measures. The survey approach was similar to that conducted in the first field visit – e.g. focus group discussions, in-depth interviews and visual surveys.

In total, 18 villages and four markets were surveyed. The outcome was an understanding of stakeholder opinions and concerns as they relate to the potential offset sites and proposed offset measures and an understanding of ecosystem services utilised by local community members.

3.4 GOVERNMENT AGENCY AND NON-GOVERNMENTAL ORGANISATION (NGO) CONSULTATION

ERM conducted stakeholder engagement with Regional Agencies, Lao PDR Government Departments, local officials and Non-Government Organisations (NGO) in February 2013, August 2013 and February 2014. Follow up consultation occurred in August 2013. These consultations included discussion and information requests regarding other hydro-electric power projects (HEPs) and other current and proposed developments, including mines and forestry.

A field mission occurred with the Independent Advisory Panel (IAP) for the NNP1 Project in November 2013 to discuss the Project as well as biodiversity offsets and concerned cumulative impacts from other HEPs and mining development Projects. A consultation forum was held with the Lao PDR Government and NGO stakeholders in March 2014 to discuss the refined framework.

Consultation occurred with the stakeholders as shown in ***Table 3.1***.

Table 3.1 ERM Consultation with Government Agencies and NGOs

Agency	Person
February 2013	
Lao PDR Government Departments	• Mr. Lamphanh Kommadam, Director of Conservation Forest Management Division, Ministry of Natural Resources and Environment, Department of Forestry Resource Management • Mr Keodokmay Phouipaseuth, Division of Water Surface and Groundwater Quality Management, Ministry of Natural Resources and Environment, Department of Water Resources • Mr Saysamone Phothisat, Deputy Director General, Ministry of Natural Resources and Environment, Department of Forestry Resource Management • Mr Khamphoui Sivongxay, Division of Water Surface and Groundwater Quality Management, Water Resource Data & Information Centre, Department of Water Resources • Mr Bounpone Sengthong, Director of Production Forest and Timber Harvest Management Division, Ministry of Agriculture and Forestry, Department of Forestry • Mr Kingkham Manivong, Head of Law Division, Water Resource Data & Information Centre, Department of Water Resources • Mr Khamtanh Vongphansipaseuth, Project Director. Federal Institute of Geosciences and Natural Resources, Department of Mines • Mr Vithoulabandid Thoummabout, Acting Director of Environment and Engineering Division, Ministry of Energy and

Agency	Person
	Mines Department of Energy Policy and Planning • Mr Soukata Vichit, Executive Director, Lao PDR Environment Protection Fund
International Aid agencies	• Rachel Jolly, Aus AID Manager - Mekong Water Resources Unit
August 2013	
Lao PDR Government Departments	• Mr Lamphanh Kommadam, Ministry of Natural Resources and Environment, Department of Forestry Resource Management Director of Conservation Forest Management Division • Mr Khamphoui Sivongxay Water Resource Data & Information Centre, Department of Water Resources, Ministry of Agriculture and Forestry, Department of Forestry • Mr Bounpone Sengthong Director of Production Forest and Timber Harvest Management Division • Mr Keodokmay Phouipaseuth Ministry of Natural Resources and Environment, Department of Water Resources Division of Water Surface and Groundwater Quality Management • Mr Kingkham Manivong Head of Law Division Water Resource Data & Information Centre, Department of Water Resources
Non-Government Organisations	• Mr Alex McWilliam and Mr Troy Hansel Wildlife Conservation Society (WCS) (Lao PDR Program) • Mr Thatsaphone Songbandith, Lao Country Manager, International Union for the Conservation of Nature (IUCN) (Vientiane Office) • Mr Somphone Bouasavanh and Mr Micah Ingalls, World Wildlife Fund (WWF) (Lao PDR Program) (Vientiane Office)
March 2014	
Independent Advisory Panel	• Ms Kathy MacKinnon, Dr Richard S Frankel & Dr Charly Mehl
Non-Government Organisations	• Mr Alex McWilliam Mr Troy Hansel Wildlife Conservation Society (WCS) (Lao PDR Program) • Mr Vene Vongphet, International Union for the Conservation of Nature (IUCN) (Vientiane Office)
Lao PDR Government Departments	• Mr Viengkeo Souksavadty, Deputy Director General, Ministry of Information, Culture and Tourism (MICT) • Outakeo Keoduangsing, Director of Legal Division, Investment Promotion Department, Ministry of Planning and Investment (MPI) • Mr Saysomone Phothisat Deputy Director General and Mr Lampanh Kommadam Director of Conservation Forest Management, Department of Forest Resource Management (DFRM) • Mr Aengphone Phaengsuwan, Director of Centre – EIA Review of Hydropower Projects, DESIA and Peter G. Jensen, Chief Technical Advisor, Ministry of Natural Resources and Environment (MONRE)

4 NAM NGIEP WATERSHED EXISTING ENVIRONMENT

This section provides an overview of the existing environment of the Nam Ngiep Watershed. It describes the water quality and quantity, biodiversity and social characteristics of the existing environment. This assessment provides a contextual background to the existing environmental and social characteristics that will be affected by Project developments within the Study Area.

A detailed Project assessment for the Nam Ngiep 1 Hydropower Project (NNP1) impacts are discussed in detail in ERI (2012), ERM (2012), ERM (2013a) and ERM (2014).

4.1 REGIONAL SETTING

The Study area for the CIA consists of Nam Ngiep watershed area which is located within the Xaysonboun, Vientiane, Bolikhamxay and Xieng Khouang Provinces, 145 kilometres (km) northeast from Vientiane or 50 km north from Pakxan District. The Nam Ngiep watershed is approximately 340,000 ha in size. The study area is shown in ***Figure 4.1***.

The population density in the Nam Ngiep watershed is low. Settlements are limited to the river valleys, with the main exceptions being the large expanse of fairly flat land towards the Mekong River and larger valleys toward the north and northeast of the watershed. These are also some of the most populated areas in the watershed. The major settlements relative to the Nam Ngiep watershed are: Phonsavan, the capital of Xieng Khouang Province is just outside the watershed boundary to the north and Pakxan, the capital of Bolikhamxay Province downstream of the proposed dam near the Nam Ngiep confluence with the Mekong River. Other settlements in the north of the Nam Ngiep watershed include Muang Khoun and Phaxai.

The main road through the watershed is National Road 1D, which was until recently a dirt road with some sections covered in gravel. It connects Phonsavan (the capital of Xieng Khouang Province) with Pakxan (the capital of Bolikhamxay Province). It runs north from Pakxan through the Nam Xan watershed and then turns west to go through the northern part of the Nam Ngiep watershed. Urban development and consolidation occurs along this road. No major thoroughfare roads are in the lower part of the Nam Ngiep watershed.

250000
300000
350000
400000
2150000
2100000
2050000

Legend

- Nam Ngiep Catchment Boundary
- Waterbody
- Road
- City or Town
- Lao PDR Boundary
- National Park Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

N
0 10 20 30Km
1:600,000

Basemap: Bing Maps
Datum: WGS84

Phoukout
Phonsavan
Nonghet
Muang Khoun
Phaxai
Nam Ngum
Nam Ngiep
Thathom
Vang Vieng
Nam Song Diversion
Nam Ngum 2 Reservoir
Nam Xan
Nam Ngum Reservoir
Hinheup
Ba. Donkha
Nam Ngum Reservoir
Longxan
Huay Ngua Provincial Protected Area
Phou Ngou Provincial Protected Area
Thinkeo
Phonhong
Nam Ngum Reservoir
Nam Kading National Protected Area
Nam Leuk reservoir
Phou Khao Khouay National Protected Area
Mekong River
Nam Mang 3 Reservoir
Ban Keun
Pakxan
Phou Pha Nang National Protected Area
Hai
Tha Ngon
bing

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_CIA_G001_R0.mxd		
Date:	10/01/2014	Drawing Size: A3	
Drawn By:	TC	Reviewed By: DN	

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 4.1 - Regional Setting

Nam Ngiep 1 Hydropower Project
Biodiversity Cumulative Impact Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

4.1.1 Nam Ngiep Watershed Overview

The Nam Ngiep Watershed has a total watershed area of 4,680 km^2 with the NNP River measuring 160 km in length. The Nam Ngiep River originates near Ban Phonsavan in the upstream area of Xieng Khouang Province and travels south-southeast through the mountain regions of Hom district in Vientiane Province and Bolikhan district in Bolikhamxay Province. It emerges from the more mountainous region via a narrow gorge approximately 7.7 km upstream of the village of Hat Gniun, where the main NNP1 Project dam will be constructed. While the upstream section of the river is located in a highly mountainous area with some intermittent, narrow, inhabited plains, downstream it follows a relatively flatter river plain as it flows out into the Mekong River at Pakxan.

The Nam Ngiep Watershed is divided into 33 sub-basins with only 10 of them being bigger than 100 km^2. The contribution of flow from each sub-basin is calculated using the information of sub-basin area and the isohyet generated from the average annual rainfall from existing stations inside and around the basin. The contribution of each sub-basin to the river in terms of annual volume shows a wide range, with the biggest contribution being 542 mcm (million cubic meters) (Nam Phouan) and the smallest one only 10 mcm (North Nam Hok).

Major floods and drought

Major recorded flood levels are shown in ***Table 4.1*** for the Nam Ngiep watershed where was in Muang Mai on August 7th 1995 and August 1st 1996 which was in monsoon season with the peak discharge of 1,266 m^3/s and 1,125 m^3/s, respectively, the rainfall of 402.9 mm. (recorded during 1-10 August 1995) and 656.3 mm., respectively, the major damages of 5,300 hectares and 3,000 hectares of flooded areas, respectively and costed around 3,000,000 USD and 2,000,000 USD, respectively. Fortunately, no missing or dead people were found during these two major floods.

Table 4.1 Major Floods in Nam Ngiep Watershed

Date	Peak Discharge (m^3/s)	Rainfall (mm) Duration	Meteorological Cause	Major Damages (Districts Affected)
7 Aug. 1995	1,266	402.9 (1-10 Aug.)	Monsoon	5,300 ha (flooded area) 3,000,000 USD
1 Aug. 1996	1,125	656.3	Monsoon	3,000 ha (flooded area) 2,000,000 USD

A major drought was recorded during 1998-1999 with the affected area of 9,000 hectares. Major damage included damage to rice crops and forest fires during the dry season.

4.1.2 *Water quality and Hydrology*

Data is only available for the NNP1 Project for river flow and water quality for the Study Area. No data is currently available for other HEPs in relation to downstream flow regimes and relative impacts. The data available for the NNP1 Project is summarised below as an indicative background for the lower Nam Ngiep Watershed.

Due to lack of long term observed data, the annual, monthly and daily discharge downstream of the re-regulation dam has been calculated by Tank Model method using 1971 to 2000 data. The calculated mean annual inflow is estimated to be 148.4 m^3/s at the main dam of the NNP1 Project and 149.4 m^3/s at the re-regulation dam. ***Figure.4.2*** presents seasonal inflow and outflow of the NNP1 main dam after construction; and ***Figure 4.3*** shows inflow to the re-regulation dam before and after construction.

Figure 4.4 shows monthly and annual natural inflow to the main dam, outflow from the main dam and outflow from the re-regulation dam over the 30-year period.

The dam-reservoir systems regulate the flood discharge during the wet seasons and increase the flow rates during the dry seasons, so that the seasonal flow regime shows less fluctuation over the year. Daily and monthly flow fluctuations are also likely to be less evident after the regulation.

Figure.4.2 ***Seasonal Inflow and Outflow of the Main Reservoir***

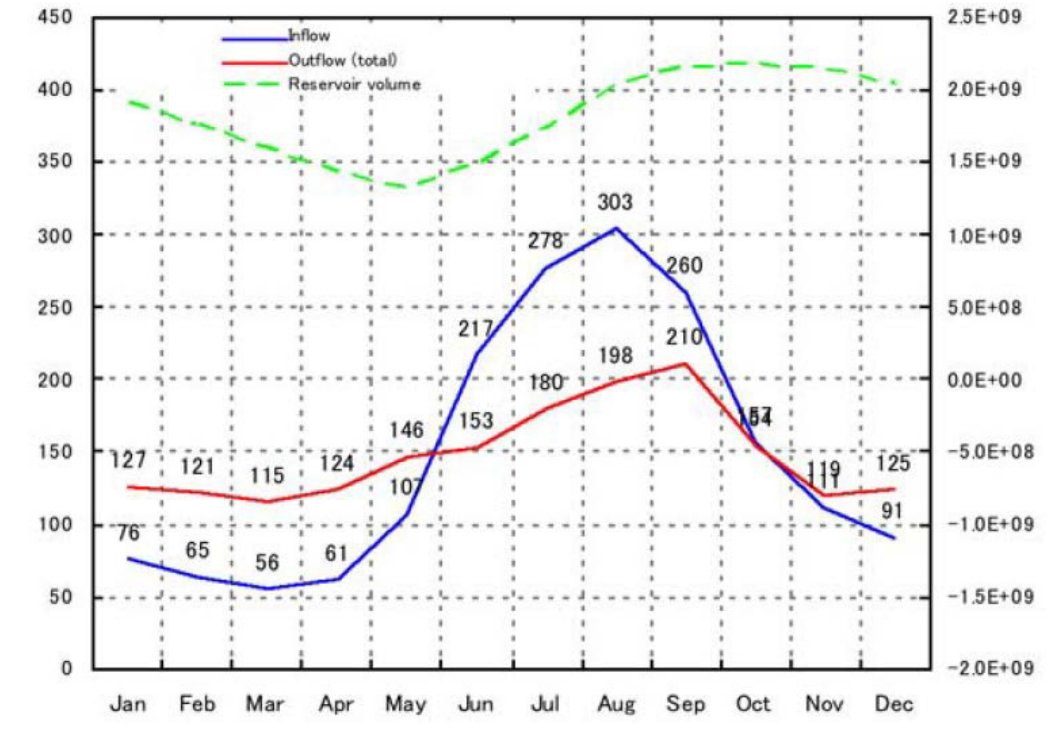


Figure 4.3 *Annual Natural Inflow to the Main Dam and Outflow from the Main Dam and the Re-regulation Dam*

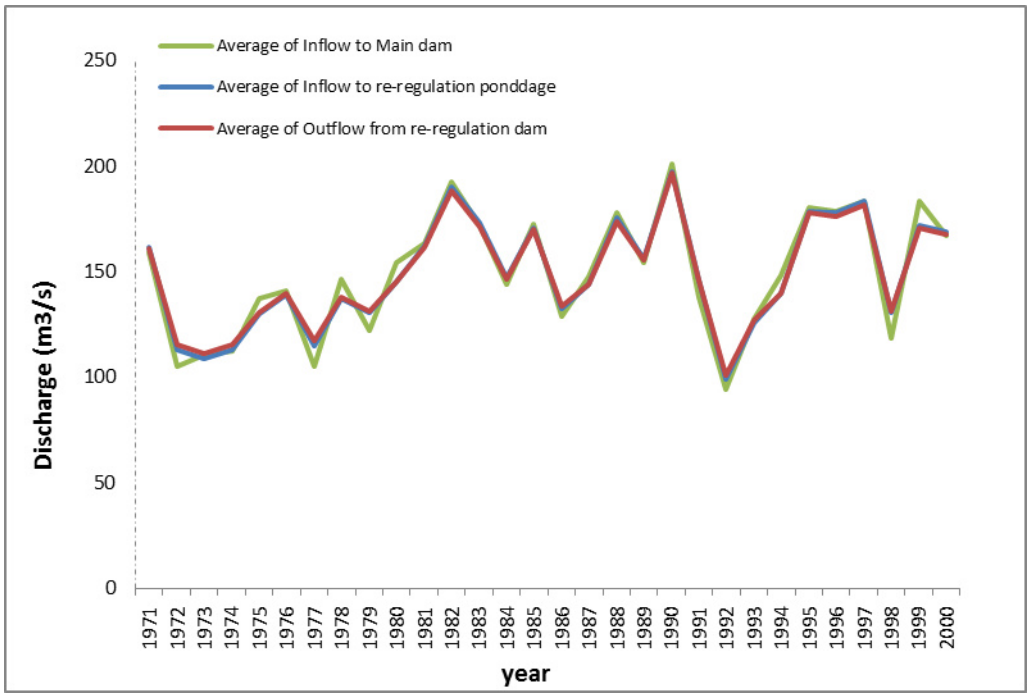
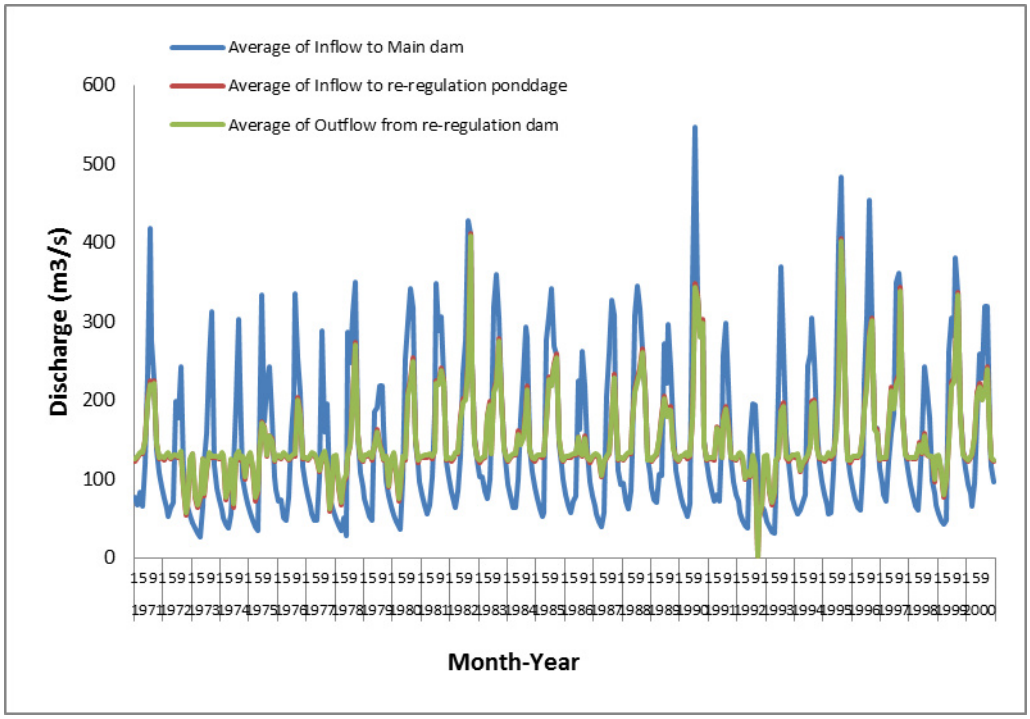


Figure 4.4 *Monthly Natural Inflow to the Main Dam and Outflow from the Main Dam and the Re-regulation Dam over the 30-year Period*



Lower Nam Ngiep Tributary inflows

The tributary Nam Xao River joins the NNP River 3 km downstream below the re-regulation dam. The minimum flow in the NNP River at the confluence will increase to more than 18.6 m^3/s (***Table 4.2***) with the July inflows from both the tributary Nam Tak and Nam Xao.

Table 4.2 Minimum Inflows From Downstream Tributaries of the Nam Ngiep River

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nam Tak minimum daily flow	1.2	1.0	0.9	1.0	1.7	3.4	4.4	4.8	4.1	2.5	1.7	1.4
Nam Xao minimum daily flow	3.3	2.7	1.8	1.3	1.6	3.7	8.7	11.2	12.0	8.5	7.3	4.4

Note: The minimum daily flow is predicted for the tributary Nam Xao stream by multiplying ratio of basin area to NNP Watershed area to the minimum daily flow recorded in the NNP River.

4.1.3 Biodiversity Values

The Study Area is located in central Lao PDR within the greater Mekong Watershed. This area is dominated by the Luang Prabang Montane Rainforest Ecoregion (IM0121) defined by the Worldwide Fund for Nature (WWF) (WWF 2003a).

The Luang Prabang Montane Rainforests Ecoregion comprises areas largely above 800 m in north-central Lao PDR and is globally recognized for its diversity in bird species (some 540 different species of birds have been recorded here) despite more than 70% of the original forest cover being lost as a result of shifting cultivation. The remaining forests contain a rich mix of tree and non-timber species including hardwoods, conifers, rhododendron, ferns, orchids and lichens (WWF 2003b). No endemic species have been recorded in this ecoregion but this is thought to be due to the lack of biological surveys rather than a true lack of endemics.

The ecoregions is characterised by a variety of forest associations including montane hardwoods, mixed conifer-hardwood forests, open montane forests, and open conifer forests (Wikramanayake *et al* 2002). These forests have been subject to heavy logging pressure and much of the forest cover of central Lao PDR is subject to existing forestry operations, or occurs within approved forest leases. Humid evergreen forest occurs at lower elevations around 800 m with *Dipterocarpus turbinatus* and *Toxicodendron succedaneum* as the dominant over storey species. The low stature of trees in this community and open understory with an abundance of broad-leaved monocots and grasses suggest severe past impacts from burning and clearance (Wikramanayake *et al* 2002).

Slash and burn agriculture is a land use that is still practiced widely in central Lao PDR, including the Study Area (ERM 2013a).

4.1.4 Land Cover

Using land cover mapping (DFRM, 2010), natural and modified habitats, in accordance with IFC definition, can be identified within the Project area and the lower Nam Ngiep. ***Figure 4.17*** identifies the land cover type categories in the watershed.

Natural habitat is an environment where the biological communities are largely formed by native plant and animal species and where human activity has not modified the areas primary ecological functions (ADB, 2012). The natural habitats within the Study area include deciduous forest, evergreen forest and bamboo vegetation.

Modified habitat is altered natural habitat, often formed by the removal of native species for harvesting, land conversion and/or introduction of alien flora and fauna species (ADB, 2012). The modified habitats within the Study area and the lower Nam Ngiep include young and old fallow land, slash and burn, rice paddy, grassland and urban areas. The Project EIA (ERI, 2009) identified during field reconnaissance and village interviews that a large portion of the main dam and re-regulation dam site has already been disturbed by conversion of forest land to other land use types (predominantly agriculture) as well as burning for hunting and illegal logging.

4.1.5 Forest Classification Mapping

Forestry classification mapping identifies both protection forest and production forest in the Nam Ngiep watershed. ***Figure 4.5*** depicts the extent of protected and production forest and shows that greater than half of the upper catchment is mapped as "protection forest". Protection forest is described as *'forest and forest land classified for the protection of watershed areas and the prevention of soil erosion. It also includes areas of forest land significant for national security, areas for protection against natural disaster and protection of the environment and other areas.'* A significant proportion of the watershed is also classified as Production forest, allowing forestry activities to remove timber.

4.1.6 Vegetation Condition

ERM undertook an analysis of the condition of vegetation types in the lower Nam Ngiep Watershed and the Project Area. This analysis used spatial techniques to analyse the "greenness" of vegetation using the Normalized Difference Vegetation Index (NDVI) for Rapideye Imagery taken in January 2013. It indicates the photosynthetic capacity of the land surface cover and has been used to refine the vegetation type extents into an additional level of detail.

Over 80 per cent of the Project area is classified as moderate or high NDVI across the lower Nam Ngiep Watershed. Upwards to 5 per cent of the Project area is classified as impacted NDVI.

Analysis of NDVI for the upper Nam Ngiep was not undertaken for the NNP1 Project and data on the condition of vegetation is not available. Given the same landuses exist in the upper catchment, it can be expected that a similar proportion of vegetation condition exists, especially in the production and protection forest components of the upper watershed.

310000 320000 330000 340000 350000

2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000

Nam Ngiep

Thathom

Nam Xan

Legend

- Nam Ngiep Catchment Boundary
- Road
- Watercourse
- City, Town or Village
- Proposed Access Road

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area

Forest Zone:

- National Protection Forest
- Production Forest

N

0 2.5 5 7.5Km

1:200,000

Basemap: Bing Maps

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_BIODIV_G009_R0.mxd	
Date:	10/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 4.5 - Forestry Classification Mapping within the Upper Nam Ngiep

Nam Ngiep 1 Hydropower Project
Baseline Biodiversity Assessment Report

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

280000 290000 300000 310000 320000 330000 340000 350000 360000 370000

2160000 2150000 2140000 2130000 2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000 2040000

Namang
Langam
Houtan
Napa
Nam Tian
Saksot
Xong
Phouvieng
Nongkang
Boau
Phoukout
Nakhuon
Nongtan
Xay
Phianloung
Mang
Dhu
Plain of Jars
Phonsavan
Nam Ngum
Muang Khoun
Phaxai
Nam Xan
Ban Pou
Thathom
Namngon
Thongkhoun
Namcha
Xiengmi
Ban Hat Gniun
Ban Hatsaykham
Ban Thahuea
Ban Sisavath
Ban Nonsomboun
Thabok
Mekong River

Legend

- Nam Ngiep Catchment Boundary
- Waterbody
- Road
- City, Town or Village

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Forest Zone:

- National Protection Forest
- Production Forest

N

0 4 8 12Km

1:350,000

Basemap: Bing Maps
Datum: WGS84

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_EIA_REV_CIA_G006_F4.19.mxd		
Date:	30/04/2014	Drawing Size: A3	
Drawn By:	TC	Reviewed By: DN	

Figure 4.6 - Forestry Classification Mapping within the Project Area and the Lower Nam Ngiep

Nam Ngiep 1 Hydropower Project
Cumulative Impact Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Newcastle, Melbourne, Perth, Port Macquarie, Sydney

ERM

4.1.7 Protected Areas

National Protected Areas (NPA) was established in Lao PDR in 1993 under a Prime Ministerial Decree. As at 2012, the total land area of Lao protected under these NPAs was 3.4 million hectares or 14.3% of the country's total area (ERI 2012). Other conservation areas and protection forests are designated at provincial and district level bringing the total national protection and conservation forest area to 11.76 million hectares or 49.6% of the total land area (ERI 2012). ***Figure 4.1*** shows the NPAs relative to the regional setting of the Project Area.

There are no NPAs in the Study Area, however the Phou Khaoy Kwai NPA is situation to the south of the Nam Ngiep Watershed. Two Provincial Protected Areas (PPA) occur in the lower Nam Ngiep, being the Huay Ngua and Phou Ngou PPA.

- Huay Ngua PPA: Located approximately 8 km downstream of the NNP1 Project and is 5435 ha in area.

- Phou Ngou PPA: Located approximately 11 km downstream of the NNP1 Project and is 6610 ha in area. Phou Ngou PPA is a narrow, elongated shape that follows a ridge line running north-west to south-east and contains no major watercourses or lakes

4.1.5.4 Flora Species

The Upper Nam Ngiep is the area adjacent to the main dam site and re-regulation dam site areas which have been surveyed. The land cover mapping shows similar vegetation covers across the watershed area and, as such, it is likely that many flora species recorded during surveys (2013) within the Project area and the lower Nam Ngiep will also occur within the wider upper Nam Ngiep area.

Deciduous forest types were recorded during Project area surveys and this vegetation is likely to be similar to the upper Nam Ngiep. The deciduous forest types were present in terms of mixed deciduous forest and lower mixed deciduous forest at the main dam site and re-regulation dam site. The dominant species recorded within these forest types within the Project area are summarised *in* ***Table 4.3*** and are considered likely to occur within the upper Nam Ngiep.

Table 4.3 ***Dominant Flora Species in vegetation communities similar to the Upper Nam Ngiep***

Canopy class	Dominant species
Mixed Deciduous Forest	
Top canopy (20-35m)	*Pometia pinnata*, *Duabanga grandiflora*, *Lagerstroemia calyculata*, *Toona ciliata*, *Pterospermum diversifolium.*
Middle canopy (10-15m)	*Nephelium hypoleucum*, *Mitrephora tomentosa*, *Baccaurea ramiflora*, *Saracia indica, Arenga weaterhoutii.*
Lower canopy (<10m)	saplings and seedling of the higher canopies
Lower Mixed Deciduous Forest	
Top canopy (~10m)	*Macaanga denticulata*, *Maesa ramentacea*, *Milletia acutiflora, Lagerstoemia calyculata*. The common species of bamboo found in the area, which are *Gigantochloa albociliata*, *Pseudostachyum polymorphum, Bambusa bambos.*

A total of nine plant species, as listed under the IUCN Red List were recorded during the forest surveys within the Project Area during 2009 and 2013 surveys. These are shown in ***Table 4.4***.

Table 4.4 ***IUCN Listed Flora Species recorded in vegetation communities similar to the Upper Nam Ngiep***

Scientific Names	Status
Dipterocarpus turbinatus	CR
Afzelia xylocarpa	EN
Dalbergia oliveri	EN
Dipterocarpus alatus	EN
Hopea ferrea	EN
Shorea roxburghii	EN
Dalbergia cochinchinensis	VU
Hopea odorata	VU
Ternstroemia wallichiana	VU

A total of ten species of plants listed as threatened under the IUCN were identified within the Project area during 2007 and 2013 surveys.

4.1.5.5 Fauna Species

The Upper Nam Ngiep

As identified for the flora species, many of the fauna species detected during surveys of the main dam site have potential to utilise the habitat of the upper Nam Ngiep. The diversity of fauna is expected to be high given the large intact area of habitat and the results obtained from surveys of the Project area. The upper Nam Ngiep River is dominated by primary forest. The fauna habitat in this area is in good condition in comparison to other areas surveyed. Site surveys during 2013 detected (through interviews with villagers or direct observation) at least 46 mammals species, 50 bird species, 28 reptiles species and 10 amphibian species.

IUCN Listed Species

The fauna species have been categorised by the IUCN (2012) and a number have been recorded within the Project area. The 2007 and 2013 surveys recorded two species, the Northern white-cheeked gibbon (*Nomascus leucogenys*) and White-backed vulture (*Gyps bengalensis*) listed as critically endangered within the Project area and as such it is considered possible these species may also inhabit the upper Nam Ngiep.

Overall, the surveys identified:

- Twenty-one mammal species (1 critically endangered, 7 endangered, 13 vulnerable);
- Six reptile species (1 endangered, 5 vulnerable);
- Four bird species (1 critically endangered, 1 endangered, 2 vulnerable); and
- No amphibian species.

Table 4.5 summarises the species recorded.

Table 4.5 IUCN Listed Fauna Species Recorded within the Project Area and the upper Nam Ngiep

Scientific name	Common name	IUCN Status
Mammals		
Nomascus leucogenys	Northern white-cheeked gibbon*	CR
Cuon alpinus	Asian wild dog, dhole*#	EN
Elephas maximus	Asiatic elephant#	EN
Manis javanica	Sunda pangolin*	EN
Panthera tigris	Tiger#	EN
Prionailurus viverrinus	Fishing cat#	EN
Pygathrix nemaeus	Red-shanked douc langur*	EN
Trachypithecus phayrei	Phayre's leaf monkey*#	EN
Aonyx cinerea	Asian small-clawed otter*	VU
Arctictis binturong	Binturong	VU
Bos gaurus	Gaur#	VU
Capricornis milneedwardsi	Chinese serow	VU
Helarctos malayanus	Malayan sun bear*	VU
Lutrogale perspicillata	Smooth-coated otter*	VU
Macaca arctoides	Stump-tailed macaque*#	VU
Macaca leonina	Northern Pig-tailed macaque*	VU
Nycticebus bengalensis	Bengal slow loris*#	VU
Nycticebus pygmaeus	Pygmy slow loris*#	VU
Pardofelis marmorata	Marbled cat#	VU
Rusa unicolor	Sambar deer*	VU
Ursus thibetanus	Himalayan black bear*#	VU
Reptiles		
Platysternon megacephalum	Big-headed turtle*	EN

Scientific name	Common name	IUCN Status
Amyda cartilaginea	Southeast Asian softshell turtle*	VU
Malayemys subtrijuga	Snail-eating turtle*	VU
Naja siamensis	Indo-Chinese spitting cobra*	VU
Ophiophagus hanah	King cobra	VU
Siebenrockiella crassicollis	Siamese temple turtle*	VU
Birds		
Gyps bengalensis	White backed vulture*	CR
Cairina scutulata	White winged duck*	EN
Aceros nipalensis	Rufous-necked hornbill*	VU
Aquila heliaca	Imperial eagle*	VU

* denotes inquiry record

# denotes secondary data source

IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable.

Lower Nam Ngiep

The lower Nam Ngiep and the Project area was surveyed for fauna during the 2007 survey with additional data collected in 2013 at eight key survey areas.

The diversity of fauna in the main dam inundation area (upper Nam Ngiep) was high in comparison to other areas sampled in 2013. Habitats varied in condition with human disturbance evident in areas downstream of the main dam. The habitat and species detected at each of the main surveyed areas are summarised in ***Table 4.6***. Threatened species are discussed separately below.

Table 4.6 Fauna Habitat in the Surveyed Areas

Survey Location	Forest Type Description
Main Dam Site	The upper area of the Nam Ngiep River is dominated by primary forest. The habitat in this area if in good condition for wildlife in comparison to other areas surveyed. Site surveys detected (through interviews with villagers or direct observation) at least 46 mammals species, 50 bird species, 28 reptiles species and 10 amphibian species.
Resettlement Site	The resettlement area is mostly and 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.
Lower Nam Ngiep	This area is mostly disturbed and dominated by agricultural landuse. There is high human activity in this area. Site surveys detected (through interviews with villagers or direct observation) at least 12 mammals species, 27 birds species, 21 reptiles species and 7 amphibian species.

IUCN Listed Species

The fauna species have been categorised by the IUCN (2012) and a number have been recorded within the Project area. The 2007 and 2013 surveys recorded two species, the Northern white-cheeked gibbon and White-backed

vulture (*Gyps bengalensis*) listed as critically endangered within the Project area.

Overall, the survey identified:

- Twenty-one mammal species (1 critically endangered, 7 endangered, 13 vulnerable);
- Six reptile species (1 endangered, 5 vulnerable);
- Four bird species (1 critically endangered, 1 endangered, 2 vulnerable);
- No amphibian species.

4.1.6 Aquatic Environments

Aquatic riverine and tributary habitats were assessed during site surveys. Seasonal variation was observed in terms of water depth, clarity, flow and wetted width. Habitat characteristics recorded are summarised in ***Table 4.7***.

In general, river habitats were fast flowing with greater water depth and flows during the wet season. Dry season river habitats exhibited riffle zones which were flooded during the wet season. The river bed was generally dominated by sand and gravel. Villagers use the river environment for fishing and other activities and cattle were observed in the waterbody.

Tributary habitats were surveyed in the Upper Nam Ngiep River and Resettlement Area (as well as Huay Ngua PPA). These habitats were generally shallower and slower flowing with some areas drying to isolated pools in the dry season.

Aquatic plants were not recorded at all sites and when recorded were noted to be sparse.

Fish

The fish community of the Mekong River is one of the largest in the world with most of the production based on migratory river species (Poulsen *et al*., 2004). Fish migration is an important component for many fish species life cycle. In the Mekong, fish migration can be generally described in terms of (Poulsen *et al*., 2004):

- Annual movement between inundated floodplains (where most fish production originates) and dry season refuges;
- Movement into spawning areas within the river system usually upstream) from dry season refuges, generally upon start of flooding; and
- Passive migration of fish fry downstream from spawning areas.

During the 2007 survey of the main dam site, 42 species were detected. The community detected included relatively similar proportion of surface feeder, column feeder and bottom feeder species. Survey within the main dam area during 2013 detected 75 species.

The EIA noted that the fish community detected in 2007 contains species common to the Mekong tributaries and was dominated by Cyprinidae species. Cyprinidae family species were reported to adapt to different environmental in various sections of the river, and this family was also the dominant group detected during 2013 survey. The EIA assessment also noted that of the larger species detected many are migratory species of the lower Mekong basin that move upstream during the wet season spawning activities (EIA citing Poulsen *et al.,* 2004). These larger species, such as mud carp (*Cirrhinus molitorella*) and Asian red tailed catfish *(Hemibagrus wyckioides*) were detected in 2007 and 2013 surveys. The surveys noted a number of juvenile individuals of the migratory species suggesting that the Nam Ngiep River plays a role in providing habitat for the reproductive cycle (EIA citing Lowe-McConnell, 1995).

Luciocyprinus striolatus

One of endangered fish species that is the major concerned issue for the Study area is *Luciocyprinus striolatus*. This species is a large predatory fish of the family Cyprinidae (Kottelat 2011). The species is differentiated from the other species of the genus by the presence of five to eight longitudinal black stripes on the body of adults, 78 to 89 lateral line scales, and 40 to 46 predorsal scales. *It* is reported to reach up to 70-100 kg in weight, however there are almost no recent reports of large specimens (greater than 60 kg) (Warren 2014a). Females have been recorded growing to about 1.5 m (reportedly up to 2 m) long, and males are reported to be smaller. The species lives in upland areas (Warren 2014a). Interviews with local fishermen and observations of the species in the Nam Theun drainage indicate that adults live in deep pools, with a possible preference for the upper and lower parts of the pool, near rapids, riffles and runs (Kottelat 2014). Interviews by Baird *et al*. (1999, cited in Warren 2014a) indicate that the species occupies middle to surface water strata and prefers rivers with small stones substrate or large slabs of rock. Deep pools of between two and six metre depth during dry season conditions are expected to be preferred (Warren 2014b).

The species is not known to migrate (Kottelat 2011), although fishermen provided anecdotal evidence of local seasonal movements (Kottelat 2014). Fishermen in Ban Pou reported that the species moves downstream to large pools from November to May (Kottelat 2014). The species is predatory and feeds on aquatic animals (mainly fish and perhaps some amphibians) (Kottelat 2014; Warren 2014). The species is not very abundant and this is typical of large predatory animals (Kottelat 2014).

Within the Nam Ngiep Watershed, two spawning sites were reported within the Project Area: Kaen Tao 'beach', about 4 km downstrean of Ban Pou, and

Wang Mon 1 km downstream of Ban Pou (Kottelat 2014). Warren (2014b) reported three additional spawning locations between Xiengkhong and Nasong in the Upper Nam Ngiep, and Viravong and Phommavong (2014) noted it is highly likely that more spawning habitats occur in the river.

The species is listed as Endangered on the IUCN list due to suspected and inferred population declines of 50% or more over the past 30 years (Kottelat 2011). The listing is due to a decline in the quality and availability of habitat resulting from hydro-power development throughout the species' range, as well as the removal of individuals through recreational and illegal fishing and poaching. Other impacts to the species' habitat include soil erosion, sedimentation and chemical pollution associated with logging, deforestation and agriculture within the species' distribution (Kottelat 2011).

Table 4.7 Aquatic habitat characteristics of the Nam Ngiep River

Sampling Area	Aquatic habitat features
Upper Nam Ngiep Dry Season  Wet Season 	• main river and tributary habitats • in tributary areas, the watercourse is dried to small pools in the dry season • the main river current flows rapidly in the wet and dry season • river depth in dry season 1-3m (shallower in riffle zone where water flows fastest), wet season 3-5m • river bed is sand and gravel with some boulders • aquatic plants present sparsely • water level is high during the wet season flooding all banks and vegetation • riparian zone is mainly original forest with agriculture close to communities • water is clear with greenish brown colour in the dry season, turbid and reddish brown in the wet season • surrounding landuse is agriculture and communities • Villagers use waterbody for fishing
Lower Nam Ngiep Dry Season  Wet Season 	• main river habitat • river depth in dry season 2-3 m (shallower in riffle zone where water flows fastest), wet season 4-5m depth • width of the river is approximately 50-100 m in dry season, 100-150 during wet season • river bed is sand and small gravel • aquatic plants present sparsely on the river bank in the dry season • water is turbid and reddish brown in wet season • riparian zone is mainly covered by big trees and bamboos • upper zone has communities where people and cattle share the river in terms of swimming and washing.

4.2 SOCIAL PROFILE OF THE STUDY AREA

The Nam Ngiep watershed covers parts of seven districts in three provinces: two districts in Bolikhamxay (Bolikhan and Pakxan Districts), two in Vientiane Province (Hom and Xaysomboon Districts), and three in Xieng Khoung Province (Thathom, Phaxai and Khoun Districts). Now Xaysomboom has been announced as the new province with some areas covering three existing province; Vientiane, Xieng Khouang and Bolikhamxay provinces. Details of social profile of the Study area will be presented as followings;

4.2.1 Human Population

Table 4.8 presents the area of the provinces, and the number of villages, households, and population (male and female) in the entire province and in each of the districts that are part of the Nam Ngiep watershed.

Table 4.8 Districts, Villages, and Population in the Provinces in the Nam Ngiep Watershed Area (2008)

Province and Districts in Nam Ngiep Watershed Area	Area (km^2)	Village	No. Households	Population		
				Total	Female	Male
Vientiane (12 districts)	22,554	528	77,069	433,567	216,595	216,972
- Hom		41	4,044	28,153	13,540	14,613
- Xaisomboun		56	4,513	28,236	14,030	14,206
Bolikhamxay (6 districts)	14,863	326	39,827	231,544	114,509	117,035
- Bolikhan		45	5,592	35,964	17,549	18,415
- Pakxan		59	8,088	42,261	21,445	20,816
Xieng Khouang (8 districts)	17,506	502	39,029	249,817	123,865	125,952
- Thathom		23	2,163	13,106	6,355	6,751
- Phaxai		32	2,018	12,031	5,975	6,056
- Khoun		52	4,777	33,490	16,748	16,742

Source: Calculated from population census (NSC 2007).

In the Study area, there were 308 villages, 31,195 household with a total population of 193,241 persons (95,642 males and 97,599 females). Ratio of the number of male and female population is quite equal. Pakxan district has the highest number of village, household and population while Thathom has the lowest number of village and Phaxai district has the lowest number of household and population.

4.2.2 *Demographic Characteristics*

Demographic characteristics of the provinces that share parts of the Nam Ngiep watershed are shown in ***Table 4.9***. It can be seen that some public health conditions have changed dramatically for the better. It should be noted that at the time this information was collected, the portion of the Study area now in Xaysomboon Province which covers some parts of Vientiane, Xieng Khouang and Bolikhamxay provinces was then in the Xaysomboon Special Region (SR). In all, the crude birth rate has declined, as has the infant mortality rate.

There has also been a drastic reduction in the crude death rates as basic health care, cleaner water, and other improvements have reached more communities. Yet the natural rate of population growth is still higher than the natural average in all but Vientiane Province. In all the poor and high priority poor areas of the watershed, it is likely that growing population is causing more pressure on the natural resources, with over-fishing, over-hunting, unsustainable use of lands, and over-extraction of non-timber forest products. As the resources are over-exploited and degrade, it is then the poorest who suffer the most (USAID 2006).

Table 4.9 ***Birth and Death Rates, Fertility and Infant Mortality in the Provinces of the Nam Ngiep Watershed: 1995 and 2000***

Name of Provinces	Crude Birth Rate		Crude Death Rate		Natural Increase Rate		Total fertility Rate		Infant Mortality Rate	
	1995	2000	1995	2000	1995	2000	1995	2000	1995	2000
Xieng Khouang	41.9	38.3	15	7.5	2.6	3.08	6.3	5.8	121	69.6
Vientiane	36.3	32.6	13.9	5.6	2.4	2.7	5.9	3.9	102	34.9
Bolikhamxay	39.3	36.9	16.5	3.6	2.5	3.33	5.8	5.2	136	26
Xaysomboon SR	40.4	44.6	16.9	6.7	3	3.79	7.2	6.8	138	58.7
Whole Country	41.3	34	15.1	6.3	2.5	2.77	5.4	4.9	104	82.2

Source: Calculated from population census 1995 (NSC 2007).

Table 4.10 presents the dependency ratio for the provinces with territory in the Nam Ngiep watershed. The dependency ratio in 2005 was 0.97 in Xieng Khouang, 0.92 in Xaysomboon SR (now part of Xaysomboon Province), 0.84 in Bolikhamxay and 0.72 in what was then the much smaller Vientiane Province.

Nearly all of those in the dependent population are under 15. In 2005, there were only about 231,000 people ages 65 and over, while there were about 2,512,000 aged 0 to 14. The national dependency ratio in 2005 was about 0.8, while in much of the project area the dependency ratio is higher, indicating even greater population pressures in coming years. The people in the Nam Ngiep watershed now rely almost solely on land-based and other natural

resource based livelihoods. The future health of the watershed will depend upon the increase in non-land based livelihoods.

Table 4.10 Dependency Ratio in the Provinces with territory in the Nam Ngiep Watershed, from the 2005 Population Census

Province	Number of people Under 15 years and 65 and older	Population 15-64 Years	Dependency ratio
Xieng Khouang	113,093	116,428	97
Vientiane	162,436	226,397	72
Bolikhamxay	102,934	122,338	84
Xaysomboon SR	18,837	20,579	92
Whole Country	2,435,016	3,186,306	76

Source: Results from the Population and Housing Census 2005, NSC,CPI

4.2.3 Ethnic and Minority Groups

In Lao PDR the main difference in use of natural resources among ethnic groups is generally due to the relative altitude of their settlements and the availability of resources at the different altitudes. A common way of dividing the groups is to classify them as either Lao Loum (lowland Lao), Lao Theung (midland Lao), and Lao Sung (upland Lao). The Lao Loum are the ethnic Lao-Tai groups, who live in the lowlands and valleys, and make up about two-thirds of the total population. Ethnic Lao were the largest of all groups, comprising 55 percent of the country's population in the 2005 population census. The Lao Theung is mainly the Mon-Khmer groups, the largest of which are the Khmu, who comprised about 11 percent of the country's population in 2005. They live in the middle hills, and were likely the original lowland inhabitants before the Lao-Tai migrated to the region. The Lao Sung are mainly Hmong-Mien or Tibeto-Burman groups who live in the highlands. The largest of these groups in Lao PDR are the Hmong, accounting for about 8 per cent of the total population of the country.

Resource use traditionally depended on the lands available for agriculture. The Lao Loum traditionally lives in permanent settlements, with a combination of sedentary rice cultivation in paddies and supplementary swidden cultivation on hillsides. The Lao Theung also tend to live in permanent settlements, and depend upon rotational swidden agriculture of upland rice, maize, and other crops on the hillsides near their settlements. The Lao Sung traditionally practice pioneer swidden agriculture on the higher slopes, using the lands until they become degraded, then moving their settlement to clear new, as yet still fertile, lands. With increasing population and fewer new lands available to move into, the Lao Sung are not able to move as frequently as before, and their swidden agriculture has become less sustainable. The swidden cultivation of both the Lao Theung and Lao Loum is also under pressure from increasing populations, forcing people to reduce the number of years they leave fields fallow.

In the Study area, all the ethnic groups now tend to practice a similar type of agriculture. The Hmong and Khmu, traditionally in the highlands and midland respectively, now live in valleys, practice sedentary rice cultivation in paddy, grow fruit trees and tend vegetable gardens around their houses, as well as vegetable gardens in small plots near the watercourses (sometimes a corner of the paddy field, after the rice crop has been harvested), with a supplementary swidden cultivation of some upland rice, maize, and other field crops in the surrounding slopes, generally on rolling hills. Most of this is upland area in the watershed is officially forest land, but now barren of larger trees, and designated as Unstocked Forest.

4.2.4 Education

Table 4.11 shows the proportion of the Lao PDR population in each province that has attained an education and the proportion that has never attended school. In Bolikhamxay province, the percentage of people who has never completed their education was highest while the lowest can be found in Vientiane province. Percentage of people who had completed in school was found highest in Vientiane province (about 34%) while the lowest can be found in Xieng Khouang province (about 25%).

Table 4.11 Percentage of Lao PDR Population who Completed Educational Qualification in the Study Area

Province	Educational Qualifications Completed (%)			
	School	Vocational	University	Not Completed
Vientiane	34	4	1	61
Bolikhamxay	29	6	1	74
Xieng Khouang	25	4	1	70

Source : World Bank and DOS, 2009

The adult literacy rate is shown in ***Table 4.12***. It shows that the literacy rate is highest in Vientiane province (84.1% in female and 90.4% in male) and lowest in Xiang Khouang province (77.5% in female and 87.8% in male).

Table 4.12 Percentage of Adult Literacy Rate

Province	Adult Literacy Rate (%)	
	Female	Male
Vientiane	84.1	90.4
Bolikhamxay	78.7	88.4
Xieng Khouang	77.5	87.8

Source : Laos Statistical Bureau, 2013

4.2.5 Poverty

Poverty is perhaps the greatest threat to the sustainable use of natural resources in the area. The majority of the people in the watershed area live in poverty and practice subsistence agriculture. While their way of life may be considered to be sustainable, any event such as drought, flooding, or an

infestation of pests or crop disease can threaten people's livelihoods, with few in such circumstances able to grow sufficient life for the entire year.

The Prime Minister's Instruction No 010/PM resulted in the definition of a poverty line together with different poverty criteria, allowing local authorities to identify and monitor poverty at the district and also at the household level. 'Poor' districts were those districts where over 51% of the villages were poor. There were additional criteria, which included districts where over 40% of the villages were without a school in or nearby the village, or without a dispensary or pharmacy in or nearby the village, or if over 60% of the villages had no access road or were without access to clean water.

Figure 4.7 shows the districts in the Nam Ngiep watershed area in terms of their level of poverty. Districts that determined to be not poor districts are white; while poor districts are yellow and high priority poor districts are red. The Nam Ngiep Watershed Area includes 4 high priority poor districts – Xaysomboon (now is the new province) in Vientiane Province, Bolikhan in Bolikhamxay Province, and Thathom and Khoun in Xieng Khoung Province. The portion of Hom District in Vientiane Province that did not yet include Xaysomboon is classified as poor, but not high priority

The relationship between poverty and natural resources is multifaceted. The rural poor generally are more dependent on the resource base for their livelihood, on non-timber forest products, fishery resources, and their crops. Yet when under pressure to provide for their families, the rural poor will need to extract whatever resources they can in order to survive, even if at an unsustainable rate. Increasing population is thought by some to be one factor that increases that pressure on the resources, particularly increasing populations in poor areas.

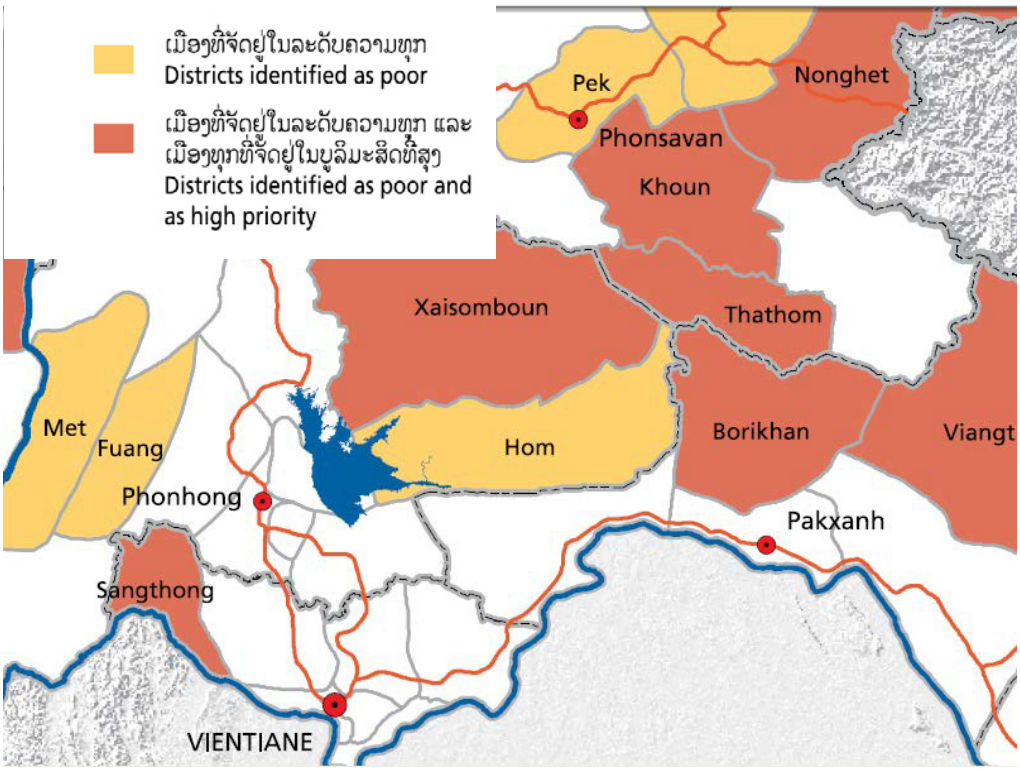
During fieldwork, most local residents identified themselves as poor but claimed they could sustain their livelihood with little use of money. Natural resources were still sufficient to make a modest living. What they felt they lacked were basic infrastructure and services such as all-weather access road, reliable health service and better schooling.

The people grow rice, vegetables, fruit and other crops for family consumption. Any surplus they have would not be able to earn them much income, because of the high transportation cost to the market. Most production provides fairly low yields. There is considerable scope for improving yields through changes in farm techniques and the introduction of fertilizers.

Most farm cash income comes from sales of poultry and livestock. These meats are eaten mainly on special occasions, and they command relatively high prices for each of the animals. The main source of protein during the year is fish, mostly from the Nam Ngiep or its tributaries.

As noted earlier, increasing population pressure on resource contributes to poverty. Some of the poorest districts also have some of the largest average family sizes, with Khoun District in Xieng Khouang having about 7 people in each household, compared to an average family size of 5.2 in Pakxan District in Bolikhamxay.

Figure 4.7 ***Districts Identified as Poor and High Priority Poor in the Study Area***



Source: Socio-Economic ATLAS of the LAO PDR, 2005

4.3 *ECONOMIC PROFILE OF THE STUDY AREA*

The Nam Ngiep watershed covers parts of seven districts in three provinces: two districts in Bolikhamxay (Bolikhan and Pakxan Districts), two in Vientiane Province (Hom and Xaysomboon Districts), and three in Xieng Khoung Province (Thathom, Phaxai and Khoun Districts). Now Xaysomboom has been announced as the new province with some areas covering three existing province; Vientiane, Xieng Khouang and Bolikhamxay provinces. Details of economic profile of the Study area will be presented as followings;

4.3.1 *GROSS PROVINCIAL PRODUCT (GPP)*

Table 4.13 shows the Gross Provincial Product (GPP) per capita in each province within the Study area. The result shows that the highest GPP per capita can be found in Bolikhamxay province (10.79 million Kip), and the lowest in Xiang Khouang province (8.00 million Kip). Since about 80% of the Lao population work in the agricultural sector (Lao Statistical Bureau, 2013),

therefore, income from the agriculture is the main source of income in rural area. Hence, the net profits from agriculture are generally higher in Bolikhamxay province than in Vientiane province.

Table 4.13 Gross Provincial product (GPP) per capita in each province of the Study Area

Province	GPP per capita (Million Kip)
Vientiane	8.41
Bolikhamxay	10.79
Xieng Khouang	8.00

Source : Laos Statistical Bureau, 2013

4.3.2 Income

Major income of Lao population comes from agriculture sector with grain (rice) production accounts for about 50% of agricultural revenue at provincial levels (***Table 4.14***). The costs of agricultural production (eg., seeds, fodder, equipment and wages) and the net profits from agriculture are highest in Xieng Khouang province while the lowest costs can be found in Bolikhamxay province and the lowest net profits in Vientiane province.

The average annual household income ranges from 8,200,000 to 17,700,000 Kip per household (or 1,000 – 2,200 USD per household) (Sriburi *et al.* 2012). Agriculture is the primary economic activity for all villagers in the Study area. Crops are often grown along the river just above the flood zone, in small fenced plots. This ensures that water is readily available for irrigation. However, a small number of villagers also have plots adjacent to their house.

Crops include rice, which is a staple in the local diet, maize, sugar cane, cassava, banana, and pineapple. Much of what is generated is consumed within the household.

In addition to crops, most villagers raise small animals (e.g. pigs, chickens, duck), which provide a source of protein. Larger livestock (e.g. cows, water buffalo) is raised for sale or inclusion in festivals and/ or celebrations.

In terms of food sources, villagers also fish in nearby waterways. Most of the fish caught is consumed within the household. Nearby forests also provide food. This includes edible plants and fruit, including bamboo shoots and leafy plants.

Table 4.14 Agricultural Income and Cost

Province	Revenue						Cost				Net Profit
	Grain	Veg. & Fruit	Meat	Fish	Forest	Other	Seed & Fodder	Equip.	Wages	Other	
Vientiane	2,673	553	1,767	811	152	752	402	166	308	369	5,464
Bolikhamxay	2,471	934	917	1,539	33	98	19	110	155	87	5,621
Xieng Khouang	3,957	976	1,867	602	21	291	644	460	277	252	6,082
Rural	3,598	797	1,460	805	41	292	170	132	149	227	6,136
Urban	1,696	379	543	508	37	375	222	151	308	233	2,624

Unit : 1,000 Kips/household/year

Source : World Bank and DOS, 2009

4.3.3 Fisheries

Fisheries are a major activity for many people living in inland and coastal areas and are considered to be the major source of protein for rural populations. Information on actual levels of consumption and catch are scant, but research data suggest that for example the inland capture fisheries in the Mekong basin may produce over 3 Million MT per annum (Bush and Hortle, 2003). The official catch estimates, where available, do not even come close to this huge amount and may underestimate the actual fish production with a factor of 2 to 3 times.

Main fisheries productions are from rain-fed rice fields especially in Bolikhamxay and Xiang Khouang provinces and Xaysomboon SR but in Vientiane province, major fisheries production is from the reservoirs. Highest total area for fish production is found in Vientiane province (about 106,375 hectares) and the lowest is found in Saysomboon SR (about 1,391 hectares). Inland fisheries and its production come from the Mekong River and its tributaries, reservoirs, swallow irrigation and small reservoirs, swamps, wetlands for capture fisheries. Aquaculture is practiced in fish ponds, fish production cum rice in rice fields, rain-fed rice fields, and irrigated rice fields, small natural pool oxbows, and irrigation weirs, cage culture.

Current Fisheries Situation in Nam Ngiep River

A dry season survey along Nam Ngiep River was conducted in January 2008 at ten stations as part of the EIA for the NNP1 Project: six located downstream from the Project Area and the other four located upstream. The study looked at the species present and the relative abundance, as well as plankton and benthic fauna. The survey found 42 fish species along the Nam Ngiep River, mostly Cyprinids. ***Table 4.15*** outlines the percentage of households in the Nam Ngiep Watershed involved in fishing activities.

Table 4.15 Percentage of households involved in fishing activities

Village	Daily	Weekly	Monthly	Fisheries contribution to Total Annual Income	Proportion of HH receiving Income from Fisheries Activities
Piengta	20.3%	49.4%	13.9%	1.4%	52.4%
Hatsamkhon	6.8%	6.8%	5.5%	2.5%	40.5%
Pou	11.0%	22.1%	9.7%	3.5%	100.0%
Upper Nam Ngiep	**12.5%**	**25.6%**	**9.8%**	**2.8%**	**74.7%**
Hatsaykham	81.8%	15.2%	0.0%		
Hat Gniun	16.4%	70.1%	28.4%	6.1%	9.9%
Somsuen	4.9%	61.0%	14.6%	1.3%	11.3%
Thahuea	0.0%	0.0%	0.0%	1.9%	96.0%
Nampa	31.3%	43.8%	81.3%	9.5%	22.6%
Houykhoun	14.5%	53.2%	3.2%	1.0%	2.8%
Thong Noi	15.4%	53.8%	0.0%	2.3%	27.9%
Thong Yai	0.0%	25.0%	12.5%	6.7%	24.4%
Phonsy	27.6%	44.8%	3.4%	12.2%	85.8%
Nam Ngiep	23.8%	28.6%	14.3%	4.3%	28.9%
Sanoudom	50.0%	5.6%	16.7%	0.0%	0.0%
Lower Nam Ngiep	**15.3%**	**43.4%**	**14.2%**	**3.5%**	**23.5%**
Total	**17.3%**	**34.2%**	**11.5%**	**3.1%**	**32.9%**

Remark : The villages included in zone 2 Lower Reaches were not included in the census data provided, some seem to have been deserted/moved.

Source : Theo Visser, Initial Assessment of Potential Fisheries Development in Nam Ngiep after Impoundment, 2013

4.4 INFRASTRUCTURE

The villages in the Nam Ngiep Watershed can be divided into two main groups in terms of the available infrastructure. First group has reasonably good quality infrastructure and services (e.g. Year round road access, electricity, schools, health centres) in or in close proximity to the village. This includes the villages of Houykhoun, Thong Noi, Sanoudon, Sanaxay, Phonsy, Phonngeng, and Dong Thaviengxay.

The second group has relatively little and/ or poor quality infrastructure and services. The majority of villages fall into this group. For example, roads are only passable during the dry season or the villages are accessible only by river. In addition, many of the houses are made primarily of bamboo. In instances, where the homes are made of wood, quality of the construction is often not good. This means that villagers are not well protected from rain, strong sun or cold conditions.

4.4.1 ROAD TRANSPORTATION

The Road Law has formally defined road categories according to their functions. ***Table 4.16*** briefly describes the most important categories for the purpose of this CIA report. For administration and management purposes, a distinction is made between the National Road Network (NRN) consisting of National roads and the Local Road Network (LRN) consisting of the Provincial, District, and rural roads are grouped together.

Table 4.16 Road Categories in Lao PDR

Road Category	Brief Description
National roads	Connecting the national capital to the provincial and special zone capitals and to international borders and other major roads of strategic significance for national defence and security.
Provincial roads	Linking provinces to the national capital and to other provinces and provincial capitals to district centres and other important locations within the province.
District roads	Connecting districts and district centres to villages and other important locations within the district.
Rural roads	Connecting villages to other villages and to production and service centres serving the village.

Source : Road Law, No. 04/99/NA, April 3rd, 1999.

Table 4.17 shows that the Lao PDR road network amounts to about 31,219 km consisting of 7,141 km of national roads, 6,485 km of provincial roads, 3,865 km of district roads and an estimated 11,365 km of rural roads. District and Rural roads make up 48 percent of the road network. Over half of the National roads are paved while 16 percent are still earth. Only 3 percent of Provincial roads are paved and half of them are earth. About 52 and 84 percent of District and Rural roads respectively are earth (about 76 percent of District and Rural roads together) and about 24 percent are gravel.

However, *Table 4.40* does not indicate the condition of roads. Earlier evidence indicates that about 60 percent of the District and Rural road network is likely to be in "Poor" or "Bad" conduction (World Bank, 2001). Following the completion of the reclassification of road, a recent study (MCTPC, 2004) has estimated the size of the maintainable road network in the Study area. In Bolikhamxay province, this has been done by a rapid road inventory while in the remaining provinces; it is based on the road reclassification approach. The results are summarised in ***Table 4.18***.

The proportion of roads in maintainable condition in Bolikhamxay province is much higher than those in the remaining provinces. This is to be expected because of the additional resources and attention this province has received. Further, while a much higher proportion of the Provincial network is maintainable in Bolikhamxay province, the maintainable proportion of District and Rural roads, is about the same in Bolikhamxay and the remaining provinces indicating that the improvement and maintenance efforts in Bolikhamxay province has focused on Provincial roads.

Table 4.17 Lao PDR Road Network

Road Type	Road Surface							
	Paved		Gravel		Earth		All surfaces	
	km	%	km	%	km	%	km	%
National	3,771	53	2,244	31	1,126	16	7,141	23
Provincial	198	3	3,038	47	3,249	50	6,485	21
District	31	0.8	1,826	47	2,008	52	3,865	12
Rural	14	0.1	1,815	16	9,527	84	11,356	36
Urban	429	24	871	49	465	26	1,765	6
Special	54	9	304	50	249	41	607	2
Total	**4,497**	**14**	**10,098**	**32**	**16,624**	**53**	**21,129**	**100**

Source : Department of Roads, Ministry of Communication, Transport, Post and Construction (MCTPC), Summary of road statistics, 2003.

Table 4.18 Estimate of the Maintainable Part of the Local Road Network

Province	All Local Roads (km)[1]	Provincial Roads (km)	District & Rural Roads (km)	Maintainable Local Roads					
				Provincial Roads		District & Rural Roads		Total	
				km	%	km	%	km	%
Vientiane	1,523	623	900	387	62.1	395	43.9	782	51.3
Bolikhamxay	1,049	483	566	433	89.7	338	59.7	770	73.4
Xieng Khouang	1,245	163	1,082	140	85.7	292	27.0	432	34.7
Xaysomboon SR	573	402	171	10	2.5	52	30.3	62	10.8

Remark: [1] Data from the Department of Roads Summary of road statistics, 203 for Xaysomboon SR the Five years maintenance plan are different.

Source: MCTPC (2004) Five years maintenance plan for Local roads in Lao PDR for the years 2004/5-2008/9, revised March 2004.

Current Road Condition in the Study Area

Road Route No. 13N: this national road lies from Louang Phabang province to Vientiane province. This paved road runs across Kasi, Vangvieng, Hinheup districts of Vientiane province.

Road Route No. 7: this national road lies from Phokhoun district in Louang Phabang province to Phoukout, Kham and Nonghe districts of Xieng Khouang province. Some part of this road is paved but some is earth and gravel.

Road Route No. 5: this national road lies from the Route No. 13N Vangvieng – Hinheup to Xaisomboon SR and Khouan district of Xieng Khouang province. This road from Route No. 13N Vangvieng – Hinheup to Xaisomboon town is gravel but some part from Khouan district to Xaisomboon town is paved. There will have plan to construct this road connecting Xaysomboon SR to Khouan District.

Road Route No. 13S: this national road lies in the southern part of Lao PDR from Vientiane City through Xaithani and Oak-Ngum districts of Vientiane province; Thaphabat, Paksan, Pakkading districts of Bolikhamxai province;

Hinbouan, Thakhek and Xebangfai districts of Khammouan province; Outhoumphon and Songkhon districts of Savannakhet province; Khongxedon district of Saravan province; Xanasomboon, Pakse, Pathoumphon and Khong districts of Champasak province and end at the border of Lao PDR-Cambodia. The road condition in Xaysomboon SR and Bolikhamxay province is paved. This road was developed and used to transport materials and equipment for several large-scale projects in the central and southern region from Vientiane province. No upgrades to these roads are currently proposed, however future road improvements may be required.

Road Route No. 1D: this is the future plan road where will connect from Khouan district of Xieng Khouang province and will run across Thathom district of Xaysomboon SR to the existing earth road route No. 1D in Bolikhamxay province and runs across Viangathong district of Bolikhamxay province and link to the existing road route No. 8 in Bolikhamxay province.

Road Route No. 8: this national pave road links road route No. 13s in Bolikhamxay province and run through Khamkuet district of Bolikhamxay province and end at the border of Lao PDR-Vietnam.

Details of the relevant national roads are shown in *Figure 4.26*.

4.4.2 WATER TRANSPORTATION

GoL's strategy regarding navigation is mainly focusing on maintaining and improving current transport capability by river and by encouraging the use of river transport in the wet season instead of land transport on poor roads. Organization strengthening (facilities and organization of river transport offices) is implemented for 2002 to 2004 in Vientiane province as well as Vientiane Capital.

While contributing in the past to the economic development of the country, river transports reveal to be a relatively low-cost investment and secure infrastructure investment, energy saving with minor pollution, to decrease heavy land traffic. Despite that resources are limited (28 Associations if River Transports and six Companies of River Transport with eight focusing on merchandise and 26 on passenger transport), river transport is increasing steadily. The policy of GoL is to improve and develop this sector according to its plan up to 2020, particularly to construct and to strengthen ports, to improve navigational channels, and to adopt relevant regulatory framework to sustain the economic development.

At present, river works are concentrated on a few projects. In the past five years, embankments have been built at Paksan and Pak Kadan in Bolikhamxay province. GoL's budget, provinces' budget, and private funds as well as foreign assistance have been used for these works.

5 IDENTIFICATION OF PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE ACTIONS

Past and present actions that have influenced the current condition of the resources or receptors within the region and Study Area were investigated. Reasonably foreseeable future actions (RFFAs) were identified based upon stakeholder consultation, review of agency planning documents and a literature review.

This section defines the Past and Present Actions to define the current status of environment and social impacts in the watershed. *Section 5.2* outlines the Reasonable foreseeable future actions and tries to quantify the likely impacts over the 27 year period from 2014.

5.1 PAST AND PRESENT ACTIONS

In general terms, the current status of resources and receptors within any Study Area are determined in large part by both human-controlled events, such as subsistence harvest or commercial fisheries, and natural events, such as species predation or climate change.

The baseline biodiversity condition of the Project Area has been described in the Project EIA and the *Biodiversity Baseline Report* (ERM 2014). The baseline includes the consideration of historical trends that have contributed to the current state of the environment, including historic clearing for agriculture such as slash and burn practices, as well as timber harvesting (both legal and illegal) and hunting pressure from the local populations and illegal poaching. These impacts are discussed in specific relation to the relevant VECs in *Section 6*.

5.1.1 HEPs

No major HEPs currently exist in the Nam Ngiep watershed, although the Nam Ngiep 2 HEP is nearing completion of construction.

Nam Ngiep 2 Xieng Khouang HEP involves the construction of a main dam and a tributary dam located 15 km away linked by a tunnel then linked to a powerhouse. The proponent is the China International Water and Electric Corporation. The concession agreement was signed 18 August 2011 and commeCIAl operation is expected in 2015.

The Project has commenced construction and is located upstream of the NNP1 Project, in the north western section of the Nam Ngiep watershed on a tributary of the Nam Ngiep, the Nam Sen. The watershed area of the proposed reservoir is 754ha. The main dam is located approximately 5 km upstream from confluence with Nam Ngiep on the Nam Sen River.

5.1.2 Forestry

Consultation with DFRM (refer *Section 3.4*) identified that currently, the Provincial government auctions timber allocations to companies on a rotational basis. These allocations are located in two types of areas: 1) in designated production forest, and 2) from land in proposed development footprints (e.g. new dams, roads or other infrastructure) prior to that development, essentially making use of the timber that is to be cleared for that development. This process is unlikely to change with changes in land use or development of NNP1, other HEPs or other RFFAs. Currently the middle reaches of the Nam Ngiep watershed are designated as production forest (***Figure 5.1***).

The Nam Ngiep watershed area consists of 432,000 ha which contains approximately 247,104ha protection forest and 119,750 ha of production forest. The timber production has been estimated from the total area of production forest in Nam Ngiep watershed based on the average annual yield of production of timber within Lao PDR.

The current estimated annual yield from the watershed based on the area and extent of forestry activities is 28,740 cubic metres per annum.

5.1.3 Mining

Figure 5.1 shows no currently active mining leases in the Nam Ngiep watershed. Three mining leases under survey coincide with the Nam Ngiep watershed. One is near the centre of the watershed with two others partly within the upper reaches of the watershed near the headwaters in the north. Two leases where survey is proposed are located in the lower parts of the watershed near the Project Area with four more partly within the upper reaches of the watershed in the north and east.

5.1.4 Agriculture

Agriculture is widespread with agricultural land cover types accounting for the majority of land cover types in the Project Area (discussed further in *Section 6.1*). Rubber plantations occur in the Project Area and continue to be established. Principal non-rice crops include cardamom, cassava, coffee, corn, cotton, fruit, mung beans, peanuts, soybeans, sugarcane, sweet potatoes, tobacco, and vegetables. Rice is the main crop grown during the rainy season, and under usual conditions, rainfall is adequate for rice production. Little irrigated rice is grown. Domesticated livestock is grown for domestic consumption or sale at local markets (pigs, cattle and chickens).

250000 300000 350000 400000

2150000 2100000 2050000

Legend

- Nam Ngiep Catchment Boundary
- Waterbody
- Road
- City or Town
- Lao PDR Boundary
- Surrounding Hydroelectric Power Projects
- Nam Ngiep 2 Tunnel

Mining Tenements:

- Mining Lease Under Survey (mining not yet approved)
- Mining Lease with Survey Proposed (mining not yet approved)
- Mining Lease with Concessions

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Candidate Offset Sites:

- Nam Ngiep Offset Area
- Huay Ngua Provincial Protected Area
- Phou Khao Khouay National Protected Area

Forest Zone:

- National Protection Forest
- Production Forest

N 0 5 10 15Km

1:400,000

Basemap: Bing Maps

Note: Known extent of mining tenements displayed, with some tenements partially shown.

Nam NKL Co., Ltd Ngum 4A
Rhonsavan
Vinacomin
COECCO
State Enterprises for Agriculture - Industry Development (DAI)
Daosavan Investment and Construction., Ltd
Phongsabthavy Construction., Ltd
Muang Khoun
Phongsabthavy Construction Ltd
PPC Consultant Ltd
Phongsabthavy Construction Ltd
Nam Ngiep 3A
Phou Bia Mining Limited
Phaxai
Nam Ngiep 2 Tributary Dam
Nam Ngiep 2 Main Reservoir
Nam Chain
Nilandon Development Mining., Ltd
Nam Pot
Nam Ngiep 2 Powerhouse
Nam San 3A
Nam Ngiep Catchment
Namchong-Namgneup
Nam San 3B
GnotNamxan NamPeuak
Nam Xan Catchment
China Base Ningbo Foreign Trade Co., Ltd
Nammo
Lao-Muang-om Mining., Ltd
Nam Ngum 2 Reservoir
Neyland Lao Mining., Ltd
Phak Beak
Nam Phouan
CAVICO Vietnam & Laoyongchaluen Trading Import-Export
Phoupasang-Punghok
Nam Xan
Nam Bak 2
PT Construction Company., Ltd
Mekong River
Nam Ngum Reservoir
Agriculture Development
Phouturne
Longxan
Nam Mang 1
Nam Leuk reservoir

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_EIA_REV_CIA_G002_F5.1.mxd	
Date:	30/04/2014	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 5.1 - Location of RFFAs Including HEPs

Nam Ngiep 1 Hydropower Project
Biodiversity Offset Design Report

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

The estimated current annual yield for agricultural products based on shown in ***Table 5.1***. The yield has been determined based on the proportion of agricultural land within the Study area and statistics derived from the FAO and GOL.

Table 5.1 Current Estimated Agricultural Yield in the Nam Ngiep Watershed

Type of Plantation Production		Area (ha)	Year 2014 (tonnes)
Rice Paddy	-	86,400	129,600-172,800
Plantation	100%	29,279	
- Para rubber	40%	11,712	17,568
- Eucalyptus	20%	5,856	8,784
- Palm tree	5%	1,464	2,196
- Kathinnalong	10%	2,928	4,392
- Jatropha	10%	2,928	4,392
- Sugar Cane	10%	2,928	4,392
- Other	5%	1,464	2,196
Total	**100%**	**115,679**	**216,720**

5.1.5 Villages and Settlements

The population density in the Nam Ngiep watershed is not high. Settlements are nearly all limited to the river valleys, with the main exceptions being the large expanse of fairly flat land towards the Mekong River and larger valleys toward the north and northeast of the watershed. These are also some of the most populated areas in the watershed. The major settlements relative to the Nam Ngiep watershed are: Phonsavan, the capital of Xieng Khouang Province is just outside the watershed boundary to the north and Pakxan, the capital of Bolikhamxay Province downstream of the proposed dam near the Nam Ngiep confluence with the Mekong River. Other settlements in the north of the Nam Ngiep watershed include Muang Khoun and Phaxai.

The Lao PDR Government currently has a policy of village consolidation. This has meant considerable population increases, particularly over the past four to five years, in a number of the villages in the Study area (Sriburi *et al.* 2012). It is expected that this will have both positive and negative impacts on the natural environment. It is expected that the natural environments surrounding abandoned villages would experience less resource use and the ecology could potentially benefit from this diminution of local resource use. Conversely, it is expected that the natural environments surrounding the consolidated villages would experience more resource use and the ecology could potentially be negatively impacted from this potential increase in local resource use.

5.1.6 Infrastructure

Roads

The main road through the watershed is National Road 1D, which was until recently a dirt road with some sections covered in gravel. It connects Phonsavan (the capital of Xieng Khouang Province) with Pakxan (the capital of Bolikhamxay Province). It runs north from Pakxan through the Nam Xan watershed and then turns west to go through the northern part of the Nam Ngiep watershed. Urban development and consolidation occurs along this road. No major thoroughfare roads are in the lower part of the Nam Ngiep watershed.

A rudimentary road network exists throughout the watershed with few major, all-weather roads. During consultation with the MPI, they identified that road upgrades/development has recently occurred. A new road was built in the Nam Xan watershed from Paksan to Khonsana in 2012 and another road was resurfaced to bitumen to service the Nam Ngiep 2 project in the upper Nam Ngiep in 2010. However, the new road in the Nam Xan watershed was severely damaged in the 2013 wet season and has yet to be reconstructed. Both of these roads have been used to transport construction materials for the NNP2 project and it would appear that the heavy construction traffic has compounded the damage. It should be noted that the terrain of both watersheds make road construction difficult and expensive. This is compounded by poor road construction techniques, traffic and the wet season. It is envisaged that these factors will continue to hamper overland transport in the short to medium term.

Electricity

A major development in the watershed has been transmission line construction for HEPs and domestic supply. It was observed by ERM in the field that a transmission line was constructed without appropriate environmental controls, causing landslips and erosion. It was also observed that multiple transmission lines have been constructed along similar routes to service both HEPs and Electricite du Laos (EDL) supply lines.

5.2 REASONABLY FORESEEABLE FUTURE ACTIONS

The timeframe for the analysis was determined based upon the Project timeframe and the reasonably foreseeable actions that could be predicted. A timeframe of 27 years has been established for the analysis, which includes the construction process, which is planned at a total of 70 months (EIA, 2014), and 9-10 years of operation. Predictions beyond this timeframe are considered to be unreliable.

5.2.1 Proposed Hydroelectric Power Projects

There is a noticeable lack of available quantitative information on the foreseeable future hydropower projects, providing a limitation for the CIA; however some projects have impact assessment documents that provide qualitative discussions of potential impacts to biodiversity. The analysis has been limited to those for which public information was available or those for which impact assessments were provided during ERM's consultation phase.

The RFFAs considered within this CIA include (refer ***Figure 5.1***)

- NNP1 (the current Project).
- Nam Ngiep 2 Hydropower Project (NNP2).
- Nam Ngiep 3 Hydropower Project (NNP3).
- Nam Pot Hydropower Project.
- Nam Phouan Hydropower Project.
- Nam Chain Hydropower Project.
- Nam Ngiep (Mouang Mai) Hydropower Project.

Interviews as part of the Resettlement Report (ERM-Siam, Co Ltd. 2013) indicated that villagers in the Project Area were aware of a number of proposed developments in the local area, including Nam Ngiep 1, Nam Ngiep 2 and the Nam Xan project. The Nam Xan project is a proposed weir, which will provide electricity generation for village consumption. Villagers at Ban Kanyong mentioned construction of Keang Tong and Keang Dao dam, which be used for electricity generation.

Table 5.2 below describes the HAP RFFAs that occur, or a predicted to occur, within the watershed (Study Area). RFFAs listed in the table below are limited to those activities that are formally listed in agency planning documents, those for which permit applications have been completed, or activities that have received funding. The listed RFFAs are ranked according to their potential impact on the proposed Project or the resources that may be affected by the proposed Project. Although many local, regional and national plans may list dozens of Projects, this is not always a strong indication that a Project will be constructed. For this reason, the probability ranking below is also based on professional judgment and discussions with Project proponents.

Seven hydropower projects are proposed within the Nam Ngiep watershed (refer ***Table 5.2***). The total installed capacity known from proposed HEPs 585 MW. NNP1 will have a capacity of 290 MW, the four other projects for which the total installed capacity is known have a combined total installed capacity of 295 MW. In this regard, NNP1 is the largest development on the Nam Ngiep River, accounting for 49.6% of the 585 MW of development that is reasonably foreseeable within the next 25 years. Four projects other than NNP1 have data available on size of the reservoirs. The two dams for NNP1 will be approximately 7497 ha in size with the sum of the other three where data are available being 1313 ha. In that regard, the reservoirs of NNP1 will

be approximately 85.1 per cent of the known size of proposed HEP reservoirs in the watershed.

Table 5.2 HEP Reasonably Foreseeable Future Actions

RFFA	Province	Electricity Generating Capacity	Status	Description	Project Watershed Size (km²)/ Total River Watershed Size (km²)	Project Footprint Size	Type (Storage or Run-of-River)	Likely Changes to Daily/ Seasonal River Flows	New Road and Electricity Infrastructure Required	Probability	Resources/Receptors affected
Nam Ngiep 1 (this Project)	Vientiane/ Bolikhamxay	290 MW	Planning and Approvals Stage	NNP1 consists of two reservoirs each impounded by a separate dam serving two separate power stations. The Project will operate a main power station and a re-regulation power station. The main power station is designed to re-regulate and stabilise the Nam Ngiep River discharge from the main power station for the safety to the downstream area of the re-regulation dam.	3700 (main dam) & 3725 (re-regulation dam includes main dam area)/ 4320	6798 ha proposed maximum main dam reservoir size; 699 ha proposed maximum re-regulation dam reservoir size; 467 ha resettlement area	Storage	Current average annual inflows 148.4 m^3/s; Re-regulation dam will release a minimum dry season flow of 27 m^3/s during the dry season and wet season inflows will equal outflows after dam is at capacity (expected to take one year). Note that a maximum flow of 5.5 m^3/s will be allowed during the reservoir filling period (expected to take one year).	Upgrade 30.45 km of existing roads; New 11.16 km road (linking Ban Hat Gniun to dam site); New temporary roads (16.81 km) (linking Ban Hat Gniun to dam site); 170 km transmission lines	Unknown	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat, Communities
Nam Ngiep 2	Xieng Khouang	180 MW	Under construction	This project involves a main dam and a tributary dam located 15 km away linked by a tunnel which are both linked to a powerhouse. The proponent is the China International Water and Electric Corporation. The concession agreement was signed 18/8/11 and commeCIAl operation is expected in 2015. The Project has commenced construction and is located upstream of the NNP1 project, in the north western section of the Nam Ngiep watershed on a tributary of the Nam Ngiep, the Nam Sen.	Unknown watershed area of proposed reservoir/ 2440 (total Nam Sen watershed area – project located approximately 5 km upstream from confluence with Nam Ngiep)/ 4320 (Nam Ngiep)	754 ha main reservoir size; 19 ha tributary dam	Storage	Unknown	Unknown	High	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat
Nam Ngiep 3A	Xieng Khouang	44 MW	Under construction.	This project is a newly constructed run-of-river hydropower plant located in Phonsavan City, Xieng Khouang province. It has a total installation capacity of 44 MW (13 MW x 3 units of vertical shaft Francis turbine generator and 2.5 MW x 2 units of horizontal shaft turbine generator). The project is expected to supply an annual average electricity of 153 GWh to the Lao Power Grid and Thailand Power Grid. EIA report was approved by MoNRE on April 20th, 2011. Construction started on 24th November, 2011. Power Purchase Agreement was approved from EdL on 26th April, 2013.	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat
Nam Pot	Xieng Khouang/ Vientiane	20-25 MW	Approved – construction planned 2015	A small project to be built in Phatay Village, Phatay District approximately 27 km south-southeast of the Xieng Khuang Provincial Capital. The project will be built on the Pot River, a 22 km long tributary of the Seum River. The power generated will be used domestically for nine-ten villages (Vientiane Times 2012).	Unknown/ Unknown	490 ha reservoir (estimated maximum)	Storage	Unknown	22 km new access roads; 6 km new transmission line	Unknown	Unknown

RFFA	Province	Electricity Generating Capacity	Status	Description	Project Watershed Size (km²)/ Total River Watershed Size (km²)	Project Footprint Size	Type (Storage or Run-of-River)	Likely Changes to Daily/ Seasonal River Flows	New Road and Electricity Infrastructure Required	Probability	Resources/Receptors affected
Nam Chain	Xieng Khouang	Unknown	Unknown	Unknown project details. The location is close to the north eastern extent of the Nam Ngiep watershed.	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Nam Phouan	Vientiane	52 MW	Approved – construction date unknown	Project Environmental and Social Impact Studies were prepared in 2012 and has been accepted and approved by Lao PDR Government (Velcan 2013). The proposed location of the Project is on the Nam Phouan river which is a tributary of the Nam Ngiep river located approximately 30 km (in a direct line) upstream of the NNP1 proposed project area. The project includes a reservoir on the Nam Phouan and a 3.7 km long tunnel that diverts this water into powerhouse in a different watershed: the Nam Om River (intermittent river with a small watershed size of 4km²). Two dam site options were considered. The downstream option sized at 50 ha and the upstream option at 30 ha.	Unknown/ 480	50 ha downstream reservoir option; 30 ha upstream reservoir option	Run-of-river	Calculated flow of the Nam Phouan River is 29m³/s. Proposed flow released from the reservoir into the Nam Phouan will be 0.5m³/s to maintain the natural flow of the river during dry season with overflows anticipated during the wet season. Discharge from powerstation into Nam Om River capacity is 35m³/s.	Unknown length of access roads; 44 km of transmission lines.	High	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat
Nam Ngiep (Mouang Mai)	Bolikhamxay	38 MW	Feasibility Stage	Information on this project is scarce. A memorandum of understanding signed 25/2/10. The Feasibility Study is ongoing, but the location of the dam site is not publically available. It is reported to be proposed for the main stream of the Nam Ngiep river, downstream of NNP1 between the Project site and Pakxan.	Unknown	Unknown	Unknown	Unknown	Unknown	Moderate	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat

Information in this table is sourced from Kansai (2011), NCC EAT (2010), Ministry of Energy and Mines (2012), China International Water and Electric Corp (2012), Maunsell (2004) and Velcan and Lem (2012).

Table 5.3 outlines the projected footprint impacts for each of the HEP Projects in the Nam Ngiep Watershed for 6 of the 7 identified HEP RFFAs. Insufficient information was available for the Nam Chain HEP to predict the likely impact from the development.

Table 5.3 ***Summary of Likely Impacts from HEP Developments in the Nam Ngiep Watershed 2015-2030***

HEP Projects	Electricity Generating Capacity (MW)	Total watershed Area (km²)	Inundation Area (km²)	New access road length (km)	Transmission line length (km)	No. of affected households		
						Inundation area	Access Road	T/L
NNP1	290	4,320	68.2	42.4	40	3,459	263	4,851
NNP2	180	2,440	*42.3*	*26.3*	*24.8*	*2,145*	*163*	*3,007*
NNP3	44	*655*	*10.3*	*6.4*	*6.1*	*522*	*40*	*740*
Nam Pot HP	25	*180*	4.9	22	6.0	*249*	*136*	*728*
Nam Phouan HP	52	480	*12.2*	*7.6*	*7.2*	*619*	*47*	*873*
Nam Ngiep (Mouang Mai) HP	38	*566*	*8.9*	*5.6*	*5.2*	*452*	*35*	*631*
Total	**629**	**8,641**	**146.8**	**110.3**	**89.3**	**7,446**	**684**	**10,830**

Assumptions:

1. *The italic letters are the estimated values from portion of generation capacity according to the Nam Ngiep 1 hydropower Project.*
2. *The affected household from inundation area was estimated from the proportion between the inundation areas derived from the number of affected household of inundation area of NNP1.*
3. *The affected household from access road was estimated from the portion between access road lengths derived from the number of affected household of inundation area of NNP1.*
4. *The affected household of transmission line of other projects were estimated from the portion between transmission line lengths derived from the number of affected household of inundation area of NNP1*

5.2.2 Forestry

Forestry will presumably continue as scheduled in the production forests present in the middle reaches of the Nam Ngiep watershed (refer ***Figure 5.1***). From consultation with DFRM (refer *Section 3.4*), forestry operations will increase in two ways:

- Development in the road network creating a denser and more extensive road network as has occurred for previously constructed Projects and will occur for NNP1 and other RFFAs will provide greater access to previously unobtainable timber resources. This could potentially increase the allocations of timber allowed by the Provincial government in newly designated forestry areas; and

- An increase in development will increase the amount of timber taken from those development footprints.

It is also reasonable to assume that increases in population increase the pressure on timber harvesting by locals for housing, boats and other domestic uses.

Table 5.4 shows the estimates yield of timber based on the existing conservative yield rates for the production forest in the Nam Ngiep Watershed.

Table 5.4 ***Estimated Timber Yield from Production Forest, 2015 - 2030***

Type of Plantation Production	Area (ha)	Annual Yield (Cubic Metres/ha)	Year 2015 (Cubic metres)	Year 2020 (Cubic metres)	Year 2025 (Cubic metres)	Year 2030 (Cubic Metres)
Timber	**119,750**	**0.24**	**28,740**	**30,177**	**31,685**	**33,269**

Data Source:

- Timber trade and wood flow –Study Lao PDR, Regional Environmental Technical Assistance 5771 Poverty Reduction & Environmental Management in Remote Greater Mekong Sub region (GMS) Watershed Project (phase I)

Assumption:

- The timber production has been estimated from the total area of production forest in Nam Ngiep watershed and the annual yield of production of timber.
- The Nam Ngiep watershed area of 432,000 ha consists of 247,104 ha Protection Forest and 119,750 ha Production Forest

5.2.3 Mining

Interviews as part of the Resettlement Report indicated that although villagers in the Project Area were aware of a number of proposed HEP developments in the local area, the villagers did not identify any proposed mining Projects.

It is unclear how mining leases currently under survey will operationally interact with the Project Area (refer ***Figure 5.1***), however it is assumed that potential mining will be many years in the future. Areas currently under survey may be at a feasibility stage with potential mining operation many years away and it will take even more years than that for mining activity to manifest in areas where survey is currently proposed.

Details of mining lease under survey and with survey proposed (mining not yet approved) and mining lease with concession are presented in ***Table 5.6***.

Table 5.5 shows the estimates production yield in millions of tons per annum based on the estimated likely yield of minerals based on the concession areas of existing mining concession productivity within Lao PDR. Note that 16 mining leases without insufficient information regarding their likely operations have been removed from this table. ***Table 5.6*** provides details on all of the mining leases with concessions (total of 24).

Table 5.5 Estimated Mining Production Yield for Current Concessions

Company Name	Area (ha)	Excavation (million ton/year)	Productivity (estimated output)	Estimated Total (20 years of operation)
Phubia Mining Limited (Phu Kham Copper and Gold Operation))	2,600,000	12-16	Cu 64,885 tons/year [1)] Au 71,223 Oz/year [1)]	**Cu 1.297Mt** **Au 1.424Mt**
Phubia Mining Limited (Ban Houayxai Gold-Silver Operation)		4	Au- Ag 23,356 Oz/year [2)]	**Au 0.47MOz**
Lao Xinhe Steel and Mining Development Co., Ltd.	1,000	N/A	Fe 129,000 tons/year Assumption : Iron mine area 62 ha produce Fe 8,000 tons/year [3)]	**Fe 2.58Mt**
Khamkueth Sane Oudom Limited	180,200	N/A	Au 4,495 tons/year Assumption : Phubia Mining area 2,6000,000 ha produce Cu 64,855 tons/year [1)]	**Au 89,900ton**
MITHAPHAB Tin Mining Co., Ltd.	1,000	N/A	Tin 490 ton/year Assumption : Phubia Mining area 4,068 ha produce Tin 2,000 tons/year [4)]	**Tin 9800ton**
State Enterprise for Agriculture Industry Development Limited (DAI)	1,400	N/A	Coal 190,735 ton/year Assumption : Coal mine area 3,670 ha produce 500,000 tons/year [5)]	**Coal 3.81Mt**
State Enterprise for Agriculture Industry Development Limited (DAI)	551	N/A	Coal 75,070 ton/year Assumption : Coal mine area 3,670 ha produce 500,000 tons/year [5)]	**Coal 1.5Mt**

Data Source:

Department of Mine, Ministry of Energy and Mines, Updated July 2013.

[1)] http://www.panaust.com.au/phu-kham-copper-gold-operation

[2)] http://www.panaust.com.au/ban-houayxai-gold-silver-operation

[3)] http://www.hoaphat.com.vn/eHome/eCIntroduces.aspx?compid=38

[4)] https://crawford.anu.edu.au/pdf/staff/rmap/lahiridutt/CR2_KLD_Improving_Rural.pdf

[5)] http://www.sourcewatch.org/index.php/Laos_and_coal

Table 5.6 Existing and Proposed Mining Tenement within the Study Area.

Companies No.	Project No.	Company Name	Enterprise	Activity	Mineral	Area (ha)	Location			Agreement	MEM Decree			License No.
							Village	District	Province		No.	Date	Expire	
1	1	Phubia Mining Limited (Phu Kham Copper and Gold Operation))	Australia	Mining	Au and Cu	2,600,000	Nam Mo, Nam Gnon	Xaysomboon SR	Vientiane	4 Apr. 2002	774/MEM	3 Sep. 2007	3 Sep. 2022	021/MEM.DOM
	2	Phubia Mining Limited (Ban Houayxai Gold-Silver Operation)	Australia	Mining	Au and Ag		Nam Mo, Nam Gnon	Xaysomboon SR	Vientiane	4 Apr. 2002	773/MEM	3 Sep. 2007	3 Sep. 2022	021/MEM.DOM
	3	Phubia Mining Limited	Australia	Survey	-	-	-	Phonsavan	Xieng Khouang	-	-	-	-	-
2	4	Lao Xinhe Steel and Mining Development Co., Ltd.	Lao-China	Mining	Fe	1,000	Nam San	Xaysomboon SR	Vientiane	17 Oct. 2011	1320/MEM	2 Nov. 2011	1 Nov. 2031	391/MEM.DOM
3	5	COECCO	Vietnam	Survey Proposed	N/A	N/A	-	Khouan/ Kham	Xieng Khouang	-	-	-	-	-
	6	COECCO	Vietnam	Survey Proposed	N/A	N/A	-	Nonghet	Xieng Khouang	-	-	-	-	-
	7	COECCO	Vietnam	Survey Proposed	N/A	N/A	-	Xaysomboon SR	Vientiane	-	-	-	-	-
	8	COECCO	Vietnam	Survey Proposed	N/A	N/A	-	Xaysomboon SR	Vientiane	-	-	-	-	-
4	9	Neyland Lao Mining	Russia-Lao	Survey Proposed	N/A	N/A	-	Borikhan/ Parkkadin	Bolikhamxai	-	-	-	-	-
5	10	China Base Ningbo Foreign Trade Co., Ltd.	China	Survey Proposed	N/A	N/A	-	Viangthong	Bolikhamxai	-	-	-	-	-
	11	Vinacomin Co., Ltd.	Vietnam	Survey	N/A	N/A	-	Pek	Xieng Khouang	-	-	-	-	-
6	12	CAVICO Vietnam and Laoyongchaluen Trading Import/ Export Ltd.	Vietnam-Lao	Survey	N/A	N/A	-	Borikhan/ Parkkadin	Bolikhamxai	-	-	-	-	-
1	1	Khamkueth Sane Oudom Limited	Military	Mining	Au	180,200	Nakadok	Khamkuet	Bolikhamxai	6 Nov. 2009	None	None	None	None
2	2	MITHAPHAB Tin Mining Co., Ltd.	Lao	Mining	Tin	1,000	Thongmani	Pakading	Bolikhamxai	20 Feb. 2009	486/MEM	1 Apr. 2009	19 Feb. 2021	302/MEM.DOM
3	3	State Enterprise for Agriculture Industry Development Limited (DAI)	State Enterprise	Mining	Coal	1,400	Namphan	Khoun	Xieng Khouang	14 Feb. 2011	0770/MEM	27 Jun. 2011	13 Feb. 2046	348/MEM.DOM
	4	State Enterprise for Agriculture Industry Development Limited (DAI)	State Enterprise	Mining	Coal	551	Khangphaneng	Nonghet	Xieng Khouang	N/A	0568/MEM	5 May 2011	13 Feb. 2046	335/MEM.DOM
4	5	PT Construction Co., Ltd.	Lao	Survey Proposed	N/A	N/A	-	Hom/ Borikhan/ Pakxan	Bolikhamxai	-	-	-	-	-
5	6	Nilandon Development Mining Co., Ltd.	Lao	Survey Proposed	N/A	N/A	-	Thatom	Xieng Khouang	-	-	-	-	-
6	7	Phongsabthavy Construction Ltd.	Lao	Survey Proposed	N/A	N/A	-	Khoun	Xieng Khouang	-	-	-	-	-
	8	Phongsabthavy Construction Ltd.	Lao	Survey Proposed	N/A	N/A	-	Khouan/ Kham	Xieng Khouang	-	-	-	-	-
	9	Phongsabthavy Construction Ltd.	Lao	Survey Proposed	N/A	N/A	-	Khouan/ Nonghet	Xieng Khouang	-	-	-	-	-

Companies No.	Project No.	Company Name	Enterprise	Activity	Mineral	Area (ha)	Location			Agreement	MEM Decree			License No.
							Village	District	Province		No.	Date	Expire	
7	10	Dansavan Investment and Construction Ltd	Lao	Survey Proposed	N/A	N/A	-	Nonghet	Xieng Khouang	-	-	-	-	-
8	11	Lao-Muang-om Mining Ltd.	Lao	Survey	N/A	N/A	-	Xaysomboon SR	Vientiane	-	-	-	-	-
	12	Lao-Muang-om Mining Ltd.	Lao	Survey	N/A	N/A	-	Hom/ Xaysomboon SR	Vientiane	-	-	-	-	-

Remark:

N/A means data not available

Data Source:

Department of Mine, Ministry of Energy and Mines, Updated July 2013.

http://www.panaust.com.au/phu-kham-copper-gold-operation

http://www.panaust.com.au/ban-houayxai-gold-silver-operation

http://www.hoaphat.com.vn/eHome/eCIntroduces.aspx?compid=38

https://crawford.anu.edu.au/pdf/staff/rmap/lahiridutt/CR2_KLD_Improving_Rural.pdf

http://www.sourcewatch.org/index.php/Laos_and_coal

5.2.4 *Agriculture*

Agriculture is very important to the communities in the Project Area. It is difficult to predict how agriculture will change over time. A broad assumption is that as population increases in the future, so too will the demand for agricultural products and therefore arable land. Interviews and observations as part of the Resettlement Report indicate that rubber plantations continue to be established. Plantations for timber and cassava are also established within the watershed. Market gardens and broad scale agriculture for food is established within riparian areas with production of corn, rice and vegetables, mainly for direct consumption.

Table 5.7 outlines the estimated agricultural yield for the Study Area from 2015 – 2030.

Table 5.7 Estimated agricultural yield for the Nam Ngiep Watershed 2015-2030

Type of Plantation Production		Area (ha)	Annual Yield (Tonnes/ha)	Year 2015 (Tonnes)	Year 2020 (Tonnes)	Year 2025 (Tonnes)	Year 2030 (Tonnes)
Rice Paddy	-	86,400	1.5-2.0[1)]	129,600-172,800	136,080-181,440	142,884-190,512	150,028-200,037
Plantation [2)]	100%	29,279	1.5				
- Para rubber	40%	11,712		17,568	18,446	19,368	20,336
- Eucalyptus	20%	5,856		8,784	9,185	9644	10,126
- Palm tree	5%	1,464		2,196	2,305	2420	2,541
- Kathinnalong	10%	2,928		4,392	4,611	4841	5,083
- Jatropha	10%	2,928		4,392	4,611	4,841	5,083
- Sugar Cane	10%	2,928		4,392	4,611	4,841	5,083
- Other	5%	1,464		2,196	2,305	2,420	2,541
Total				**216,720**	**227,514**	**238,887**	**250,830**

Data source

1) World Rice Statistics, FAO 2008

2) Sustainable Development in the Plantation Industry in Laos: An Examination of the Role of the Ministry of Planning and Investment National Economic Research Institute, 2009

Assumptions:

1. Each type of plantation area has been estimated from the agricultural area of Lao PDR, FAO 2011, according to the portion of each type (refer to the source above). The yield of the plantation was assumed to use the minimum value of annual yield of rice paddy.
2. The data prediction year 2015 to 2030 were developed by annual yields from each existing data source above, and the production is assume to steadily increase to year 2030.
3. Assumes a 5% increase in yield per annum based on increases in agricultural extent and productivity improvements.

5.2.5 *Villages and Settlements*

It is anticipated that there will be an influx of people to the area to work on the construction of NNP1 and this will potentially have a legacy if those people decide to remain after the construction is complete. Overall, as the road network and electricity availability are improved, there will likely be an increase of settlement. The patterns of that potential settlement however are unpredictable.

Village consolidation will have both positive and negative impacts on the natural environment. It is expected that the natural environments surrounding abandoned villages would experience less resource use and the ecology could potentially benefit from this diminution of local resource use. Conversely, it is expected that the natural environments surrounding the consolidated villages would experience more resource use and the ecology could potentially be negatively impacted from this potential increase in local resource use.

Table 5.8 outlines the Projected population of the Study area from 2015-2030. This is based on data Projected from 2012 provided by the World Bank.

Table 5.8 Estimated population of the Nam Ngiep Watershed (Xaysomboun Province 2015-2030)

Data	2012	Average Percentage (as of 2008-2012)	2015	2020	2025	2030
Population in Lao PDR (peoples) [1)]	6,645,827	2.000	7,193,657	7,942,378	8,769,028	9,681,715
Population in Nam Ngiep Watershed	1,234,549	2.000	1,310,113	1,446,471	1,597,021	1,763,240
GDP Growth (%) [2)]	8.2	1.015	8.7	9.4	10.1	10.9

Sources;

1) http://countryeconomy.com/demography/population/laos

2) http://www.worldbank.org/en/country/lao

Assumption: The data prediction year 2015 to 2030 were developed by average values from the existing data sources above (2008-2012).

5.2.6 *Infrastructure*

Roads

Very little detailed information is available regarding specific proposed road upgrades in the area. During consultation, the MPI (refer *Section 3.4*) indicated that increases in the road network are in response to development pressures. The development of NNP1 and the other HEPs will provide an improved road network in the watershed. The consequences of this improved road network will be to allow people greater transport around the watershed during more parts of the year due to upgrades of dry season roads to all-weather roads and likely into new areas where roads were not previously

present or where access was difficult. New roads in the Nam Ngiep watersheds will increase the ability to transport minerals and thus may increase the economic/logistical viability of mineral extraction Projects. It should be noted that the terrain of both watersheds make road construction difficult and expensive. This is compounded by poor road construction techniques, traffic and the wet season. It is envisaged that these factors will continue to hamper overland transport in the short to medium term.

Table 5.9 outlines the estimated traffic increases within the Nam Ngiep Watershed based on predicted traffic flows within Lao PDR.

Table 5.9 Predicted Traffic Flow Volume 2015 – 2030

Data	2012	Average Percentage (as of 2008-2012)	2015	2020	2025	2030
Traffic Volume (vehicles/day)	250-540	10.000	366-790	590-1,273	950-2,050	1529-3,302

Data Source:

http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/EXTEAPREGTOPTRANSPORT/0,,contentMDK:20767668~menuPK:2069285~pagePK:34004173~piPK:34003707~theSitePK:574066,00.html

Assumption:

The data prediction year 2015 to 2030 were developed by average values from the existing data sources above (2008-2012).

Electricity

Past and present electricity infrastructure developments discussed above (refer *Section 5.1*) have resulted in various impacts. Although it is not clear the exact location of any future power line construction for other HEPs or RFFAs, it is reasonable to assume that there is the potential for both positive and negative impacts from power line development. The positive impacts include an enhanced quality of life for people who are the beneficiaries of the available power and potentially negative impacts to the environment if development is poorly planned or controlled as has been described in *Section 5.1*. ***Table 5.10*** outlines the estimated electricity consumption for Xaysomboun province from 2015-2030.

Table 5.10 Estimated Electricity Consumption, Xaysomboun Province 2015-2030

Data	2012	Average Percentage (as of 2008-2012)	2015	2020	2025	2030
Electricity Consumption (billion kWh)	2.23	14.554	3.84	7.78	14.94	29.48
Date Source http://www.indexmundi.com/g/g.aspx?c=la&v=81 Assumption: The data prediction year 2015 to 2030 were developed by average values from the existing data sources above (2008-2012).						

6 CUMULATIVE IMPACT ASSESSMENT

ERM has identified the following VECs according to the methods outlined in *Section 2* of this report, the Project baseline and impacts presented in the EIA, supporting literature, peer reviewed journals and other investigations undertaken during the Initial Report.

The four VECs of importance to the Project and that are the foci of this CIA are:

- VEC 1: Terrestrial biodiversity and habitats
- VEC 2: Aquatic biodiversity and habitats
- VEC 3: River flows and water quality
- VEC 4: Ecosystem services

Discussion of these VECs is provided in this Section framed in terms of the parameters (consistent with the ADB review of the draft Initial Report):

- Known or suspected impacts by the Project and RFFAs;
- Known cumulative impact issues in the region; and
- Concerns generally recognized as important on the basis of scientific concerns.

Impacts from the development of transmission line and access road are included as parts of HEPs development. However, since there is limited data for mining development, subjective description of expected impacts are presented.

6.1 VEC 1: TERRESTRIAL BIODIVERSITY AND HABITATS

6.1.1 Impacts from HEPs Developments – Construction Phase

Habitat Loss

The total estimated total watershed impacts for all HEP developments are 8641 square kilometres. The total estimated road length from all HEP developments is estimated at 110 km. Total; estimated transmission line length is 89.3 km. These cumulative impacts are likely to have the following impacts on habitat values within the study area.

Temporary disturbance of terrestrial habitat in areas required to facilitate construction. Temporary disturbance will mainly be associated with access roads to construction areas, laydown areas and construction camps.

Construction activities will require clearing of some vegetation to facilitate the construction process which will remove habitat. The habitats are common and widespread within the region and the loss will be limited to that necessary for construction. The areas to be temporarily disturbed are considered unlikely to impact the viability or functioning of adjacent ecosystems. Where possible topsoil will be managed locally and natural regeneration or rehabilitation using native species will be undertaken in areas not required for the operation of the HEPs development.

Also, EIA report of Nam Ngiep 2 Project specified that the ecological stability generated by the flooding of a large area and the consequent movement of large numbers animals can have an impact on public health and on crop damage. Crop pests can become more serious problem for a short period on fields close to the reservoir. The more rapidly moving fauna could leave the area during logging and biomass destruction. Most of down animals are those of small flightless terrestrial animals, immature and injured animals incapable of moving. The main threat to amphibians and reptiles is habitat destruction, illegal poaching, and temporary and permanent human settlement in the forest at the main dam. Many species are expected to be disturbed by clearing the forest and human exploitation. Loss of habitat and poaching are the main threats to birds. During the construction phase, habitat and nest sites will be cleared and replaced with large infrastructures. Many bird species living in these areas may migrate to new habitat.

Permanent loss of habitat from the dam construction would result in the loss of forest area and be replaced by the reservoirs. For NNP1, the area of National Protection Forest within the main dam inundation area is 5180 ha. In the context of the surrounding area, the habitats are representative of the larger watershed and not considered unique. A diversity of flora and fauna species were reported to occur (based on ecological surveys or village surveys) in the disturbance area and the habitat for these populations will be reduced within the watershed. Approximately 50% (3946 ha) of the footprint is considered to be natural habitat. In the context of the Nam Ngiep sub-watershed the proportion of habitat to be removed to facilitate the Project represents approximately 4% of natural habitat in the sub-watershed and as such not likely to threaten the long-term viability of the habitat and biodiversity. For modified habitats approximately 45% (3589 ha) of the footprint is considered to be modified habitat. In the context of the Nam Ngiep sub-watershed the proportion of habitat to be removed to facilitate the Project represents approximately 13% of modified habitat in the sub-watershed and as such not likely to threaten the long-term viability of the habitat and biodiversity. Therefore, total loss of forest area is about 8,013 hectares (***Table 6.1***).

For NNP2, the total loss of forest area at the two reservoir areas is anticipated to about 627 hectares in total (***Table 6.2***).

It should be noted that only the NNP1 Project proposes to establish a biodiversity offset to achieve a no-net-loss of biodiversity values to offset the residual impacts on biodiversity values of the Project. This offset area is located within the watershed of the Nam Ngiep and is designed to enhance and restore biodiversity values over the life of the concession agreement (27 years).

Table 6.1 Land Cover within the NNP1 Project Area

Land Cover	Total (ha)	% of Total	Watershed Total (ha)	% of Watershed
Deciduous Forest	2896	36	61974	4.67
Evergreen Forest	514	6	38180	1.35
Bamboo	502	6	15667	3.20
Old Fallow Land	1678	21	5174	32.43
Young Fallow Land	1261	16	6996	18.02
Slash and Burn	374	5	1874	19.96
Rice Paddy	127	2	296	42.91
Grassland	108	1	4008	2.69
Urban Area	41	1	48	85.42
Water	410	5	532	77.07
Rock	1	<1	162	0.62
Cloud	4	<1	34	11.76
Shadow	16	<1	165	9.70
Total	**8013**	**100.00**	**135110**	**5.93**

Table 6.2 Land Cover within the NNP2 Project Area

Land Cover	Total (ha)	% of Total	Watershed Area (ha)	% of Watershed
Deciduous Forest	41	6.54	61974	0.06
Evergreen Forest	429	68.42	38180	1.12
Bamboo	-	-	15667	-
Old Fallow Land	-	-	5174	-
Young Fallow Land	-	-	6996	-
Slash and Burn	56	8.93	1874	2.99
Rice Paddy	27	4.31	296	9.12
Grassland	74	11.80	4008	1.85
Urban Area	-	-	48	
Water	-	-	532	
Rock	-	-	162	
Cloud	-	-	34	
Shadow	-	-	165	
Total	**627**	**100.00**	**135110**	**0.46**

Indirect Impacts

Noise and light disturbances have the potential to influence fauna breeding, roosting or foraging behaviour of native fauna. The consequences of these influences are dependent on the extent of disturbance but in extreme cases these factors can influence local populations if breeding and communication is inhibited.

Excessive noise can impede fauna communication and deter the use of habitats nearby. Similarly, introducing light sources has the potential to deter foraging and dispersal activities of nocturnal species.

The development areas contain numbers of villages currently where human habitation is likely to induce a base level of disturbance in directly adjacent areas however the construction activities are likely to increase these types of disturbance and introduce them to areas where there is currently limited influence of noise, light and vibration. The habitats that may be impacted are common and widespread within the region and the loss will be limited to that necessary for construction. This impact will be temporary and localised hence unlikely to impact the viability/function of adjacent habitats.

The construction and inundation phases of HEPs development and the construction of mine and refinery plant areas of mining development will generate newly disturbed forest edges around the margins of the reservoir and mining areas and at the infrastructure locations. Edge effects are an indirect impact of land clearing. Where vegetation clearing occurs, adjacent vegetation and habitats are exposed to increased noise, light, dust and wind environment as well as increased competition from predators and invasive species. In extreme cases some of these effects have potential to alter the habitat characteristics of the ecotone and influence suitability for native flora and fauna. 'New' habitat edges will be created where infrastructure is located in natural habitat areas, not previously disturbed.

Introduced Species

Invasive or alien species have the potential to be introduced or spread throughout the construction areas through increased movement of people, vehicles, machinery, vegetation and soil. An increase in the prevalence of weeds or other pests has the potential to reduce the quality of habitat for some native flora and fauna, including threatened species. Invasive flora species can rapidly germinate in disturbed areas whereby affecting the ability of native vegetation communities to re-establish. Alien animals also have the potential to be introduced or increased in abundance. These animals may adversely impact native fauna as a result of increased competition for resources, predation or habitat degradation.

HEPs components will include the storage and handling of hazardous materials, including refuelling. Accidental release or spill of these materials can be toxic to flora and fauna locally and downstream if substances are

released into the aquatic environment. The Nam Ngiep River experiences substantial flows and as such it is likely that an accidental spill can be diluted such that impacts are localised however the watershed provides habitat for nationally and globally listed species.

Species Impacts

The NNP1 and NNP2 Projects and adjacent areas contain biodiversity and conservation values. Baseline studies undertaken for the Biodiversity Impact Assessment identified a diversity of terrestrial flora and fauna species, and ecosystems, including some species listed on the IUCN Red List of threatened species.

The IUCN listed critically endangered, endangered or vulnerable terrestrial species that have been recorded or have potential to occur (indirect records or interview results) within the NNP1 and NNP2 Project areas are summarised in ***Table 6.3*** along with the land cover code for the forest type that the species may inhabit (based on species profiles).

Table 6.3 IUCN Listed Terrestrial Flora and Fauna Species recorded in the NNP1 and NNP2 Project Areas

Scientific Names	Common Name	Land Cover Code	Status
Flora			
Dipterocarpus turbinatus		DF, EF	CR
Afzelia xylocarpa		DF, EF	EN
Dalbergia oliveri		DF, EF	EN
Dipterocarpus alatus		DF, EF	EN
Hopea ferrea		DF, EF#	EN
Shorea roxburghii	White meranti	B, DF, EF	EN
Dalbergia cochinchinensis	Thailand rosewood	DF	VU
Hopea odorata		DF, EF	VU
Ternstroemia wallichiana		DF, EF	VU
Mammals			
Nomascus leucogenys	Northern white-cheeked gibbon	EF	CR
Cuon alpinus	Asian wild dog, dhole	DF	EN
Elephas maximus	Asiatic elephant	B, DF	EN
Manis javanica	Sunda pangolin	DF	EN
Panthera tigris	Tiger	DF	EN
Prionailurus viverrinus	Fishing cat	EF	EN
Pygathrix nemaeus	Red-shanked douc langur	EF	EN
Trachypithecus phayrei	Phayre's leaf monkey	B, DF, EF	EN
Aonyx cinerea	Asian small-clawed otter	W	VU
Arctictis binturong	Binturong	DF	VU
Bos gaurus	Gaur	DF	VU
Capricornis milneedwardsii	Chinese serow	B, DF, EF	VU
Helarctos malayanus	Malayan sun bear	B, DF	VU
Lutrogale perspicillata	Smooth-coated otter	RP, W	VU
Macaca arctoides	Stump-tailed macaque	DF, EF	VU

Scientific Names	Common Name	Land Cover Code	Status
Macaca leonina	Northern pig-tailed macaque	DF, EF	VU
Nycticebus bengalensis	Bengal slow loris	DF, EF	VU
Nycticebus pygmaeus	Pygmy slow loris	B, DF, EF	VU
Pardofelis marmorata	Marbled cat	B, DF, EF	VU
Rusa unicolor	Sambar deer	DF, EF	VU
Ursus thibetanus	Himalayan black bear	B, DF, EF	VU
Reptiles			
Platysternon megacephalum	Big-headed turtle	W	EN
Amyda cartilaginea	Southeast Asian softshell turtle	W	VU
Malayemys subtrijuga	Snail-eating turtle	W	VU
Naja siamensis	Indo-Chinese spitting cobra	DF, EF, G, OFL, YFL, RP, SB	VU
Ophiophagus hannah	King cobra	DF, EF, G, OFL, YFL, SB	VU
Siebenrockiella crassicollis	Siamese temple turtle	W	VU
Birds			
Gyps bengalensis	White backed vulture	SB, U	CR
Cairina scutulata	White winged duck	DF, EF	EN
Aceros nipalensis	Rufous-necked hornbill	DF, EF	VU
Aquila heliaca	Imperial eagle	DF, EF	VU

#Little habitat information is available and an assumption has been made for suitability based on plant form.

*Represents the area of potentially suitable habitat within the NNP1 and NNP2 Project areas.

The Environmental and Social Impact Assessment (ESIA) (Velcan and Lem 2012) for the Nam Phouan HEP indicates that the forest types in the Nam Phouan Project Area are disturbed primary and secondary forest vegetation (secondary forests being those that have regenerated from shifting cultivation areas). The reservoir area to be inundated is covered with disturbed primary and secondary forests. Secondary forests have regenerated on abandoned areas of shifting cultivation. This is regenerating mixed deciduous forest with some areas of secondary shrubs, grasslands and bare lands with some grasses and scattered trees. There is some dry evergreen forest along the proposed transmission line that has been degraded due to selective logging. Velcan and Lem (2012) estimated that the Project will result in the clearing of 50 hectares of forest. The habitats of the study area are locally and regionally common. The proposed inundation area has been extensively and significantly disturbed from years of forest conversion for other uses such as slash and burn agriculture, burning as a hunting tool and illegal logging.

This section concludes that based on the field assessment, the proposed reservoir area contains virtually nothing of biodiversity conservation value and claims in support of this conclusion the fact that neither the proposed inundation area nor any surrounding area has been proposed as a NPA. The impact assessment claims the impact on biodiversity from forest clearance will be insignificant and predicts a small change to the forest type from the increased presence of soil moisture adjacent to the lake which could favour the

proliferation of evergreen species. The report claims that this could potentially be a positive impact as a greater diversity of forest types will be present.

The results of fauna surveys and inquiries (it is possible that inquiries means interviews however this is unknown) by Velcan and Lem (2012) identified no threatened species listed on the IUCN Red List present in the study area. The impact assessment document assesses the impact of the vegetation clearance for reservoir establishment at the regional scale as having 'medium' impacts on biodiversity. At the local scale, Velcan and Lem (2012) identify that the impact of habitat reduction and biodiversity loss is at 'medium scale'. The report claims that the Project will not sever forest connectivity.

Therefore, a total permanent loss of forest area in Nam Ngiep watershed area is about 8,690 hectares or 6.43% of total Nam Ngiep watershed area.

Mammal species that may be impacted include the Asian wild dog, Asiatic elephant, Sunda pangolin, Northern white-cheeked gibbon, Tiger, Fishing cat, Red-shanked langur, Phraye's leaf monkey, Binturong, Guar, Malayan sun bear, Stump-tailed macaque, Northern pig-tailed macaque, Clouded leopard, Bengal slow loris, Pygmy slow loris, marbled cat, Sambar deer, Himalayan black bear and Large spotted civet. The disturbance area is dominated by natural habitat in particular deciduous forest of which most of these species inhabit. The majority of the mammal species are highly mobile although home ranges vary and some resident populations may have home ranges contained within the HEP development areas.

The Impressed tortoise, Indo-Chinese spitting cobra and King cobra occupy a variety of natural and modified habitats. This fauna group is susceptible to mortality during construction, predation by introduced species as well as loss of forage resources. Habitat availability in the wider watershed is well represented.

Bird species that may be impacted include the White winged duck, green peafowl, the Rufous-necked hornbill and Imperial eagle. The white-winged duck is noted to prefer stagnant or slow-flowing wetland adjacent to evergreen, deciduous or swamp forest. The lentic habitat generated by the reservoir has potential to contribute some habitat values for the species. The Green peafowl is reported to occupy a variety of habitats including primary and secondary, tropical and subtropical, evergreen and deciduous forest types, mixed coniferous forest, swamp forest, open woodland, forest edge, bamboo, grasslands, savannah, scrub and farmland edge.

Fauna Mortality

Fauna mortality can occur during vegetation clearing activities for the reservoirs of HEPs and the mine area of mining developments in the event individuals are struck by vehicles and machinery. Animals that are unable to disperse during clearing activities are vulnerable to being injured or destroyed through interaction with machinery or falling debris.

It is likely that most individuals will disperse from clearing locations into adjacent habitats however some less mobile species may experience a localized reduction in abundance during this period, such as amphibians, reptiles and small mammals.

6.1.2 Impacts from Mining Developments – Construction Phase

Since the existing and proposed mine concessions located in the Nam Ngiep watershed area where lies within the forest area, therefore significant impacts on vegetation are likely to include impacts on high biodiversity value and ecosystem of the Evergreen and Mixed Deciduous Forests, which covers a significant area with the mine footprints and refinery plants. Therefore, subjective descriptions of expected impacts are presented as follows.

Direct Impacts

The following direct impacts are likely as a result of mining developments within the Study area:

- The proposed mine areas and refinery areas including the wastewater treatment sites will result in the loss of forest resources and wildlife habitats including NTFPs, natural herbs and medicine.
- The clearance of forestland in the proposed mining area and refinery area including the conveyor belt right of way where are seen as the significance wildlife habitat, resulting in potential loss of habitat, local biodiversity and local resources (wild animals).
- Narrow wildlife habitats, wildlife trails and food-sources of wildlife and birds which will be affected some existing wildlife species that would be found within and around the mine concession areas.
- Clearance of vegetation will result in potential loss of habitat, local biodiversity and local resources (NTFPs).
- Physical risks posed to birdlife and other fauna during construction phase.

Indirect Impacts

Indirect impacts that are likely as a result of mining activities within the Study Area include:

- Increase pressure on the ecology resources in the remaining vicinity forest around and nearby the mine concession area.
- Increased pressure on ecological resources due to in-migration to the area caused by stimulation of the local economy.

- Increased exploitation of ecological resources by the local community and working community due to improved access provided by the Projects.

- Increased destroying natural habitat and hunting pressure in the resettlement areas and nearby.

Major expected impacts are noise, dust and vibration disturbance to wildlife and birds caused by construction activities of mine and refinery plant. The main impact is likely to be some short-term migration of noise-sensitive wildlife away from the source of noise, resulting in much-localized decrease in numbers of some species around active areas. For the example, owls, flying squirrels and bat colonies are particularly affected by the introduction of night time noise and vibration.

Major direct impact is the increased hazard from the construction workforce that will generate the degradation of Nam Ngiep watershed area. Also, mining and refinery plant construction activities, such as the introduction of people and goods from the outside, could result in the introduction of non-native plants pose a threat to the biological diversity of the region by competing with native species and affecting natural processes such as plant community succession. Wildlife hunting activities will be increased by the construction workforce of mine and refinery plant areas resulting in the decreasing amount of wildlife in the Nam Ngiep watershed area.

6.1.3 HEP Developments - Impacts during Operation Phase

Permanent Disturbance to Fauna Behaviors

Expected impacts are the disturbance and displacement of resident fauna due to noise and light as a result of the operation facilities (power plants, offices and resettlement area).

Noise and light disturbances have the potential to influence fauna breeding, roosting or foraging behaviour. The consequences of these influences are dependent on the extent of disturbance but in extreme cases these factors can influence local populations.

Excessive noise can impede fauna communication and deter the use of habitats nearby. Similarly, introducing light sources has the potential to deter foraging and dispersal activities of nocturnal species.

The requirement for permanent lighting and noise influences will be focussed at the power plants, offices and the resettlement area and the habitats that may be impacted are common and widespread within the region. This impact will be localised hence unlikely to impact the viability/function of adjacent habitats.

Barrier to Movement and Habitat Fragmentation

Expected impact is the barrier to terrestrial fauna movement and habitat fragmentation. Regionally, the Nam Ngiep River currently plays a role in restricting movement of fauna in an east-west direction across the region however some movement by higher mobility species is likely to occur during the dry season especially when water levels are low and swimming distance is shorter. The inundation area of the dams will introduce a much wider water crossing that does not necessarily reduce during the dry season. In some areas the width may be too great for fauna movement to occur and as such the functionality of the corridor may be impacted.

The riparian corridor is likely to provide corridor values in the north-south direction. It is expected that fauna currently utilising the riparian zone as a movement corridor will also be able to move along the vegetation adjacent to the inundation area.

Locally, the transmission line has potential to create a barrier to fauna movement however it is expected that the footprint will be restricted to the pylon footprint and the line will be suspended and as such the barrier to movement will be limited.

Degradation of Habitat

Invasive or alien species have the potential to be introduced or spread throughout the development areas through increased movement of people and vehicles. An increase in the prevalence of weeds or other pests has the potential to reduce the quality of habitat for some native flora and fauna, including threatened species. Invasive flora species can rapidly germinate in disturbed areas whereby affecting the ability of native vegetation communities to re-establish. Alien animals also have the potential to be introduced or increased in abundance. These animals may adversely impact native fauna as a result of increased competition for resources, predation or habitat degradation.

Vehicle movement and activities which introduce a risk of invasion will be focussed along access road.

HEPs components will include the storage and handling of hazardous materials, including refuelling. Accidental release or spill of these materials can be toxic to flora and fauna locally.

6.1.4 Mining Developments – Impacts during Operational Phase

Noise and vibration caused by mining activities and machine, particularly blasting can disturb wildlife and forest. These impacts will be long terms during the mining concession year. It should be noted that some main wildlife species that may be affected by the mine operation generally have large home

ranges that extend well beyond the mining areas. This expected impact should be examined in time of the availability of mining EIA reports.

Major direct impact is the increased hazard from the operation workforce that will generate the degradation of Nam Ngiep watershed area. Also, mining and refinery plant operation activities, such as the introduction of people and goods from the outside, could result in the introduction of non-native plants pose a threat to the biological diversity of the region by competing with native species and affecting natural processes such as plant community succession. Wildlife hunting activities will be increased by the operation workforce of mine and refinery plant areas resulting in the decreasing amount of wildlife in the Nam Ngiep watershed area.

6.1.5 Potential Impacts on Protected Areas

The NNP1 Project Area is not near any NPAs however it still does contain some important forests, including village conservation forests and special spirit pool forests at Namyouak, Sopyouak and Sopphuane Villages, Hom District and at Hatsaykham Village, Bolikhan District. These are on quite steep terrains, on lands relatively inaccessible to humans, allowing the vegetation to remain relatively intact and keeping the areas as viable sites for a number of species. These forests are at elevations above the flood level of the proposed reservoir of this Project (ERI 2012).

Figure 4.1 shows the NPAs relative to the regional setting of the Project Area. There are no NPAs in the NNP1 Project watershed. Two NPAs occur near the Nam Ngiep River channel downstream from the NNP1 Project area: Huay Ngua Provincial Protected Area (PPA) and Phou Ngou PPA.

- Huay Ngua PPA: Located approximately 8 km downstream of the NNP1 Project and is 5435 ha in area.

- Phou Ngou PPA: Located approximately 11 km downstream of the NNP1 Project and is 6610 ha in area. Phou Ngou PPA is a narrow, elongated shape that follows a ridge line running north-west to south-east and contains no major watercourses or lakes

Also, the IEE (2012) for the NNP1 Project describes wildlife conditions along the proposed transmission line routes. The field survey and comments from the villagers' interviews revealed that the only significant remaining wildlife habitats near the transmission line routes are on the steep inaccessible areas of Nam Ngiep and in the Phou Khao Khouay NPA to the west of the Nam Ngiep River and the parallel transmission lines, and then to the north of the 230 kV transmission line, quite distant from the Project Area. Wildlife in the Project Area, including areas near the transmission line alignments, has been hunted extensively, so much so that the majority of all significant wildlife species have either been eliminated or they have retreated to the comparative safety afforded by the higher and comparatively inaccessible habitats (more than a day's walk from settlements) of the highlands and the NPA (IEE 2012).

For NNP2 HEP Project, the EIA report (2010) specified that NNP2 does not contain any form of existing protected areas or forests of any kind hence impose no thread to NPA or protected areas or forests in this region.

For Nam Phouan HEP, the Environmental and Social Impact Assessment (ESIA) (Velcan and Lem 2012) indicated that the proposed reservoir area contains virtually nothing of biodiversity conservation value and claims in support of this conclusion the fact that neither the proposed inundation area nor any surrounding area has been proposed as a NPA.

It can be summarized that none of protected area will be impacted from NNP1, NNP2 and Nam Phouang HEPs.

6.2 VEC 2: AQUATIC BIODIVERSITY AND HABITATS

6.2.1 HEP Developments - Impacts during Construction Phase

Permanent Loss of Habitat

Expected impact is the permanent transition of lotic (flowing water) aquatic habitat to lentic (still water) aquatic habitat. The Nam Ngiep River is a flowing system that varies seasonally with rainfall in the watershed. Installation of the dam will transition the currently lotic habitats in the reservoir area to lentic habitats. This change in character changes the ecosystem process of the aquatic habitat and in turn the suitability of the area for some native species.

The baseline assessment identified a diversity of aquatic biota that utilise the main river and tributary habitats for the watershed for both foraging and breeding. The community includes species that migrate upstream for spawning. Some species will adapt to the modified conditions however a number of the species detected during surveys are migratory, requiring movement within the watershed for spawning.

The big headed turtle would utilise some areas of aquatic habitat within the Project area. Little is known about the population of the species however preferred habitat includes narrow fast flowing, cool, rocky mountain brooks and streams. The lotic habitat created by the Project is not likely to be suitable and individuals would be required to relocate to upstream or downstream tributary habitat areas.

The Giant barb, leaping barb, Striped catfish, Yellow tail barb and Thicklipped barb are also found in the aquatic habitats of the HEP development areas. A number of these species will not persist in impoundment waters, as such this habitat area will be permanently lost for the species.

The Asian small-clawed otter, smooth coated otter inhabit a variety of habitats through seem to prefer slower flowing and shallower areas. The lentic habitat generated by the reservoir has potential to contribute some habitat values for the species.

The Snail-eating turtle and Siamese temple turtle are species reported to prefer slower flowing habitats with aquatic vegetation. The lentic habitat generated by the reservoir has potential to contribute some habitat values for the species.

Fish Species Profile Report: *Luciocyprynus Striolatus* (ERM, 2014) specifies that this endangered fish species according to IUCN's Red List of threatened species, are also threats associated with the hydropower infrastructure upstream (Nam Ngiep 2 Hydro Scheme) of NNP1 that may also impact other spawning areas that may occur, though the extent of these effects is unknown.

Approximately 73 km of the Nam Ngiep River will be inundated and the existing lotic habitat will be transitioned to lentic habitat (within the inundation area). The habitat within FSL includes two known spawning areas. Village interviews identified six spawning areas upstream of the FSL and suggest it is likely others would occur. Two are currently known to be within designated fish conservation pools. The interviews also reported the species to occur in the Nam Siam and Nam Chain tributaries of the Nam Ngiep watershed which are unlikely to be impacted by the NNP1 Project. It also indicates that spawning habitat is characterised to be shallow, flowing and pebble, gravel or sand. As such inundation is likely to transition these areas to deeper water not necessarily suitable for spawning.

Impact to a breeding area has potential to lead to an adverse impact to the population by limiting opportunity for reproduction and thus survival of the population. Current information indicates a limited number of populations are known across the species distribution and as such loss of a population in conjunction with threats to other populations may have severe impacts to the survival of the species.

Similarly, the water flow barrier leads to an alteration in the hydrological pattern and volume to downstream. This is likely to include an increase in dry-season discharge, reduction in discharge at the beginning of the wet season and potentially daily fluctuations of discharge. Specific to the Nam Ngiep population, the discharge from the NNP2 project and NNP3, located upstream of the spawning locations identified, may already threaten the downstream habitat. Daily fluctuation in water level is a well-known cause of destruction of fish habitat, especially spawning sites (Kottelat 2014). Eggs attached to vegetation or deposited in sand/gravel (as observed for *L. striolatus*) become exposed and die within a few minutes. The extent of this potential impact is unknown with additional detail regarding the wet-season condition of the spawning sites and the planned discharge from NNP2. The testing phase of NNP2 also presents a threat to the habitats within the Nam Ngiep with the short but potentially intense discharge flows. These threats are likely to be associated with all dam installations in *L. striolatus* inhabited rivers.

Degradation of Habitat

Turbidity in the Nam Ngiep River water as a result from construction activities could be expected. High sediment can cause reduction or dead of benthic fauna. These are due to many construction activities including site clearing, earthworks, soil levelling, transportation of forestry products, heavy equipment, construction of temporary office, housing and storage causing soil dispersion from surface run-off leading to turbidity of Nam Ngiep River water. High turbid water, as a consequence, reduce light to penetrate into the water and thus rate of photosynthesis in aquatic plants and phytoplankton decrease. As a result, chlorophyll could change to pheophytin and dissolved oxygen declines while carbon dioxide increases. Such phenomenon may cause proper natural fertility. Since, fish can swim, there would be no negative impact on them, if any, it will be low. Besides, inappropriate management of solid and wastewater from construction activities may lead to even worse foul water.

Fish eggs also have negative impact by small particles in the water. This may block the exchange of nitrogenous gas and oxygen during respiration resulting in abnormality or no hatching.

Another expected impact is the accidental release of hazardous substances stored or used during construction phase. HEPs components include the storage and handling of hazardous materials, including refuelling. Accidental release or spill of these materials can be toxic to flora and fauna downstream if substances are released into the aquatic environment. The Nam Ngiep River experiences substantial flows and as such it is likely that an accidental spill can be diluted such that impacts are localised however the watershed provides habitat for nationally and globally listed species.

6.2.2 *Mining Developments – Impacts during Construction Phase*

Expected impact will be the increased pressure on aquatic resource (fishing and collection of aquatic resources) due to the in-migration and increased population during the construction phase. The in-migration of temporary work during the construction phase is likely to increase the demand for fish and aquatic resources. If not managed properly, this could place additional pressure on these resources.

Expected impacts during construction phase will be as follows;

- Increased turbidity and sedimentation resulting from erosion and sediment transport. Research has suggested that in altered conditions, aquatic organisms are sensitive to sediment regime that exceeds the natural background range of tolerance (Zhong and Power, 1996). One possible impact on aquatic fauna and fisheries comes from the potentials of toxic metals (e.g. mercury, zinc, chromium, lead) which may become liberated from overburden material following vegetation

clearance during the exploration, especially during the rainy season (Deshpande, 2003).

- Water pollution resulting from accidental release of hazardous material, discharge of sewage and greywater and contamination of silt run-off.

6.2.3 HEP Developments - Impacts during Operation Phase

Barrier to Movement and Habitat Fragmentation

Installation of the dam will introduce a barrier to water flows and flushing, and biota movement not previously experience in the region of the watershed. Fish migration is an important component for many fish species life cycle and the barrier that the dam wall creates will limit spawning area for a number of species known to occur in the Nam Ngiep River (including threatened species). An impact to breeding area availability has potential to influence native fish populations at the downstream of the Nam Ngiep River.

Hydropower and other dam development result in physical blockage of up- and downstream fish movement. *L. striolatus* is not a long-distance migrator however is expected to move within watersheds to access feeding and spawning habitat areas. The barrier induced by dam infrastructure has potential to limit natural movements and interrupt reproductive behaviours.

Overall the dam infrastructure will reduce the area of waterway available for spawning within the watershed.

Degradation of Habitat

Expected impact is the accidental release of hazardous substances stored or used during operation phase. The HEPs components include the storage and handling of hazardous materials, including refuelling. Accidental release or spill of these materials can be toxic to flora and fauna downstream if substances are released into the aquatic environment. The Nam Ngiep River experiences substantial flows and as such it is likely that an accidental spill can be diluted such that impacts are localised however the watershed provides habitat for nationally and globally listed species.

6.2.4 Mining Developments – Impacts during Operational Phase

Fauna Impacts

Expected impact is the interruption of fish movement from the raw water intake dams and creation of the slime pond. Dams can also create a barrier to fish migration, which plays a crucial role in many life history aspects (spawning, dispersal, feeding, etc.) of numerous species in the region (Paulsen *et al.*, 2002; Baran, 2006).

Degradation of Habitat

Expected impacts are presented as follows;

- Increased turbidity and sedimentation resulting from erosion and sediment transport from the mining activities. Research has suggested that in altered conditions, aquatic organisms are sensitive to sediment regime that exceeds the natural background range of tolerance (Zhong and Power, 1996). One possible impact on aquatic fauna and fisheries comes from the potentials of toxic metals (e.g. mercury, zinc, chromium, lead) which may become liberated from overburden material following mine development process, especially during the rainy season (Deshpande, 2003). Ferric and aluminium hydroxides, for example, can decrease oxygen availability as they form; the precipitate may coat gills and body surfaces, smother eggs, and cover the stream bottom, filling in cervices in rocks, and making the substrate unstable and unfit habitation by benthic organisms.

- Water pollution resulting from accidental release of hazardous material, discharge if sewage and greywater and contamination of silt run-off. According to the results of previous study (acero, 1997), for example, it was found that in the processing process, fluoride emission from the smelter may cause impact to the aquatic ecosystem especially those sensitive species. In addition, uncontrolled waste and/or spill of hazardous material or seepage can also impact, moreover, damage to aquatic animals as well as aquatic ecosystem.

6.3 VEC 3: RIVER FLOWS AND WATER QUALITY

6.3.1 Impacts from HEPs Developments – Construction Phase

River flows into and from the HEP developments will be a major environmental impact during construction phases. With the construction of the dams, the dam-reservoir systems regulate the flood discharge during the wet seasons and increase the flow rates during the dry seasons, so that the seasonal flow regime shows less fluctuation over the year. Averaged daily and monthly flow fluctuations are also likely to be less evident after the regulation. At the weekly and hourly operation levels, flow hydrologic regime will vary dependent on the regulation of water discharged from the power houses of the dams.

No other HEPs are known to have set environmental flows or reregulation dam facilities to re-regulate downstream water flow to limit impacts within the Nam Ngiep Watershed. HEPs without re-regulation facilities are likely to see drying out and major impacts to downstream aquatic environments during construction. Barriers to movement of migratory fish species, damages to spawning habitat and other important habitat requirements for aquatic biota is likely. This is likely to include endemic and EN fish such as *L.*

striolatus. Water quality impacts from river diversions and tunnels, sediment and erosion impacts are likely if not appropriately engineered and managed.

6.3.2 *Impacts from HEP Developments – Operational Phase*

Change to Flows to Receiving Environment

Data on the current flow rates at the location of five of the seven proposed HEPs are unavailable. The changes that these five proposed HEPs might cause to the flows of the rivers on which they are proposed is not known.

For NNP1, the current average annual inflow is 148.4 m^3/s (ranging between 200-325 m^3/s in the period June-September and 50-75 m^3/s in February to April). The re-regulation dam will release a minimum dry season flow of 27 m^3/s during the dry season and wet season inflows will equal outflows after dam is at capacity (expected to take one year) as flood water will overflow over the dam walls. There will be a period of one year after construction that the maximum flow will be 5.5 m^3/s during which time the reservoirs will be filling. Data on the impact that NNP2 will have on flow rates in unknown.

The proposed HEP on the Nam Phouan River will result in a reduction of flows from the current 29 m^3/s to 0.5 m^3/s (Velcan and Lem 2012). This Project involves diverting the water from the Nam Phouan to the Nam Om so that water from the Nam Phouan will flow into the Nam Om at a maximum flow rate of 35 m^3/s (Velcan and Lem 2012). The water will flow out directly into the reservoir of the NNP1 main dam should it be completed.

A change in flows downstream from any of the proposed HEPs has the potential to influence downstream aquatic biota populations that are currently adapted to the seasonal cycle of wet and dry season flow volumes and peaks. For the largest of the proposed HEPs (NNP1), environmental flows assessment identified that annually, inflow and outflow regimes during operation of the Project will be the same as current. For NNP1 the regulation design will regulate the flood discharge during the wet season and increase the dry season flow rates, though the seasonal flow regime shows less fluctuation over the year. The peaks in daily and monthly flow fluctuations are less evident however are modelled to replicate the existing cycle prior to dam construction. Species downstream of the proposed NNP1 re-regulation dam that are adapted to a large inter-seasonal fluctuation in the flow rates may be negatively impacted by the alteration of the flow rates to a more consistent inter-seasonal flow.

Within the impoundment, water quality is likely to change, in particular relating to dissolved oxygen, temperature and as a result of reduced flushing, nutrient levels. The effect of impoundment on the growth of plankton and benthos will be high due to organic loading in the first year of the reservoir impoundment. There is potential for a positive impact within the reservoir forage resources for fish increases. Conversely, the physio chemical

characteristics of the water may impact downstream environments as the regulated releases occur. Releasing low oxygen water has potential to lead to fish kills and reduced productivity downstream of the dams.

Downstream of the Nam Ngiep River, the fishery resource is an important source of food and the chief source of protein for the villagers. The effect of changes in water quality within and downstream of the dams may impact the fish populations locally however the reservoir areas may provide habitat for populations of species adapted to no flow environments.

6.3.3 VEC 4: Ecosystem Services

Known or Suspected Impacts by the Project and RFFAs

The main reservoir of the NNP1 Project will cover parts of Xaysomboun, Vientiane and Xieng Khouang provinces, with a surface area of 67.98 km² when at full supply level of EL320 m (ERI 2012).

Apart from the loss of timber species, the submerged forest will reduce the total availability of NTFPs, but only to a relatively minor extent at the watershed scale (ERI 2012). Some of the high value NTFPs (including medicinal plants, fruits, material, value for animals and conservation) that will be affected include medicinal plants or herbs such as cardamom *(Amomum xathioides)*, Beberin *(Coscinium fenestratum)*, *Neolourya pierrei, Ziziphus attopoensus,* while others are used as food, such as mushrooms, bamboo shoots, wild vegetables, and wild fruits (ERI 2012).

It is reasonable to assume that infrastructure development such as what will occur for the Project would increase human settlement and therefore an expansion of agriculture will likely occur, potentially at the expense of remaining forest types in the lowland areas thereby potentially removing some of the little remaining (although degraded) forest around the Project Area. There will be an increase in accessibility of the more distant forest areas at the upper reaches of the watershed due to the reservoir creation as it will provide easier access for people to reach these areas which could potentially lead to an increase in human use of the ecosystem services in these formally remote and less anthropogenically impacted forest areas (i.e. hunting, poaching and logging). These factors could lead to a diminution of the availability of ecosystem services.

NCC EAT (2010) presents a discussion of potential impacts on ecosystem services from the proposed Project. Those include:

- Increased fishing by construction workers;
- Potential increases in illegal fishing methods; and
- An anticipated increase in fish abundance in the reservoir providing people with more protein in their diets.

NCC EAT (2010) presents no discussion of the cumulative impacts of the NNP2 HEP in their EIA.

The environmental impacts assessment report for the Nam Phouan HEP (Velcan and Lem 2012) identifies the NTFPs of general importance in Laos and in the study area identifying as 'very important' for subsistence the following: wildlife/fish, rattan, bamboo, medicinal plants and spices, honey, vegetables, mushrooms and tubers. The investigations identify NTFPs in the proposed inundation area that are at 'exploitable densities' as *Bambusa arundinacea, Calamus spp., mushrooms, Amomum spp., Tea chinensis and Nothaphoebe umbelliflora*. The report identifies some valuable NTFPs to the economies of many local households are wild fish, rattan, mushroom and bamboo shoots.

Velcan and Lem (2012) identify the indirect impacts of human exploitation of wildlife as being the major potential threat to local terrestrial animals of the Project area. It identified the potential impacts of exploitation as 'potentially unsustainable' unless adequate wildlife protection measures are put in place.

Velcan and Lem (2012) claims some positive impacts to the ecology of the local area from the proposed Project are the increase in controlling illegal logging and animal exploitation, potential community education programs regarding sustainable use of resources and benefits in ecological understanding of the local wildlife through increased monitoring. Although Velcan and Lem (2012) also identify that a potential negative impact could be the increased access for hunters.

Summary

The HEPs across the NNP1 watershed are expected to provide an improved quality of life for people living in settlements to which the generated electricity will be distributed. It is expected that if all of the seven proposed HEPs in the area are constructed, the improvements to quality of life will be rather widespread. It is expected that these improved living conditions in settlements will lead to population increases which will in turn lead to increased pressure on the ecosystem services of the surrounding areas as people will look to gather resources from surrounding forest areas.

It is likely that in general, an increase in human populations and both terrestrial and aquatic resource use will have a negative impact on species and populations through a predicted increase in hunting. There could potentially be a positive impact for local human populations around the created reservoirs if fish abundance increases in the reservoirs due to the creation of large water bodies and large expansion of semi-lacustrine environments. This increase in fish abundance will likely occur in species adapted to the semi-lacustrine environments with a decline in the number of species that require the lotic water to complete their life cycle.

In the short term (1-5 years) it is anticipated that people living in nearby settlements will realise the improved transport infrastructure (i.e. new roads

and a water reservoir) will provide increased opportunity to access previously inaccessible areas of forest for gathering non-timber forest products and illegal logging.

There is a potential that in the medium term (10-15 years) the realisation of the benefits of improved transport infrastructure, increased water supply and electricity infrastructure may lead to the expansion of commercial industries such as forestry, mining and potentially large-scale agriculture. These industries are reliant on ecosystem services such as soil regulation, water regulation and pollination vectors. An increase in commercial ventures such as these will potentially attract more human settlement in the region which will further increase the pressure on non-timber forest products.

Known Cumulative Impact Issues in the Region

Forest products, especially NTFPs, play an important role in the rural economy of the Project Area and Lao PDR as they provide animal protein, calories, vitamins and dietary fibre, materials for house and handicraft production, traditional medicines, and cash income (from the sale of NTFPs). Although there is still considerable animal hunting in the country (most villagers depend on hunting for part of their diet), the relative abundance of forest habitat and, in some cases, its considerable distance from human settlements and inaccessibility have provided some protection for the country's wildlife. However, human population and development pressures are increasing, especially since 1990, and consequently the wildlife population has declined dramatically throughout the country due to hunting pressure exerted by human populations (ERI 2012).

Based on a field survey and interviews with local residents undertaken for the EIA (ERI 2012), it is apparent that the only significant remaining wildlife habitats are in the forested areas on the steep upper slopes or in the still abundant forests outside the Project Area. Whatever remaining wildlife found in the Project Area lives mostly in the higher elevations, and these have been and are still being indiscriminately and extensively hunted and captured (ERI 2012). There are still some wildlife habitats, though not as significant, within the proposed reservoir area where the mixed deciduous forest still remains. In the other more accessible lower and less steep slopes, the forests have been destroyed by indiscriminate logging, bush fires, and shifting cultivation, and the wildlife and their habitats there have also been severely disturbed (ERI 2012).

The land is a medley of vegetation communities, with local agricultural practices (shifting cultivation, i.e. converting forested land into agricultural land) that have heavily impacted on forest tree species composition and maturity (ERI 2012). This in combination with burning forests for hunting and illegal logging has removed much of the original forest which has led to a diminution of the availability of NTFPs and placed further pressure on the remaining areas of forest and NTFPs (ERI 2012).

Consultation to supplement the biodiversity surveys (ERM 2013b) occurred as market surveys (where researchers observed what was available for sale at local markets) in 2012/3 and interviews at the focus group level and in-depth interviews. These occurred in both the impact area (Nam Ngiep watershed) and the proposed resettlement area (Nam Xan). The results found that with regard to Ecosystem Services it is evident that villagers in the Project area regularly use local terrestrial and aquatic biodiversity – e.g. as a food source. However, the dependence on natural resources varies by village and is largely associated with accessibility. For example, remote villages tend to rely more heavily on medicinal plants as access to pharmaceuticals is limited.

Under subheadings following is discussion of the uses and cultural values placed on (and/ or associated with) biodiversity by local villagers in the Project area. Much of the data is from village and market surveys undertaken by ERM in February and March 2013.

Hunting and Gathering

Villagers, both Lao and Hmong people, hunt and gather. This is done primarily for household consumption. However, when surplus exists, it is sold within the village or neighbouring villages.

Although the norm is to consume the materials locally, there are a small number of species that are collected for sale. Access to markets from villages is limited due poor road access, so external sales are to intermediaries who travel to the villages.

Hunting for small animals is common across all villages. Villagers rarely admitted to hunting larger animals as all were aware this is illegal. Bamboo traps are predominantly used for capturing squirrels and rats, though hunting dogs, firearms and knives are also reportedly used.

Hmong families tend to hunt together while lowland Lao hunt individually or in small groups of either men or women. Hunting activity is no longer a daily activity, and is only triggered when a change from chicken or fish is desired or a ceremony requires it (i.e. a wedding or Hmong New Year). Villagers will generally travel as far as the need to hunt and gather though based on survey data this is unlikely to be further than 3-5 kilometres from the village (i.e. walking distance).

Villagers have noted that availability of naturally occurring resources, especially forest animals and fish, has been declining in recent years.

Medicinal Plants and Materials

Usage, and therefore dependence, appears to be predicated on access to health services - the easier the access to pharmaceuticals, the lower the usage of natural medicines. In the Project area, villages have indicated a preference for

pharmaceuticals but said natural medicines were generally used in the first instance.

Timber Products

Timber products are actively sourced from the forests by villagers and commeCIAl operators. For instance the local villagers were observed sourcing and processing hardwood into planks near the proposed dam site.

Illegal logging within the watershed has been reported as occurring by both government and local officials. The extent of the impact has not been quantified and is only anecdotal. Based on various field trips by ERM and sub-contractors, the extent of illegal logging in the watershed is substantial. This included observations of logging contractors removing timber in the upper and lower parts of the watershed. The illegal logging may be complicit with involvement of local villagers. The extent of illegal logging may impact on the ability of locals to access ecosystem services in the future.

Fishing

When compared to hunting, fishing occurs on a more regular basis. This is largely because of the close proximity of villages to waterways.

Fishing may have been more important for income generation in earlier times though with greater availability of alternative protein sources and reported reduction in stock availability and size, villages have adapted. Fish is generally caught only for household consumption, but it is also a common item used in inter-household exchange and transactions. Surplus fish tends to be sold at below market rates suggesting such transactions may more likely be part of a local gift economy rather than a commercial transaction. This being said, it was common to hear that small fish are eaten at home while big fish, when found, are sold.

The most common fishing method is with a cast weighted net, an item commonly seen in most houses. Larger nets are used during the rainy season to catch larger fish that swim up river from the Mekong River. At Hatsaykham, the survey team observed other methods such as scaring fish into a net hung across a short section of the river and gathering by hand. Other equipment observed in villages included lines, hooks and spear guns. Fishing takes place at established riverside sites at which small shelters are built.

Cultural Services

Most of the villages surveyed in the Project area have been settled only relatively recently signalling a lesser dependence on cultural services provided within proximate ecosystems. While length of residence is not an exclusive factor in determining usage and dependence, the less time people have to form attachments to aspects of an ecosystem, the less significant these

features are likely to be. Indeed the relatively new nature of the villages acts to sever any bonds that people may have with prehistoric features within the environment such as tangible objects (i.e. stone tools, brass or ceramic objects) and intangible knowledge (i.e. creation myths or site specific rituals). This is not to say that the cultural values villagers derive from the ecosystem are insignificant, it is to signal that what values they do use are likely severable and reproducible elsewhere.

Numerous locally collected polished stone tools have been found in the Project area indicating human occupation in the area occurred between 4,000 and 12,000 years ago. However, most of the existing villages were settled in the early-1980s and 1990s.

The most significant social, religious and cultural sites people were able to identify (during the surveys) in villages in the Project area were grave sites. Reflecting the severable nature of connections people have with grave sites, villagers indicated that the ancestor spirits associated with such grave sites are transferrable to a new location through the performance of a complex ceremony conducted by the village shaman (called a Yao in the surveyed villages).

Each of the Hmong villages visited in the lower reservoir zone had a shaman residing there. Each house has a small shrine that is used by the shaman for ceremonies. The shaman is essentially a conduit between the human and spirit worlds. Sickness among Hmong is believed to be the result of contact with evil spirits. At risk of overgeneralising, the shaman's role is to free a person's spirit (or soul) from the malevolence brought through this contact with spirit world. The shaman was identified in these villages as the person most dependent on the naturally occurring forest though little detail was able to be collected about the extent of this dependence. Naturally occurring bamboo is used by both Lao and Hmong to make an animist symbol that is hung above doorways to ward off evil spirits.

6.4 *ANALYSIS OF IMPACTS OF RFFAS ON VECS*

Table 6.3 analyses likely impacts from VECs from RFFAs. This analysis uses information from the current condition of the watershed and considers the scenarios based on the relative impact of the VECs.

The assessment is constrained due to the lack of quantitative data available on the impacts of RFFAs within the watershed. The impact assessment has focussed on the likely impacts on VECs from HEPs, forestry and agriculture and villages and settlements.

Summaries of the estimated likely impacts and production values for the RFFAs are outlined below. The data summaries provide an indication that significant economic development will occur in the watershed over the next 30 years. Of most likely impact will be from HEP and mining developments,

leading to a subsequent increase in economic indicators (electricity consumption, GDP, traffic) within the watershed. Agricultural production and forestry is likely to increase at a much less steady rate, indicating a slight decline in these industries within the watershed from their current dominance of economic activity.

6.4.1 HEP Developments

The summary of the estimated footprint from HEPs is outlined in ***Table 6.4*** from the present day to 2034. These figures do not include the HEPs currently being constructed and are yet operational.

Table 6.4 Summary of the estimated footprint from HEPs in the Nam Ngiep Watershed 2014 - 2030

Year	Electricity Generating Capacity (MW)	Total watershed Area (km^2)	Inundation Area (km^2)	New access road length (km)	Transmission line length (km)	No. of affected households		
						Inundation area	Access Road	T/L
2014	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2030	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

6.4.2 Mining Developments

Summary of the estimated production of minerals in the Nam Ngiep watershed between 2014 and 2034 is shown in ***Table 6.5***.

Table 6.5 Summary of the Estimated Change in Agricultural Yield 2014-2034

Type of Plantation Production	Year 2014 (Tonnes)	Year 2015 (Tonnes)	Year 2020 (Tonnes)	Year 2025 (Tonnes)	Year 2030 (Tonnes)
Total	**216,720**	**216,720**	**227,514**	**238,887**	**250,830**

6.4.3 Agriculture

Summary of the estimated agricultural yield changes from 2014 to 2034 is outlined *in* ***Table 6.6***.

Table 6.6 Summary of Estimated Mineral Production in the Nam Ngiep Watershed 2014-2034

Mineral	Production 2014	Estimated Total Production 2034
Cu	**0**	**Cu 1.297Mt**
Au	**0**	**2.2MOz/annum**
Fe	**0**	**Fe 2.58Mt/annum**
Tin	**0**	**Tin 9800ton/annum**
Coal	**0**	**5.31Mt/annum**

6.4.4 Forestry

Summary of the estimated forestry yield changes from 2014 to 2034 is outlined in ***Table 6.7***.

Table 6.7 Estimated Changes in Forestry Yield from 2014 to 2030

Year 2015 (Cubic metres)	Year 2020 (Cubic metres)	Year 2025 (Cubic metres)	Year 2030 (Cubic Metres)
28,740	**30,177**	**31,685**	**33,269**

6.4.5 Social and economic indicators 2014 – 2030

Estimated changes in traffic volumes, electricity consumption and GDP are outlined in ***Table 6.8***.

Table 6.8 Economic and Social Indicator Changes, 2014 - 2030

Data	2015	2020	2025	2030
Traffic Volume (vehicles/day)	366-790	590-1,273	950-2,050	1529-3,302
Population in Nam Ngiep Watershed	1,310,113	1,446,471	1,597,021	1,763,240
GDP Growth (%) [2)]	8.7	9.4	10.1	10.9
Electricity Consumption (billion kWh)	3.84	7.78	14.94	29.48

Table 6.9 Likely Impacts of RFFAs on VECs in the Nam Ngiep Watershed

Reasonably Foreseeable Future Actions	Valued Environmental and Social Components			
	VEC 1: Terrestrial biodiversity and habitats	**VEC 2: Aquatic biodiversity and habitats**	**VEC 3: Water quality and flows**	**VEC 4: Ecosystem services**
Hydro Power Projects	• Impacts to habitats across the watershed are estimated to be 201,500ha for all existing and proposed HEP Project footprints. • NNP1 is expected to remove less than 6% of the vegetation in the watershed, and NNP2 in 0.46% of the watershed. • NNP1 has designed a biodiversity offset program to offset impacts in relation to habitat loss. • CR and EN listed species are expected to be disturbed by clearing the forest, however this will be managed to achieve a no-net loss for the NNP1 Project. • Distribution and abundance of species within the watershed is likely through fragmentation of habitat and the creation of barriers to movement from HEP reservoirs across the watershed.	• Impacts for HEPs on migratory, endemic and listed EN fish within the watershed are likely, especially in the upper watershed. • Permanent barriers will be created on 7 HEP locations within the watershed, including 2 on the main channel. • Impacts on the movement of fish species within the watershed in the upper reaches and tributaries is likely to occur. • Assessment as part of the NNP1 Project indicated that no major migratory fish use the Nam Ngiep River for their life cycle. Some intra river migrations may however be impacted. • Cumulative impacts are likely on populations of *L striolatus* from NNP1 and NNP2 HEPs, including a reduction in the number of spawning sites and deep pools to support breeding for the species. • Watershed management activities associated with the NNP1 Project are likely to reduce significant impacts on L striolatus in the watershed between NNP1 and NNP2	• Appropriate environmental flow regimes that mimic natural flows to maintain biodiversity and ecosystem services will be maintained in the lower watershed by the NNP1 Project. • Environmental flow regimes are not planned in the upper watershed, leading to impacts on natural flow regimes from HEPs. • Water quality will likely be impacted from deoxygenated water discharges from HEPs • Potential impacts from eutrophication within shallow upstream reservoirs from HEPs may occur in the Upper watershed. • Reservoir water quality of HEPs in the lower Nam Ngiep may suffer from increases in sediment inflows from upstream activities.	• Employment opportunities are likely to increase the opportunities for locals to rely less on natural resources to supplement their incomes and diet, reducing pressure on natural resources. • Ecosystem services are likely to be damaged through impacts from biodiversity loss and inappropriate environmental flow regimes from implemented in Upper Nam Ngiep HEP developments • Impacts on fishing livelihoods and provision of clean water quality are likely to occur in the upper watershed from HEP developments through changed river flows. • Lower Nam Ngiep watershed is likely to maintain environmental flows contributing to the maintenance of ecosystem services in the lower portion of the watershed.

Reasonably Foreseeable Future Actions	Valued Environmental and Social Components			
	VEC 1: Terrestrial biodiversity and habitats	**VEC 2: Aquatic biodiversity and habitats**	**VEC 3: Water quality and flows**	**VEC 4: Ecosystem services**
Forestry & Agriculture	• Forestry activities will likely increase in the upper watershed due to increased accessibility, impacting on the habitats for species. • Forestry concessions issued may impact on the sustainable use of timber resources in the Upper watershed. • Illegal logging is likely to continue without proper controls in production and protection forests of the upper watershed. • Implementation of a biodiversity offset in the lower watershed will slow illegal forestry practices, including protection forest near the NNP1 Reservoir through the reclassification of the forests as a "total protection zone". • Agricultural expansion may increase especially slash and burn agriculture, plantations and seasonal cropping adjacent to reservoirs created for HEP developments. This will impact on terrestrial biodiversity values adjacent to these reservoirs.	• Agricultural developments are likely to be expanded through increased access to areas of the watershed, impacting on aquatic biodiversity from diffuse source water pollution. • Plantation timber, broad scale agriculture and slash and burn agriculture is likely to expose soil surfaces, leading to water quality impacts, especially in areas adjacent to HEP reservoirs. • Creation of the biodiversity offset for the NNP1 Project is likely to increase protection of habitats in the lower watershed, protecting water quality of the NNP1 reservoir. • Runoff from forestry activities in the upper watershed will likely impact on aquatic biodiversity values from polluted water runoff.	• Forest harvesting and plantation activities may impact on temporary water yield from forestry stands. • Illegal forestry operations are likely to impact the upper watershed through increased sedimentation and erosion; • Clearing of land for agricultural use along riparian areas of the upper catchment is likely to impact water quality through increased surface flows.	• Aquaculture activities may increase the availability of fish species within HEP reservoirs, providing a valuable source of protein for local villagers. • Collection of NTFP is likely impacted in illegally logged forest or forest subject to concessions.

Reasonably Foreseeable Future Actions	Valued Environmental and Social Components			
	VEC 1: Terrestrial biodiversity and habitats	**VEC 2: Aquatic biodiversity and habitats**	**VEC 3: Water quality and flows**	**VEC 4: Ecosystem services**
Villages and settlements	• Village consolidation allows regeneration of native vegetation at abandoned villages, leading to increased extent of habitat, and reducing hunting and harvesting pressures in the vicinity of abandoned villages. • Population growth exacerbates existing threats to terrestrial ecology, including increased hunting pressures and habitat removal. • Resettlement areas are created without management of NTFP collection, impacting on biodiversity within the watershed.	• Development of new and expanded settlements is undertaken in a way that avoids disturbance to aquatic habitats, including maintaining vegetated buffers to water bodies. • Fisheries management is supplemented with aquaculture to reduce reliance on natural fish stocks. • Construction of new and expanded settlements, and increased litter and chemical pollution from intensified settlement density, negatively impacts water quality and subsequently aquatic habitats. • Consolidation of villages increases fishing pressures to a level that threatens fish populations. • Unsustainable fisheries exploitation damages habitats from resettlement sites.	• Development of new and expanded settlements is undertaken with appropriate environmental management to minimise impacts to water quality and flows. • Social programs delivered by HEP and mining proponents supports improvement of wastewater treatment and storm water management. • Construction of new and expanded settlements and increased litter and surface pollution from intensified settlements negatively impacts water quality. • Water quality impacts from HEPs from water use or impacts on water quality on potable water supplies.	• Increased population density allows efficiencies in resource use, limiting the increase in demands on ecosystem services. • Increased population density at some settlements intensifies resource use to an unsustainable level, leading to shortages of provisioning resources. • Resettlement areas are not appropriately sited and allow access to forest areas, leading to unsustainable collection of NTFP.

6.5 *ISSUES ANALYSIS*

The CIA has identified a number of likely impacts on the environment that may occur due the development within the Nam Ngiep watershed. These impacts could be adequately controlled to protect the environment.

Primary likely impacts on VECs from RFFAs can be summarised to include:

- Impacts on river flows and water quality downstream of HEPs in the upper watershed;
- Land use conflicts within the watershed from competing development pressures allows inappropriate development to occur in sensitive areas;
- Biodiversity related impacts from all RFFAs through the loss of habitat; and
- Impacts on ecosystem services from the unsustainable use of natural resources by RFFAs and population pressures.

Management of these primary likely impacts is required. Actions by individual developments and GoL are necessary to adequately control these impacts through a coordinated approach across the watershed.

The NNP1 Project has prepared a comprehensive environmental assessment and has responded with a similarly comprehensive suite of mitigation and management measures, including biodiversity offsetting. These measures are not matched by other current and future RFFAs within the watershed.

In relation to biodiversity offsets, the achievement of no-net-loss on biodiversity values by the NNP1 Project enables a positive contribution to management within the watershed. Without a biodiversity offset, biodiversity values would be lost and not adequately compensated through management measures. It is likely that there would be an ongoing decline in biodiversity values within the watershed, including for species such as *L. striolatus* and the White Cheeked Gibbon. Conservation initiatives proposed for the biodiversity offset area will be aimed at ensuring the persistence of these species in the landscape.

This will contribute to the improvement in biodiversity values within the watershed, reducing the chances of further and continued loss of biological resources. The NNP1 Project can therefore be considered as positive to the biological environment in the longer term.

In relation to water quality and environmental flows, the lower watershed will be supplemented through the mitigation and management measures proposed by the NNP1 Project. Of particular note is the environmental flow regime

afforded by the re-regulation dam from the Project. This will enable sufficient environmental flows to be maintained downstream to assist in the protection of aquatic biodiversity values and ecosystem services in the lower watershed.

Recommendations to manage the primary likely impacts are discussed in *Section 7 Recommendations*.

7 RECOMMENDATIONS

To limit further cumulative impacts from development within the Nam Ngiep catchment, the following measures have been identified as necessary and are outlined in *Table 7.*1below.

Table 7.1 Recommendations for Management to Limit Cumulative Impacts

Action	Responsibility
Coordinated watershed management planning across government and involving development, community and government stakeholders to preserve natural resources within the watershed	GOL
Watershed management techniques should be implemented across. These techniques should focus landscape management planning and managing key threats to natural resources.	GOL - MONRE
Drinking water supplies are provided to local settlements where drinking water standards are not met by local sources	GOL - DESIA
Auditing and enforcement of relevant laws and regulations should occur to manage illegal activities, such as poaching, illegal logging, illegal landuses and activities and compliance of developments with Concession Agreements	GOL – MONRE; DESIA
Application of appropriate biodiversity assessments, including use of the mitigation hierarchy and the no-net-loss standard should be applied to all developments within the watershed	GOL, HEP, Mining and Road developments
Biodiversity offsets should be designed to offset the residual impacts on biodiversity values of projects. The outcome should be to restore degraded landscapes to protect threatened species and their habitats.	GOL - MONRE
Sediment and erosion control guidelines should be developed and applied to all land use activities in the watershed, including for road and infrastructure development, agriculture, forestry, mining and hydro power	GOL - MONRE
Resettlement plans should incorporate management of NTFP collection	GOL – MONRE; DESIA
Environmental flow regimes should be applied to call hydropower developments in the watershed through Concession Agreement Requirements, including the installation of re-regulation of downstream flows	GOL - MONRE
Sustainable forest management practices should be applied to all production forests in the watershed. This should occur through extension activities	GOL - DFRM
Sustainable agriculture management activities should be undertaken. Extension activities undertaken to improve agricultural management.	GOL - MONRE
Mine planning requirements should be outlined and incorporated to manage waste and wastewater discharge in the environment.	GOL - MONRE

REFERENCES

ADB (2009). **Safeguard Policy Statement**. Asian Development Bank Policy Paper.

China International Water and Electric Corporation (2012) **website** http://219.237.219.18/default.aspx

Council on Environmental Quality (CEQ) (2012) **Considering Cumulative Effects Under the National Environmental Policy Act**, January, 1997, Washington, D.C.

Environmental Research Institute (2012) **Nam Ngiep 1 Hydropower Project Environmental Impact Assessment Draft Report**, Prepared by Environmental Research Institute, Chulalongkorn University, 2012

ERM (2013a) **Nam Ngiep 1 Hydropower Project Biodiversity Assessment and Offsets: Initial Report** for KANSAI Electric Power Co., INC.

ERM (2013b) **Nam Ngiep 1 Hydropower Project Biodiversity Baseline Report** for KANSAI Electric Power Co., INC.

ERM Australia (2014) **Nam Ngiep 1 Hydropower Project Species Profile - *Luciocyprinus striolatus*** for KANSAI Electric Power Co., INC.

ERM-Siam, Co Ltd. (2013). **Nam Ngiep 1 Hydropower Project Resettlement Technical Review Final Report**. Prepared by ERM-Siam, Co Ltd. for the Kansai Electric Power Company Inc., May 2013.

ESSA & IFC 2012 (2012). **Good Practice Note - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets**. Jointly prepared by ESSA Technologies Ltd., Richmond Hill, ON and the International Finance Corporation – World Bank Group. [Washington, DC] [51] pp.

Hortle, K.G. and S.R. Bush, 2003. **Consumption in the Lower Mekong Basin as a Measure of Fish Yield.** In: New Approaches for the Improvement of Inland Capture Fishery Statistics in the Mekong Basin. FAO RAP Publication 2003/01, 145 pp.

ICEM (2003) **Lao PDR National Report on Protected Areas and Development: Review of Protected Areas and Development in the Lower Mekong River region**, International Centre for Environmental Management, Indooropilly, QLD, Australia

IEE (2012) **Nam Ngiep 1 Hydropower Project, Draft Initial Environmental Examination,** Prepared by The Kansai Electric Power Company, Inc., EGAT International Company, Ltd. And Lao Holding State Enterprise for the Asian Development Bank, January 2012

International Finance Corporation (IFC) World Bank Group (2012) **Performance Standards on Environmental and Social Sustainability**, January 2012, available from: www.ifc.org/sustainability

JACO CDM (2014). Validation Report on Nam Ngiep 3A Hydropower Project. Phongsubthavy Road & Bridge Construction Co., Ltd. 29th January 2014.

Kansai (2011). **Technical Report on Nam Ngiep 1 Hydropower Project (Draft)**. The Kansai Electric Power Co. Inc.

Kottelat, M, Baird, I.G., Kullander, S.O, Ng, H, Parenti, L.R., Rainboth, W, J. and Vidthayanon, C. 2008. Chapter 3. **The status and distribution of freshwater fishes of Indo-Burma**. In IUCN Red List The status and distribution of freshwater biodiversity in Indo-Burma compiled by D.J. Aleen, K.G. Smith and W.R.T Darwall.

Kottelat, M. 2011. *Luciocyprinus striolatus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org Download on 18 March 2014

Kottelat, M. 2014. **Survey of fishes in fast water habitat in Nam Ngiep 1 project area**. Prepared for Nam Ngiep Power Company.

Lao National Mekong Committee, 2004. **Report on the Outcomes of Studies and Analysis Carried Out in Sub-area 4L**. Published in April 2004.

Maunsell (2004). **Power System Development Plan for Lao PDR: Final Report, Volume C: Project Catalogue.** Prepared for Lao People's Democratic Republic, Ministry of Industry & Handicrafts, Department of Electricity and World Bank by Maunsell Limited 2004.

MCTPC, 2004. **Five years maintenance plan for Local Roads in Lao PDR for the years 2004/5 to 2008/9**, Department of Roads, LRD/LSRP2, revised March 2004.

Mekong River Commission (2011) **Planning Atlas of the Lower Mekong Watershed**, Mekong River Commission Basin Development Program

Mekong River Commission (2010) **State of the Basin Report 2010 Summary**, Mekong River Commission, Vientiane.

Ministry of Energy and Mines (2012) **List of Hydroelectric Projects in Lao PDR Available** at:

http://www.poweringprogress.org/index.php?option=com_jotloader&cid=10&Itemid=91

NCC Environmental Assessment Team (NCC EAT) (2010) **Nam Ngiep 2 Hydropower Project Final Environmental Impact Assessment Report**, Prepared by NCC Environmental Assessment Team, February 2010.

Nogales A., 2004. **Lao PDR: Transport Sector Brief**. Prepared for East Asia and Pacific Region Transport Sector Unit, May 2004.

NSC (2007). **National Statistics Centre of the Lao PDR**. Lao Department of Statistics.

http://www.nsc.gov.la/Products/Populationcensus2005/PopulationCensus2005_chapter1.htm

Poulsen, A.F., Hortle, K.G., Valbo-Jorgensen, J., Chan, S., Chhuoun, C.K., Viravong, S., Bouakhamvongsa, K., Suntornratana, U., Yoorang, N., Nguyen, T.T. and B.Q. Tran (2004). **Distribution and ecology of some important riverine fish species of the Mekong Watershed**. MRC Technical Paper No.10, Mekong River Commission, Phnom Penh. 116 pp.

Sriburi T., Kroutnoi L., Suntornvongsagul K., Rujiravanich S., and Mehl C.B. (2012). **Nam Ngiep 1 Hydropower Project Social Impact Assessment Report**, prepared for the Kansai Electric Power Company Inc. May 2012.

UNDP (2009) **Agrobiodiversity, Mainstreaming Biodiversity in Lao PDR's Agricultural and Land Management Policies, Plans and Programmes**, Fact Sheet 04/2009 ABD April 2009

US EPA (1999). **Consideration Of Cumulative Impacts In EPA Review of NEPA Documents**. United States of America Environmental Protection Agency (US EPA), Office of Federal Activities (2252A), May 1999.

USAID (2006). **Natural Resources Information Clearinghouse, Issues in Poverty Reduction and Natural Resource Management**. Washington, D.C.:

Vaidya K. and Tusanasorn P., 2004. **Review of Rural Road Maintenance in Lao PDR: Current Status, Issues and Options**, prepared for Local Roads Department, Ministry of Communication, Transport, Post and Construction. August 2004.

Velcan (2013). **Nam Phouan Hydro Project (Lao PDR): Major Steps Achieved**. Press Release, 2 May 2013.

http://www.velcanenergy.com/docs/2013/20130502PressReleaseVE.PDF

Velcan and Lem (2012). **Nam Phouan Hydropower Project: Environmental and Social Impact Assessment**, Prepared by Velcan Energy, and Lem Consultants, September 2012.

Vientiane Times (2012). **Hydro Plant to Power Rural Communities in Xieng Khuang**. Vientiane Times article: 7 June 2012.

Visser T. 2013. **Initial Assessment of Potential Fisheries Development in Nam Ngiep after Impoundment**, September 2013.

Warren, T. 2014a. **The status of *Luciocyprinus striolatus* populations within the Lao PDR's national boundaries outside of the Nam Ngiep watershed area**. Prepared for Nam Ngiep Power Company

Warren, T. 2014b. **Final Report Big Fish – *Luciocyprinus striolatus* (Pba Gooan Sai)** Study April 3 to 8 2014. Prepared for Nam Ngiep Power Company

Wikramanayake E, Dinerstein E, and Loucks C J (2002) **Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment** World Wildlife Fund, Washington, United States of America

World Bank, 2012. **Lao People's Democratic Republic Road Maintenance Project**, Report No. 1773-LA, Transport Sector Unit, East Asia and Pacific region, January 31st, 2012.

WWF, (2003a) **WWF Ecoregions**, Worldwide Fund for Nature. Available at http://www.worldwildlife.org/science/ecoregions.cfm

WWF, (2003b) **Luang Prabang montane rain forests** (IM0121), Worldwide Fund for Nature. Available at: http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im0121_full.html

ERM has over 100 offices across the following countries worldwide

Argentina
Australia
Belgium
Brazil
Canada
Chile
China
Colombia
France
Germany
Hong Kong
Hungary
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Korea
Malaysia
Mexico
The Netherlands
New Zealand
Panama
Peru
Poland
Portugal
Puerto Rico
Romania
Russia
Singapore
South Africa
Spain
Sweden
Taiwan
Thailand
United Arab Emirates
United Kingdom
United States
Venezuela
Vietnam

ERM's Bangkok Office

179 Bangkok City Tower
24th Floor, South Sathom Road
Tungmahamek, Sathorn
Bangkok 10120, Thailand
Tel: +66 2 679 5200
Fax: +66 2 679 5209

www.erm.com