Environmental Assessment of Hydropower: A Case Study of the Hewa-A Hydropower Project, Panchthar, Nepal

A Dissertation Submitted in Partial Fulfillments of the Requirements for Masters of Science in Environmental Science

Submitted to:

Tribhuvan University

Central Department of Environmental Science

Kirtipur, Kathmandu

Submitted by:

Bipeen Acharya

Roll No: 880

TU REGD NO: 5-1-37-513-99

May, 2009

Tribhuvan University

Institute of Science and Technology

Central Department of Environmental Science

Kirtipur, Kathmandu

Date: 6 April, 2009

LETTER OF RECOMMENDATION

This is to certify that the dissertation work entitled **"Environmental Assessment of Hydropower : A case study of Hewa-A Hydropower Project, Panchthar, Nepal"** submitted by *Mr.Bipeen Acharya* for the partial fulfillment of the requirement for the completion of Masters' Degree in Environmental Science has been carried out under our supervision and guidance. The entire work is based on the results of his research work and has not been submitted for any other degrees to the best of our knowledge.

I recommend this Dissertation work to be accepted as per the requirement of Central Department of Environmental Science, Tribhuvan University.

……

Supervisor

Mr Kuber Mani Nepal

Environmentalist,

Arun Valley Hydropower Development Company Limited.

Tribhuvan University

Institute of Science and Technology

Central Department of Environmental Science

Kirtipur, Kathmandu

APPROVAL

The Dissertation paper submitted by *Mr. Bipeen Acharya* entitled **"Environmental Assessment of Hydropower: A case study of Hewa-A Hydropower Project, Panchthar, Nepal"** has been accepted as a partial fulfillment of Master of Science in Environmental Science.

Expert Committee:

…… ……

Head of Department

Prof. Dr. Umakant Ray Yadav

Central Department of Environmental Science,

Tribhuvan University

……

External Examiner

Dr. Ram Bahadur Khadka

!

……

Supervisor

Mr. Kuber Mani Nepal

Arun Valley Hydropower Development

Company

Date of Examination: 6 May, 2009

DECLARATION

I, Bipeen Acharya hereby declare to the Dean of the Tribhuvan University (TU), Nepal that this is my original work and all sources of information used are duly acknowledged. This work has not been published or submitted elsewhere for academic award.

…….

Signature

Date: 6 April, 2008

Bipeen Acharya
Central Department of Environmental Science
Tribhuvan University, Kirtipur, Kathmandu, Nepal

ACKNOWLEDGEMENTS

This research entitled "**Environmental Assessment of Hydropower: A case study of Hewa-A hydropower Project, Panchthar, Nepal**" would have been a complex and difficult task and would not have come in is from if there had not been enough support, cooperation and guidance of different distinguished personnel.

My humble thanks go to Mr. Kuber Mani Nepal for his guidance and painstaking support throughout the study to shape my dissertation in this form.

Besides this, I would like to thanks our teacher Prof. Dr. Umakant Ray Yadav, Head of the Department of Environmental Science.

I would also like to thank our to lab boy Anju Thapa for her cooperation during the lab study and Umesh Dangal, Engineer, for his kind help in field study.

I wish to express my sincere thanks all my friends and local people of the project site, without their cooperation this study wouldn't have been completed.

Last but not the least; I would like to thank all those who have helped me in the preparation of this report.

My special thanks to Alliance Consults Private Limited for giving me financial support.

Bipeen Acharya

April 10, 2009

bipeen.acharya@gmail.com

Abstract

Although hydropower is very environmentally and economically sound project, it has effects on a local or regional scale. Present work addresses these issues and presents viable mitigation and enhancement measure for implementing such projects. Environmental impact assessment of Hewa-A on the physical, biological and socio-economic and cultural environment was done on the basis of baseline information of the project corridor from impact identification method (NPC, 1993). The predicted major and irreversible impacts of the project are: The project will require 3.92 ha of land permanently and 5.26 ha of land temporarily, and compensation should be given to the people for land acquisition. Clearance of 374 plant species from natural and private forests should reimburse by plantation of indigenous tree species (25 saplings per each tree loss). Creation of dewatered zone at 5 km stretch on dry months minimize by compensatory release of water by the project during the dryer months (10% of lean flow) 0.122m^3/s is expected to reduce the impact on aquatic life. An amount of 31.45 tones of standing crops losses by the implementation of project, cash compensation is proposed for the loss of standing crop. Royalty, job opportunities, infrastructure development such as road, transmission line, health post are the positive impact of the project. In EMP of Hewa- A, monitoring program, project management and cost of implementation of project management and monitoring is included.

Key Words

Hydropower, Environmental Assessment, Impact, Mitigation, EMP

Table of Contents

	Page No
Title Page	i
Letter of Recommendation	ii
Letter of Approval	iii
Acknowledgement	iv
Abstract	v
Table of Contents	vi
List of Tables	viii
List of Figures	viii
Abbreviations	ix

Chapter I

Introduction

1.1 Background	1
1.2 IEE and Small Hydropower	3
1.3 Rational of the Study	3
1.4 Objectives of the Study	4
1.5 Limitation of the Study	4

Chapter II

Project Description

2.1 Background	5
2.2 Salient Features	8

Chapter III

Literature Review

3.1. The Interim Constitution of Nepal 2007	11
3.2 Review of Strategy Plan/Policies	11
3.3 Relevant laws	13
3.4 National Environmental Guidelines	21
3.5 International Convention	24
3.6 Related Environmental Studies	25

Chapter IV

Materials and Method

4.1 Desk Study	28
4.2 Field Study	28

4.3 Laboratory Analysis 30
4.4 Data Processing and Analysis 30
4.5 Impact Identification and Prediction (Assessment) Method 31
4.6 Mitigation and Enhancement Measures 32

Chapter V

Baseline Information

5.1 Physical Environment 33
5.2 Biological Environment 40
5.3 Socioeconomic and Cultural Environment 43

Chapter VI

Result

1.1 Impact Identification and prediction 52
1.2 Mitigation and Enhancement Measures 65
1.3 Environmental management plan 76

Chapter VII

Discussion

7.1 Impact Identification and Mitigation measures 82
7.2 Environmental Management Plan 88

Chapter VII

Conclusion and Recommendation

8.1 Conclusion 89
8.2 Recommendation 90

References

Annexes

Photographs

List of Tables

Table 5.1 Grain Size distribution of the material 34
Table 5.2 Grain Size distribution of the material 35
Table 5.3 Grain Size distribution of the material 37
Table 5.4: Water Quality analysis of Hewa Khola 38
Table 5.5: Demography of the Project Affected VDCs 43
Table 5.6: Demography of PAFs 43
Table 5.7: Population PAFs by Age Group 44
Table 5.8: Population According to Caste 44
Table 5.9: Population According to Religion 44
Table 5.10: Distribution of Religion among PAFs 45
Table 5.11: Education Status of PAFs 45
Table 5.12: Occupational Distribution of PAFs 46
Table 5.13: Landholding by PAFs 46
Table 5.14: Source of Irrigation 46
Table 5.15: Agricultural Types and Productivity 47
Table 5.16: Food Sufficiency of PAFs. 47
Table 5.17 Main source of income of PAFs 48
Table 5.18: Average Livestock Holding of PAFs 48
Table 5.19: House with Different Number of Story 48
Table 5.20: Different Source of Fuelwood of PAFs for Cooking 49
Table 5.21: Social Service Facilities and their Distance from Project site 49
Table 5.22: Social Organizations on the Project Affected Area 50
Table: 6.1 Land Use of Hewa Khola Hydropower Project 53
Table 6.2: No of Tree Cut Down During Project Construction 57
Table 6.3: Projected Royalty Amount of the Project 65
Table 6.4: Details Breakdown of the Mitigation and Enhancement Costs 75
Table 6.5: Environmental Monitoring Plan 78
Table 6.6 List of Professional of Environmental Unit 81
Table 6.7: Annual Budgeting for Monitoring Activities 81

List of Figures

Figure 2.1 Location Map of the Studied Area 10
Figure 7.1: Comparison of Land Use in Hydropower Project 83
Figure 7.2: Capacity and Dewatering region of the Hydropower Project 85
Figure 7.3: No of Trees cutting during Hydropower Project Construction 86
Figure: 7.4 No of Employee in Hydropower Project 87
Figure 7.5: Loses of Standing Crops 88
Figure 7.6: Annual Energy Productions and Revenue of the Project 88

List of Abbreviation

AAPA :	Aquatic Animals Protection Act
AC:	Alternating Current
AD :	Anno Domini (Chrishtian Calander to show particular number of year)
ADB:	Asian Development Bank
amsl:	Average Mean Sea Level
ASWV :	Average Standing Wood Volume
BS :	Bikram Sambat (Nepali Calander to show particular number of Year)
CDO :	Chief District Office
CFUG:	Community Forest User Group
Ch :	Chainage
CITIES:	Convention on International Trade in Endangered Species
cm:	Centimeter
cumec:	Cubic Meter per Second
DAO :	District Administration Office
dbh:	Diameter at Breast Height
DDC :	District Development Committee
DFO :	District Forest Office
DHM :	Department of Hydrology and Meteorology
DoED :	Department of Electricity Development
DoF:	Department of Forest
EIA :	Environmental Impact Assessment
EMP :	Environment Management Plan
EPA :	Environment Protection Act
EPR :	Environment Protection Rules
GoN :	Government of Nepal
GWh :	Giga-Watt hour
H :	Height
ha :	Hectares
HEP :	Hydro-Electric Project
HHs :	Households
HMG :	His Majesty Government of Nepal
Hz :	Hertz
ICIMOD :	International Center for Integrated Mountain Development
IEE :	Initial Environmental Examination
IUCN :	International Union for the Conservation of Nature
Kg :	Kilogram
Km :	Kilometer
kV :	Kilo Volt
kVA :	Kilo Volt Ampere
kW :	Kilo-Watt

LRMP :	Land Resource Mapping Project
Ltd. :	Limited
Lx B x H :	Length x Breadth x Height
m :	Meter
m^3 :	Cubic Meter
MFSC :	Ministry of Forest and Soil Conservation
mm :	Milimeter
MoEST :	Ministry of Environment, Science and Technology
MOPE :	Ministry of Population and Environment
MOWR :	Ministry of Water Resources
Mt :	Metric-ton
MW :	Mega Watt
NCS :	National Conservation Strategy
NEA :	Nepal Electricity Authority
NEPAP :	Nepal Environmental Policy and Action Plan
No. :	Number
NPC :	National Planning Commission
NPWCA :	National Parks and Wildlife Conservation Act
NRs. :	Nepali Rupees
PAFs :	Project Affected Families
ppm :	Parts per Million
PRA :	Participatory Rural Appraisal
Pvt. :	private
Sp :	Species
Sq :	Square
SWCA :	Soil and Watershed Conservation Act
ToR :	Terms of References
V :	Volt
VDC :	Village Development Committee
% :	Percentage
˚C :	Degree Celsius

Chapter I

INTRODUCTION

1.1 Background

Before a hydropower project is undertaken, it is important to try to predict in what way the project is likely to affect the area and the people living in it, and to include actions in the project plan that will prevent, mitigate or compensate for negative impacts (Ames and Buetlkofer, 2003). An environmental impact assessment provides general information about the potential for adverse environmental impacts associated with a proposed development. An environmental impact assessment facilitates community planning by assisting local government officials, community leaders, and citizens. Environmental impact assessment is done by finding out impacts of the project and their mitigation measures. Impacts of project activities on the environment are identified, predicted and evaluated. Impact is primarily based on the quality of location-specific baseline information. Impacts also help in estimating future state of the environment "with" or "without" project. It would be of different nature-direct or indirect, reversible or irreversible, beneficial or adverse, and of different magnitude, extent and duration. Though the impacts are beneficial as well as adverse, mostly impact analyses are done for the negative impacts in order to the address of the problems (Duah, 1996). Mitigation measures are recommended actions to reduce, avoid or offset the potential adverse impact on environmental resulting from proposed activities of projects. The objectives of mitigation measures are to minimize and remove undesirable impacts and maximize project benefits. It aims to achieve both environmental and economic benefits (Khadka, 2002).

Environmental Impact Assessment (EIA) is a tool used for reducing negative environmental consequences of development activities and for promoting sustainable development (Lee and George, 2002). EIA is a process of identification, prediction and evaluation of a projects impact on the environment and is, essentially, an aid to the decision-makers responsible for planning (Brismar, 2003)**.** It could also be manipulated into a management tool for environmental sustainability so that a project will be both economically and environmentally sound (Hartley and Wood, 2005).

EIA is a management tool for studying and evaluating potential environmental consequences of proposed development projects in order to;

- Identifies potential environmental consequences,
- Examine the significance of the environmental implications,
- Assesses whether impacts can be mitigated, and if so,

- Recommend preventive and corrective measures
- Inform decision-makers and interested parties about the environmental implication,
- Advise whether proposed development projects should proceed (Khadka, 2002).

United States of America (USA) was the first country to assign mandatory status to EIA via national Environmental Policy Act (NEPA), 1969, since then the concept of Environmental Impact has spread throughout other countries (Gilpin, 1995). In Nepal, the need for EIA was stressed in the seventh fifth year plan (1985-1990) which required preparation of EIA for all major development projects related to the sectors of tourism, water resources, transportation, urbanization, agriculture, forestry and industry (GoN/IUCN, 1993, Uprety, 2003).

The incorporation of EIA in hydropower projects was initiated in the early eighties. The integration of EIA in hydropower projects in Nepal has now become compulsory with the enforcement of the (Environment Protection Act) (EPA) and Environment Protection Rules (EPR), 1997. Large scale hydropower projects were gaining attention for the integration of EIA prior to enforcement of EPR, but they were all initiatives from donor agencies. At present we have own national system of EIA. A large number of proposed and ongoing hydropower projects have already completed an EIA study. Some of them have been approved by the government agencies and some are in the process of implementation (DOED, 2002). In the Nepalese Initial Environmental Examinations (IEEs) and EIAs, no demarcation has been maintained between effects and methods and techniques i.e. they are synonymously. It would be appropriate to distinguish them and streamline at least in the project, level assessment (Uprety, 2003).

Hydroelectricity is generally considered a clean, environmentally friendly form of energy because there is no burning of fossil fuels that cause atmospheric pollution and there, none of the attendant waste disposal problem and unlike the thermal systems, there is no heat generation to contend with and no added dangers like those encountered in nuclear power plants (Subba, 2001). Water logging, land use change, displacement of people, resource use conflicts, effect upon natural, aquatic and riverine habitats, local climate change, ecological impacts, as well as erosion of and watershed disturbances are the environmental implication of hydropower projects. Similarly transmission and distribution of electricity projects may have implications upon human settlements, displacements of the people, and potential radiation impact on humans from the overhead high voltage lines (Joshi et. al., 2003). Environmental concerns of hydropower related to development and production stages rather than consumption. The severity of these concerns depends on the size, type and location of the hydropower projects- the bigger the project the greater will the environmental problem. Reservoir projects are likely to result in much higher environmental and social impacts than run-off the-river type projects. Many bigger hydropower projects around the world have

become environmentally and socially contentious and many have encountered unanticipated difficulties in the course of development or operation just like the Arun III hydropower project and the Kulekhani Reservoir project in Nepal (ADB/ICIMOD, 2006).

1.2 IEE and Small Hydropower

Projects in which the requirement for an EIA needs to ascertained, should be subjected to an Initial Environment Examination (IEE) (Khadka, 2002). IEE is carried out to determine whether potentially adverse environmental effects are significant or whether mitigation measures can be adopted to reduce or eliminate those adverse effects. IEE requires in depth analysis than applied in the screening procedure. IEE also involves more time and resources. It requires expert advice and technical input from environmental problems can be clearly defined. IEE is able to provide a definite solution to environmental problem.

The development of small hydropower in a mountain country like Nepal is of utmost importance. These projects are extremely important and useful as they can invariably be located in rural and hilly areas of the country. With standardized adoption of canal or cluster approach to achieve larger volume and turnover and careful planning to achieve short gestation periods, small hydel installations can prove to be competitive with other electricity generating projects. Besides, being highly reliable, small projects have the advantages of being environmentally superior, requiring no resettlements or leading to deforestation or submergence and have reduced transmission and distribution losses. They are best suited for construction on canal, falls irrigation, dams and natural falls in the hilly regions with reduced capital and recurring costs and commissioning en-schedule (Sinha, 1995). In order to develop small hydropower in isolated rural area, where power supply cannot be connected economically to the national grid system of transmission lines, the Small Hydel Department Board was established by the GoN in 1975 (Shrestha, 1991). NEA with the support from Germen Technical Cooperation (GTZ) has in between 1990 and 1993, carried out a master plan of small hydropower development in the rural areas of mountains and hills of Nepal. The master plan has aimed to identify systematically the optimum small development to match the demand of rural electricity (Shrestha and Shrestha, 1994).

1.3 Rationale of the Study

Implementation of any hydropower project degrades the environment. It is a vivid fact that developmental activities are mounting every day and environmental problems are increasing simultaneously. It has to assess the adverse and beneficial impact of project on environment for sustainable development. So, to find out the environmental impact of Hewa-A this studied had done.

Nepal's legal regimes on environment oblige the proponent to prepare an Initial Environmental Examination (IEE) report for all prescribed projects of size between 1 to 50

MW. Each hydropower project falling on environment sensitive area should follow all processes as included in the Environment Protection Act (EPA, 1997) and the Environment Protection Rules (EPR, 1997). Since the proposed project is of capacity 5000kW, the provision in Schedule 1, of EPR 1997 is attracted.

1.4 Objectives of the Study

The main objective of the IEE study is to assess the likely impacts of Hewa Khola Small Hydropower Project on the environment and facilitates to make the project environmentally sound and sustainable. As per the approved Terms of Reference the specific objectives are:

- to study baseline status of physical, biological and socio-economic and cultural system in the project area;
- to identify major physical, biological and socio-economic and cultural impacts of the project;
- to identify positive impacts from the implementation of the project;
- to suggest mitigation measures for avoiding/reducing the adverse effects;
- to provide information for decision-makers and concerned parties about the of the project implementation and associated cost for the implementation of mitigation of adverse impacts;
- to formulate monitoring plan and cost while implementing the project;

1.4 Limitation of the Study

Purpose of this study is for the submission of dissertation as the partial fulfillment of the masters' degree of environmental science. Owing to various constraints, the study was completed with the following limitations.

- The study was completed limited span of time, based on 20 days field work.
- The study had to be completed with limited economic resources.
- The findings of the study cannot be generalized. However, they can be applicable to similar projects, in area with similar type of biological, physical and socioeconomic and cultural environments.

Chapter II

PROJECT DESCRIPTION

2.1 Background

2.1.1 Accessibility

Hewa Khola is a tributary of Tamor River. Hewa - A Small H ydropower Project is located in Yangnam and Sidin VDC of Panchthar district. Mechi highway at Phidim links the project site with terai region. The project area is assessed by fair weather motorable road from Phidim to Yangnam and ultimately towards Memen VDC. The distance of powerhouse from Phidim by road is 20km and further 5km for headworks. The nearest airport is Bhadrapur Airport, which is 4 hour distance by bus.

2.1.2 Project Location

The Hewa-A Small hydroelectric Project is located in Panchthar district, Mechi zone of Eastern Development Region of Nepal. The project area spreads in Sidin, Yangnam, Memeng and Ektin VDCs of Panchthar district.

The proposed headworks site is located at Thoppan-Sanghubote village of Sidin VDC and the proposed powerhouse site is located at Alichikhet of Yangnam VDC. The project area ranges from $27^0$10'50" to $27^0$11'50" Lattitude and $87^0$51'00" to $87^0$53'45" Longitudes.

2.1.3 Project Component

The major civil component of the projects are : diversion weir, under sluice, connecting canal, gravel trap, desansding basin, penstock pipe with anchor blocks and saddle supports, powerhouse complex, tailrace canal and protection structures.

2.1.4 Diversion Weir

Diversion weir is used to divert required amount of water from river towards the intake structure even during dry month. Overflow type diversion weir has been proposed for this project. The weir is designed to pass 85% of the design instantaneous flood with 100 years of return period without damage to the intake structure.

A 20 m long RCC (Reinforced Cement Concrete) diversion weir having its crest level at an elevation of 1150m will be constructed to divert water towards intake. The height of the overflow spillway from its sill level shall be 3.5m and the top width of the weir section 2m.

2.1.5 Under Sluice

Under sluice structure is provided to flush the river bed loads effectively and to contribute towards discharging high floods so as to protect the intake structure. The slice opening is arranged in the main course of river flow so that the bed load is directed towards it. Double

bayed under sluice structure has been proposed at the left bank of Hewa khola adjacent to the intake structure. Two divide walls, parallel to the water course in the river, have been provided- one in between the diversion weir and under sluice structure and the other at middle of under sluice opening to optimize the size of undersluice gates. Two vertical lift gates have been proposed to control the river flow. During dry period, the gates will be closed to divert the water towards intake where as they remain opened during floods. The upstream and downstream aprons are similar to those at the diversion weir.

2.1.6 Side Intake

Intake structure is designed to receive the design discharge even during driest flows. A side intake consisting of free fall type weir having crest length of 4.4m has been proposed. A vertical lift gate is proposed to regulate the flow towards approach canal. Intake structure is aligned at an angle of 75^0 with the direction of river-flow.

2.1.7 Connecting Canal

An 80m long open trapezoidal RCC connecting canal will convey water from intake to desanding basin. The canal shall be capable to accommodate the flood discharge up to the spillway just before descending basin. The longitudinal slope of the canal bed is kept at 1:500. The thickness of sidewalls of the canal is proposed as 50cm.

2.1.8 Desanding Basin

The desanding basin is designed to settle the suspended particles with grain size greater than or equal to 0.2mm. The dufour type two bays RCC descending basin having 5m width of each bay is proposed. The total length of the basin including transition and other accessories is proposed to be 50m. A lateral spillway shall be provided to discharge the excess flow. Vertical lift outlet gates are provided before entering the water into the penstock. The sidewalls of descending basin are designed to withstand the lateral pressure due to the backfill material. The descending basin will be constructed of RCC.

The sand flushing channel with concrete slab cover is proposed. The flushing channel shall be equipped with electrical operated vertical lift gate.

2.1.9 Headrace Pipe

Water from the descending basin is conveyed to the forebay tank by a 4300m long steel penstock pipe. The diameter of headrace pipe, designed as non pressure flow, to carry the design discharge of $3.0 m^3/s$ shall optimized considering the criteria of no turbulence ($y/D < 0.82$). The headrace pipe shall be supported by PCC blocks at every bend and intermediate saddle supports made of stone masonry, where the alignment happens to be in filling. Expansion joins shall be provided right after the bend blocks. A vent pipe pressure flow created due to turbulences.

2.1.10 Powerhouse compels

Powerhouse complex consists of powerhouse building containing turbines, generators and accessories. The powerhouse of the proposed project is located at Aliachi khet of Yangnam VDC on the cultivated land at left bank of Hewa khola. A surface type powerhouse is proposed. . The powerhouse consists of a RCC structure that houses the machine floor, control section and all the mechanical and electrical equipment. The powerhouse consists of main plant, auxiliary plant and control room. The size of the powerhouse is 23m*10m*8m. Two generating units of total 5000kW installed capacity will be accommodated in the powerhouse. There will be provision for the auxiliary plants and service area. A concrete raft foundation is provided for the machine foundation in the building.

2.1.12 Generating Equipment

Two sets of pelton turbine are proposed for Hewa A Small Hydropower Project. The turbine set shall be provided with complete set of runner, jet deflector, spear nozzles, inlet valve, auxiliary equipment and other accessories. Two sets of generator each of 3125kVA capacity operating generation voltage level of 690V are directly coupled with the turbine. The generation voltage 690V is stepped up to 33kV with the help of power transformer of capacity 6250kVA.

The output power from the transformer shall be connected to 33 kV Phidim substation. Alternatively, it is proposed to connect to 132kV transmission line joining Kabeli A Hydropower Project.

The plant shall run both in isolated mode as well as in parallel mode to the interconnected national grid. When the power plant receives the power from the NEA national grid then the power house shall be shut down and again run in isolated mode feeding local load as soon as the power If restored in the grid then the power plant should be synchronized with the national grid to run the plants in parallel mode to the grid.

The complete control and supervision of the power equipment will be made possible to operate from the control room inside the powerhouse with the help of integrated control and protection system. The control room shall consist of control panel and control desk. The control panel shall have indicators and alarms for any type of mechanical and electrical failure and trips. It shall also consist of automatic recorders for generator kW, kWh, voltage and temperature measurements. The control desk shall consists of indicating lamps and alarm for sequence control operation and displaying single line diagram up to 33kV feeder line with push buttons/handles for energy stop.

The station service transformer of capacity 100kVA shall be used to step down the voltage to 400/230V. It shall be used for lighting powerhouse, switchyard, charging DC batteries, which are used for startup and emergency lighting.

2.1.11 Tailrace Canal

A rectangular RCC closed conduit of 2.0m*2.0m has been proposed to convey water from powerhouse to the source Hewa Khola. The length of the tailrace conduit is 200m.

2.2 Salient Features

1. *General*

Development Region	:	Eastern
District	:	Panchthar
VDCs	:	Yangnam, Sidin, Ektin, Memen
River	:	Hewa Khola
Type of Scheme	:	Run-of-River
Installed Capacity	:	5.0 MW

2. *Hydrology*

Catchment Area	:	140Km^2
Design Discharge	:	3.0m^3/s
Gross Head	:	220 m
Net Head	:	205 m

3. *Headwork*

Type of Intake	:	Side Intake
Length of diversion weir	:	20m
Elevation of Intake	:	1150m

4. *Power Canal*

Type	:	Open Trapezoidal type
Length	:	80m

5. *Desanding Basin*

Type	:	Rectangular
Length	:	50m
No of Chambers	:	2

6. *Water Conveyance System*

Option-1

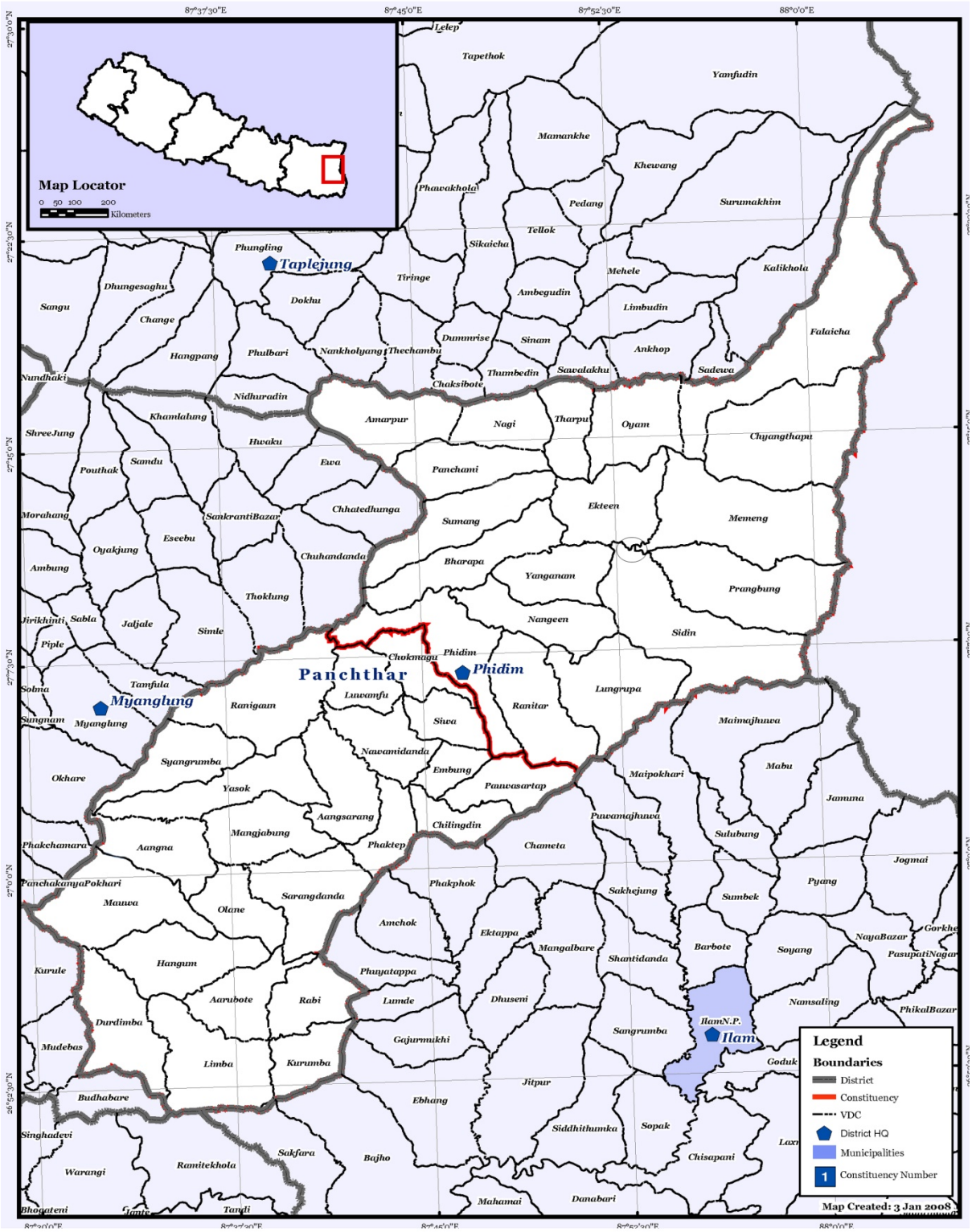
Type	:	Penstock
Length	:	4.3 Km

Option-2

Type	:	Open canal
Length	:	150m
Type	:	Tunnel

Length	:	3000m
Type	:	Penstock
Length	:	500m
7. Power House		
Type	:	Semi-Surface
Type of Turbine	:	Pelton
Number of Unit	:	2
Elevation of turbine axis	:	930m
8. Tailrace Canal		
Type	:	RCC closed conduit
Dimension	:	2m x 2 m
Length	:	200m
9. Transmission Line & Grid Connection		
Proposed Transmission Line	:	33 kV transmission line to join INPS 33KV transmission line joining Phidim s/s to Taplejung s/s
Alternate transmission line	:	Proposed 132 kV transmission line joining Kabeli-A Switchyard
Length for grid connection	:	12 Km
10. Transformer		
Type	:	Step up
Nos.	:	1
Rated Capacity	:	6250KVA
Voltage Levels	:	0.69/33 KV
Type of cooling	:	ONAN
Phase	:	3Ø
Frequency	:	50 Hz
11. Generator		
Rated capacity	:	3125 KVA (two units)
12. Switchyard type	:	Indoor
13. Approach Road Connection	:	20 Km from Mechi Highway to reach
	:	Powerhouse, next 5 Km road to access Intake site.
14. Total Cost of Project	:	NRs. 650 million
15. Cost per kW	:	US$ 1800
16. Construction Period	:	24 months

Figure 2.1 Location Map of the Studied Area



Chapter III

LITERATURE REVIEW

3.1 The Interim Constitution of Nepal 2007

Article 35(5) of the Interim Constitution of Nepal, 2063 BS (2007 AD), states that the State shall implement necessary management to conserve the environment. The State shall aware public to maintain environment and gives priority for the protection of environment and prevention of further damage of the environment on the account of physical development activities and shall take special measures for the conservation of environment, rare and endangered species. The State shall act to conserve forest and vegetation, biodiversity and their sustainable uses, and the benefits thus obtained from these resources shall be equally shared.

3.2 Review of Strategy Plans/Policies

3.2.1 National Conservation Strategy

In 1988, the National Conservation Strategy (NCS) was formulated. NCS, as indicated during the Eighth Plan, recognizes that in order to meet the basic needs of the Nepalese people substantial development activity must be undertaken. Such development will cover a wide range of projects. The NCS provides that:

- An Assessment and Review Office (ARO) will be established and it will be responsible for socio-economic and environmental assessment,
- The proponent of a development project or industrial activity that may have significant detrimental social and or environmental impacts must prepare and file with ARO a statement concerning the potential socio-economic and environmental effects of the proposed development. The impact statement must be prepared in accordance with the guidelines provided by ARO, and
- A review process that is open to both government and non-government participants and consistent with government's policy concerning public participation will consider the proponent's socio-economic and environmental impact statement.

3.2.2 Nepal Environmental Policy and Action Plan, 1993 (NEPAP, 1993)

In 1993, another important document, Nepal Environmental Policy and Action Plan (NEPAP) was endorsed to further institutionalize environmental protection in the development processes. NEPAP recognizes that a growing number of people are exposed to pollution from industrial enterprises.

NEPAP identifies the following factors as contributing to this process:

- Industrial plants inappropriately sited close to population centers,
- Insufficient emphasis on fuel efficiency,
- Little, if any pollution abatement equipment used for reducing emissions and
- A total lack of industry pollution standards.

Hence, the NEPAP emphasized the need for mitigating adverse environmental impacts to address urban and industrial development, air and water pollution and infrastructure development. The Action Plan for Infrastructure Development within NEPAP recommends the finalization of draft EIA guidelines for water resources, the development of EIA guidelines for road construction and the use of EIA when designing hydroelectric projects. Recently, a subsequent document "NEPAP II" has been finalized including recommendations for implementing environmental programs and action plans.

3.2.3 Fifth Year Plan of Nepal

The then, HMG/N for the first time in the planning history of Nepal, introduced the concept of integrating environmental aspects in the development projects and programmes by carrying out EIA studies from the *Sixth Plan* (1980-'85) onwards. This commitment was reinforced in the *Seventh Plan* (1985-'90), the *National Conservation Strategy,* 1988, and the *Master Plan for Forestry Sector, 1989.* The *Eighth Plan* (1992-'97) elaborated the need for institutionalizing EIA system to attain the goals of sustainable development by integrating environmental aspects into development activities. The Nepal Environmental Policy and Action Plan (NEPAP) also recognized EIA as an essential planning and management tool to internalize environmental management aspects into development projects, including the hydroelectric ones.

The *Ninth Plan* (1997-2002) emphasized participatory EIA to involve the stakeholders in natural resource management and also to internalize environmental management in sectoral development projects and programs, including hydroelectric projects with a view to attaining sustainable development objectives. The *Environment and natural Resource Management Policy,* as included in the Ninth Plan, has reemphasized the need for internalizing and institutionalizing the EIA system right from the local level through coordinated effort.

The Tenth Plan (2003-2007) has also identified EIA as a priority area, and it emphasizes on environmental monitoring of the project that have undergone EIA process. The Plan focuses on the need for setting up national environmental standards with the strategy of internalizing environmental management into the development programmes. The plan has also realized to carry out Strategic Environmental Assessment (SEA) with the long-term policy of promoting environmental governance. The plan emphasizes on the local participation in environment conservation, according to the Local Self-Governance Act 2055, through the local bodies, make them responsible and capable to manage local natural resources. It stresses to mitigate

environmental degradation in the lower regions by development activities in the upper regions (hydropower, irrigation), and to initiate the rehabilitation programs for the affected parties (NPC, 2002). The then HMG has also made commitment to provide electricity services to about 66% of the total population through national electricity system. For this, hydroelectricity projects will be implemented to generate a total of 842 MW during the plan period. The strategic thrust is on implementing small, medium and large hydroelectric projects taking into account environmental conservation, and involvement of private sector. In other words, electricity development will contribute to environmental conservation.

3.2.4 Hydropower Development Policy, 2001 (HPDP, 2001)

Based on experiences gained in the course of implementing the principles followed by the Hydropower Development Policy 1992, emerging new concepts in the international market and their impacts, technological development, possibility of exporting electricity, and foreign investment and commitment on the environmental protection, the Hydropower Development Policy, 2001 (B.S. 2058) was introduced with a view to make clear, transparent and investment-friendly hydropower development in Nepal The objective of Hydropower Policy, 2001, which guides the hydroelectric development in the country, is to produce clean energy through the development of hydroelectric projects, which could also assist in environmental conservation. One of the policies is to utilize indigenous labor and skill in hydropower projects. It emphasizes to extend the use of electricity in rural areas to reduce fuel wood consumption. Clause 6 of the policy refers to the arrangements of compensation, land acquisition and resettlement of displaced families. Provision of water rights has also been mentioned in sub-clause 6.2.

3.2.5 Forestry Sector Policy, 2000 (FSP, 2000)

Forest sector policy was developed in the legislative accordance with the national Conservation strategy (NCS), National Biodiversity Action Plan (NBAP) and other plans in order to enforce the sustainable management of land resources, to protect natural resources such as soil, water, flora, fauna and scenic beauty and to maintain ecological balance and to conserve bio diversity.

3.3 Relevant Laws

Existing regulatory instrument—the law—provides an opportunity to identify and mitigate environmental problems associated with the projects. The regulatory agency is also obliged to assist the proponent in achieving environmental management goals.

3.3.1 Environmental Protection Act, 1997 (EPA, 1997) and Environment Protection Rules 1997 (EPR, 1997)

Nepal has enacted a comprehensive and umbrella type environmental act, the Environment Protection Act (EPA) 1997, and followed by Environmental Protection Rules 1997 and its first amendment 1998 and its second amendment 2007 which are now enforced through appropriate regulatory measures.

Environmental Protection Act, 1997, recognizes that sustainable development is possible through proper consideration of inter-dependence between economic development and environmental conservation by minimizing adverse impacts on physical, biological and socio-economic environments, wise use and management of natural resources, incorporation of environmental concerns in the development process, participatory role of communities and stakeholders, are among the salient features of the Act. The Act has outlined procedure and framework for: (a) project planning and project approval; (b) project implementation and pollution control mechanism; (c) punishment and penalties for non-compliance. Section 10 has a provision to maintain any place within Nepal as environment protection area. This Act defines the term "environment" as a physical, biological and socio-economic aspects based on their interaction and inter-relationship.

As per the Environmental Protection Rules, 1997, section 24 of EPA, GoN can formulate rules to operationalize the Act. Section 2 of these rules deals with IEE and EIA procedures which were amended in 1999. Annexes specify particular environmental requirements. Scoping and the Terms of Reference (TOR) are to be approved by concerned agency or the Ministry of Environment, Science and Technology (erstwhile Ministry of Population and Environment) dependably upon the size of the project mentioned in EPR 1998 (first amendment). Emphasis has been given to stakeholders' involvement and public participation. Appendix 6 of the rules specifies matters related to EIA report preparation.
Section 12 of the rules states that proponent should comply with all matters specified in the EIA report and the conditions prescribed by the concerned agency. Provision and actions to be taken in case of environmental pollution and indiscriminate waste disposal are dealt in Section 17 and 18. Section 8 specifies provision and processes to be followed by the victim of violation of pollution standards.

Emphasis on Resource Conservation

The objective of the EPA is to recognize the interdependence between development activities and the environment, and to maintain a clean and healthy environment by minimizing, as far as possible, the impacts of environmental degradation on people, animal and plant species, and physical surroundings. This act gives great emphasis on the proper use and management of natural resources including the assimilative capacity of ecosystem.

Environment Impact Assessment

The EPA and EPR provide a legal basis for the concerned authorities for regulating an Initial Environmental Examination (IEE) or/and Environmental Impact Assessment (EIA). Section 3

of the Act requires the proponent to conduct and IEE and EIA in relation to the prescribed proposals. The act uses the word "proposal" instead of "projects" which makes the scope of the act much broader in relation to EIA. "Proponent" includes any person or government, quasi-governmental or non-governmental agency or organization submitting and application for the approval of a proposal and possessing the responsibility to work according to such proposal or implementing the proposal. It is apparent from this provision that any private party or government agency who wishes to implement any proposal prescribed in the Regulations must prepare either and IEE or EIA, as the case may be. After having prepared the IEE or EIA, the proponent is required to apply to the relevant government agency with the IEE or EIA report for approval of the proposal.

Implementation of any proposal without the approval of the relevant agency is prohibited by the Act. Under Sections 6(1) of the Act, the relevant agency is empowered to grant approval for the IEE report, only if it finds that no significant adverse effects will be caused to the environment by the implementation of the proposal. The government agency is required to forward the EIA report submitted along with a proposal to it, with its opinion on the report to the Ministry of Environment, Science & Technology. Any member of the public is entitled to copy the EIA report, on their own initiative and at their own expense, for the purpose of providing their opinion or suggestions on it. Ministry of Environment, Science & Technology is empowered to set up a committee to provide opinions on EIAs received by it.When granting approval to any proposal, Ministry of Environment, Science & Technology is required to take into account public comments received on the EIA if it is approved contrary to public opinion. However, the Ministry can only grant its approval to implement the proposal if it does not cause significant adverse effects on the environment. Without this provision, the relevant agency or the ministry in empowered to approve the implementation of the proposal with specific conditions. If the IEE or EIA has identified such conditions, measures need to be taken to reduce or control the significant adverse effect the environment resulting from the implementation of such proposal. Thus, it is mandatory under the Act that there should not be any significant adverse effects on the environment from the implementation of any proposal, which requires the preparation of an IEE or EIA.

Rule 7 of the recently amended Environment Protection regulations (1997) requires the proponent to conduct public hearing and collect suggestions in the area of Village Development Committee (VDC) or Municipality where the project will be executed. Rule 8 stipulates that after the proponent prepares and EIA report, proponent must send a copy thereof to the relevant VDC or Municipality or District Development Committee (DDC) to enable them to offer their opinion and suggestion on it. Rule 8(2) obliges the proponent to make the EIA report public for a period of 30 days for perusal or study by any interested individuals or institutions. However, the regulation is silent on the mode of making the EIA report public. In cases where any EIA report is received by a VDC or Municipality or a DDC

is seeking their opinion and suggestions on it, the relevant VDC, Municipality or DDC is empowered to forward its opinions and suggestions to the proponent within 30 days from the date of its receipt. In the case of individuals or institutions, they may offer their opinion and suggestions, if any, to the proponent within 30 days from the date when the report is made public. Rule 13 of the Environment Protection Regulations requires the relevant agency to monitor and evaluate the impact of the proposal on the environment resulting from the implementation of the proposal. If greater impacts than those stated in the EIA report are noticed, the relevant agency is required to give necessary directives to the proponent to mitigate the adverse impact or to adopt measures to control them. The proponent is obliged to carry out those directives. Monitoring and evaluation is usually the mandate of an independent institution.

Section 17 of this Act is concerned about compensation. In case of pollution, creation of disposal, sound, heat or wastes by anybody contrary to this Act, any person or organization that suffer any loss or damage, may, if s/he desires, have compensation recovered from the person, institution or proponent doing such act. An application must be made to the prescribed authority (Chief District Officer) stating the details thereof. In connection with the determination of the amount of compensation, the CDO possesses the power to summon the concerned individual. The amount of compensation determined by the CDO under this rule must be appropriate and reasonable.

Pollution Prevention and Control

EPA 1996, for the first time in the Nepalese legal regime, makes causing pollution or allowing such pollution to be caused a punishable act. Under section 7(1) of the Act, industries or any others are required not to discharge, emit or dispose waste, sound, radiation or any such acts which will cause pollution or to allow pollution to be caused in manner which is likely to have significant adverse impacts on the environment or to harm human life or public health.

3.3.2 Water Resources Act, 1992

The objectives of the *Water Resources Act, 1992* is to make legal arrangements for determining beneficial uses of water resources, preventing environmental and other hazardous effects thereof and also for keeping water resources free from pollution. According to the Act the ownership of water resources within Nepal shall be vested in the country.

The Act strives to minimize environmental damage to water-bodies, especially lakes and rivers through environmental impact assessment studies and the proponents who wish to use water resources for various purposes should prepare EIA report before a license can be granted. While making use of water resources, the water quality must be maintained by the proponent as prescribed by GoN. Any discharge of waste into water body should not exceed the pollution tolerance limit for water resources. As the water quality standards and pollution

tolerance limit have not yet been determined by the government, it puts the proponent on the safe side. Thus there is an urgent need to determine water quality standards and pollution tolerance limit in order to avoid the situation of confusion and conflict. The Act stipulates that soil erosion, flooding, landslides or any significant impact on the environment should be avoided in all uses of a water resource. Penalties could be imposed on offenders.

3.3.3 Water Resources Regulation, 1993 (WRR, 1993)

It is mandatory under Rule 17(e) of the regulation that any person or corporate body, who desires to obtain a license for utilization of water resources must state in his application that appropriate measures will be taken to lessen the adverse effects due to the project on the overall environment. Measures are to be taken for the conservation of aquatic life and water environment, and for mitigating social and economic effects of the project in the concerned area. Local labor should be utilized and the local people should get benefits after the completion of the project. The regulation also emphasizes training to the local people in relation to construction, maintenance and operation of the project. The mitigation plan should give details of people to be evacuated and a necessary plan for their rehabilitation. Rule 19 stipulates that the water resources committee shall publish a notice giving detail information about the project to the people. If any person found that the construction and operation of concerned project is likely to cause adverse effects, he or she may furnish his/ her reaction stating the reason within the thirty-five days from the date of publication of the notice. If the committee is satisfied with the reason given by the people, the proponent will be asked to revise the plan.

3.3.4 Electricity Act, 1992 (EA, 1992)

Electricity Act 1992 is related to survey, generation, transmission and distribution of electricity. Electricity includes electric power generated from water, mineral oil, coal, gas, solar energy, wind energy, atomic energy, or from any other means.

Section 4, sub-section 1 of the Act, requires any person or corporate body who wants conduct survey, generation, transmission or distribution of electricity over 1 MW to submit an application to the designated authority along with the economic, technical and environmental study report. The environmental study report refers to IEE/ EIA report. The proponent will have to show in the EIA report that the proposed, water resource development project is not likely to cause soil erosion, flood, landslide and air pollution etc.

3.3.5 Electricity Regulation, 1993 (ER, 1993)

Rules have been formulated for the implementation of the provision made in the Electricity Act, 1992.

Rule 2 (f) and 13(g) are related to EIA, which emphasize that the EIA report should include measures to be taken to minimize the adverse affects of the project on social, biological and physical environments, maintenance and operation, facilities required for construction site, and safety arrangements.

The above mentioned provisions under Water Resources Act/ Regulation and Electricity Act/Regulation make it mandatory that any person or corporate body including NEA who wishes to use water resources for any purpose must have to prepare socio-economic and environmental impact assessment and must publish the detail information for the public viewing. The NEA should ensure that the comments provided by the people, if round reasonable, are implemented by the proponent. Failure to follow these mandatory provisions may cause court litigation which may unnecessarily delay the project.

3.3.6 Soil and Watershed Conservation Act, 1982 (SWCA, 1982)

The mismanagement of watersheds leads to the degradation of valuable land by flooding, water-logging and accelerated slit in storage reservoirs. In order to properly manage the watersheds of Nepal, the *Soil and* Watershed *Conservation Act, 1982 (SWCA)* was enacted. Section 3 empowers GoN to declare any area a protected watershed area. Section 4 provides that a watershed conservation officer has the authority to implement the following works in protected watershed areas:

- Construct and maintain dams, embankment, terrace improvements, diversion channels and retaining walls,
- Protect vegetation in landslide-prone areas and undertake afforestation programs and
- Regulate agricultural practices pertinent to soil and watershed conservation

Under Section 20 of SWCA, power is extended to the Watershed Conservation Officer to grant permission to construct dams, drainage ditches and canals, cut privately owned trees, excavate sand, boulder and soil, discharge solid waste, and establish industry or residential areas within any protected watershed. SWCA outlines the essential parameters necessary for proper watershed management (including both rivers and lakes). The Act is applicable only to protected watershed.

3.3.7 Forest Act, 1993

The *Forest Act, 1993* recognizes the importance of forests in maintaining a healthy environment. The Act requires decision makers to take account of all forest values, including environment services and bio-diversity, not just the production to timber and other commodities. The basis of the Act's approach to forest and forest products is "resource oriented" rather than "use oriented".

Section 23 of the Act empowers the government to delineate any part of a national forest, which has "special environmental, scientific or cultural importance", as protected forest.

Section 49 of the Act prohibits reclaiming lands, setting first, grazing, removing or damaging forest products, felling trees or plants, wildlife hunting and extracting boulders, sand and soil from the National forest without the prior approval.

The Act empowers the government to permit the use of any part of government managed forest, community forest, leasehold forest, if there is no alternative except to use the forest area for the implementation of a plan or project of national priority without significantly affecting the environment. Industrial Enterprises Act, 1992 under its schedule 4 has defined hydropower projects as national priority project.

3.3.8 Forest Regulation, 1995

Rule 65 of the Forest Regulation stipulates that in case the execution of any project having national priority in any forest area causes any loss or harm to any local individual or community the proponents of the project itself shall bear the amount of compensation to be paid. Similarly the entire expenses required for the cutting and transporting the forest products in a forest area to be used by the approved project shall be borne by the proponents of the project.

3.3.9 Aquatic Animals Protection Act, 1961 (AAPA, 1961)

The *Aquatic Animals Protection Act, 1961 (AAPA)* indicates an early recognition of the value of wetlands and aquatic animals. Section 3 renders punishable to any party introducing poisonous, noxious or explosive material into a water source, or destroying any dam, bridge or water system with the intent of catching or killing aquatic life. AAPA has been in effect since 1961, yet both noxious and explosive materials are increasingly used in water bodies throughout Nepal. There is no reported case of prosecution for a breach of AAPA. This demonstrates the government's ineffectiveness in developing or surveillance system for conserving aquatic life. Under section 4, the government is empowered to prohibit catching, killing and harming of certain kinds of aquatic animals by notification in the *Nepal Gazette.* However, notice under this section has never been published by the government.

3.3.10 National Parks and Wildlife Protection Act, 1972 (NPWPCA, 1972)

The conservation of ecologically valuable areas and indigenous wildlife is provided by the National Parks and Wildlife Conservation Act (NPWCA). Rule 30 of the Mountain National parks Regulations (1979) stipulates that permission from Ministry of Forest and Soil Conservation must be obtained in the case of any plan to be implemented within a mountain national park. In Section 10, complete protection is accorded to 26 species of mammals, nine species of birds and three species of reptiles, although little has been done to systematically enforce these provisions.

3.3.11 The Local Self-Governance Act, 1998

This act provides more autonomy to District Development Committees, Municipalities and Village Development Committees. Section 25 of the Act provides the functions, rights and duties of the Ward Committee. Section 25(e) of the act requires the ward to help for protection of environment through plantation over the bare land, cliff and mountains. Section 28 has mentioned the functions, rights and duties of VDC. VDCs are required to protect the environment, nature and natural resources by:

- Planting trees on bare land, public lands and other lands including fallow land,
- Formulation and implementation of programs for conservation of forest, plants, bio-diversity and soil conservation and
- Formulation and implementation of various plans for the protection of environment and organizing the programs.

Section 55 empowers VDC to levy taxes on utilization of natural resources. Section 68 lists the property of the VDC which includes natural resources. Apparently, natural resources include water resources and thus VDCs have an absolute authority over the natural resources. However there is inconsistency in the Water Resources Act, 1992 that vests the ownership of water resources in Nepal.

Section 189 of the Local Self-Governance Act provides the power and functions of the District Development Committees (DDC), which include formulation, and implementation of plans for conservation of forest, vegetation, biological diversity and soil. If section 189 and section 202 are read together, DDCs would have power to stop some of the development projects considered environmentally unsound. Section 220 of the Act provides provision relating to revenue allocation to DDC and mentions the royalties in water resources, mining, natural resources, and petroleum products.

3.3.12 Land Acquisition Act, 1977

This act must be followed when acquiring lands for projects on either a short or long-term basis. This land may be individually or government owned. The following clauses will be especially applicable:

- Clause 3: GoN must be notified and requested about lands that need to be acquired,
- Clause 4: The project may acquire lands for the implementation of project works either for structures, housing areas or storage. The project's company will bear all expenses incurred in acquiring land.
- Clause 7: The Company will pay fair compensation to the landowners.

3.3.13 Labor Act, 1991

- Clause 4: Non-Nepali citizens are not allowed to work without proper permit and only if the manpower required is not available in Nepal.
- Clause 5: Child labor (defined as anyone less than 14 years of age) is prohibited.
- Clause 18: Thirty minutes will be allowed for rest and/or refreshment for every five hours of work.
- Clause 19: Over-time payment must be given at 1.5 times the normal wage if employees are required to work more than normal working hours (i.e. 8 hours/day)

3.3.14 Explosive Substance Act, 1961

Section 3 of this act states that GoN, by a notification in the Nepal Gazette, may declare any substance as explosives. Section 4 forbids producing, storing, selling, carrying and importing explosive without license. The section also provides the person to apply for the license to the CDO with necessary descriptions as prescribed.

3.4 National Environmental Guidelines

3.4.1 National EIA Guidelines

As mentioned above, NCS recognizes impact assessment and the review process as one of the basic criteria for achieving sustainable development. To address this, National Environmental Impact

Assessment (EIA) Guidelines were formulated. The guideline provides criteria for project screening and Initial Environmental Examination (IEE). This includes scoping preparation of terms of reference for EIA methods of EIA report, impact identification and prediction, impact mitigation measures, review of the draft EIA report, impact monitoring evaluation of impact studies, impact auditing, community participation and schedules and annexes to IEE and EIA. Section 19 of the guideline requires the proponent to prepare and EIA report upon completion of the EIA exercise of a project. The EIA report must be concise: pay attention to significant environmental issues and impact; analyses extent and depth of impact commensurate with the nature of potential impact; and due consideration must be paid to the responsibilities of target user such as project proponent, designers and decision-makers.

The EIA study should identify the possible positive and negative impact of the project and analyze them on the basis of their extent using various methods such as checklist, matrix and networking.

Section 23 of the guidelines requires the proponent to pay attention to socio-economic impact, biological impact, physicochemical impact and cultural impact. These impacts should be categorized as direct, indirect and cumulative impact. Under section 25 of the guidelines the proponent is required to pay special attention to the magnitude of the impact extent of impact and duration of each impact.

The guidelines require the proponent to consider alternatives to the proposed project. The proponent must consider the alternatives of scale, technology, location, fuel, raw materials, design, time schedule and economic aspects. A comparative study of adverse impacts and benefits of the project must also be included, taking into consideration the alternative of abandoning the project totally.

Section 28 states that EIA report must be released for public reviews and comments. The comments received should be made available for review by the project proponent along with other stakeholders. The report review must attain, among other, the following objectives;

- Whether the draft EIA report complies with the terms of reference presented at the beginning of the study,
- Whether the draft report is in concurrence with the National EIA Guidelines,
- Whether the draft report addresses the key environmental issues that need to be finalized before making a decision,
- Whether the report result are scientifically and technically sound and coherently organized so as to be understood by decision-makers and the public in general,
- Whether the study identifies all the significant adverse environmental impacts likely to arise in the course of the project implementation with mitigation measures for each impact,
- Whether the methodology adopted, techniques applied, assumptions made and limitations faced during the course of study have been fully described and

Whether reasonable alternatives have been suggested to the action proposed.

It is the duty of the project proponent to collect comments and suggestions from reviewers and get the report revised by the EIA study team. Section 32 requires monitoring of the environmental impact to ensure that the impact does not exceed legal standard, to check the implementation of mitigation measures to see whether it is in conformity with the EIA report and to provide a timely warning on the potential environmental damage. Community participation has also received prominent place in the guidelines. The guidelines mention that the effectiveness of EIA is determined largely by how successfully the community has been involved and that community participation is necessary during project identification; feasibility and scoping; initial environmental examination; detailed EIA study; and monitoring, evaluation and auditing phase. Section 49 of the guidelines also stipulates that local beneficiaries, target groups, user groups, affected groups, special interest groups (such as women), relevant government and private sector agencies, local leaders and academic groups, relevant non-government organizations and recognized experts must be involved in the EIA process.

Guidelines for Environmental Impact Assessment of Water Resources and Energy Projects, 1995

This guidelines contains information of a general description concepts and principles for initial assessment studies, an overview of the main components of an initial assessment; environmental screening and initial environmental evaluation (IEE), a description of the steps involved in screening and IEE of a water resource project and an indication of the requirements for documentation of initial assessment studies.

Guidelines for Environmental Monitoring of Water Resource and Energy Projects, 1995

This guidelines contains the information of a general description of the concepts and principles for environmental monitoring programs, an overview of the major components of environmental monitoring programmes, an indicator of the different types of environmental monitoring, a list of considerations for planning, design, and implementation of monitoring programme, a description of the general procedures for environmental surveillances monitoring and responsibilities of the surveillance monitors and an outline of the documentation for monitoring programmes.

EIA Guidelines for Forestry Sector

Nepal government is keeping with spirit of the national environmental impact assessment guidelines (EIA) 1993 framed EIA guidelines for the forestry sector 1995. The guidelines aims;

- To facilitate the sustainable use of forest resources for socioeconomic development and for meeting basic needs of the communities for forest products,
- To make proposal socio-culturally acceptable, economically feasible and environmentally begin to conserve generic resources and bio diversity and minimize environmental damage in forest areas and
- To facilitate in identification of positive and negative impacts of program to be implemented by other agencies in forest areas.

The guidelines emphasize the need of carrying out EIA study of development projects and program proposed for implementation on forest areas.

3.4.2 Manuals and Guidelines for Electricity Generation and Environmental Study

Manuals, hand books and guidelines published by the EIA executing Ministries were reviewed during the course of EIA study. A Hand book on Licensing and Environmental Assessment Processes for Hydropower Development in Nepal published by the Ministry of Environments Science and Technology has been reviewed. Similarly, other guidelines such as: A Guide to Streamlining of Environmental Impact Assessment Approval Process; A guide to Environmental monitoring of Hydropower Projects and A Guide to Environmental

Management Plan of Hydropower Projects published by the same ministry have been reviewed. Other guidelines and manuals such as – Manual Developing and Reviewing Water Quality Monitoring Plans and Results for Hydropower Projects; Manuals for Preparing Terms of Reference for Environmental Impact Assessment of Hydropower Projects, with Notes on EIA Report Preparation; Manual for Preparing Scoping Document for Environmental Impact Assessment for Hydropower Projects; and Manual for Public Involvement in the Environmental Impact Assessment Process of Hydropower Projects published by the Department of Electricity Development have been reviewed.

3.4.3 Forestry Sector EIA Guidelines, 1995

The forestry sector EIA guidelines aim to facilitate the sustainable use of forest resource for the socio-economic development and to meet the basic needs of the communities for forest product. The positive and negative impacts of any development project in the forest area are to be identified and plans must be developed to minimize environmental damage, conserving genetic resources and bio-diversity.

3.5 International Convention

Nepal is signatory to number of International Conventions including those concerning habitat, bio-diversity and cultural heritage protection which must also be taken into account during the EIA of projects. The EIA team will identify issues, avoidance or mitigating measures such as those associated with agreements on:

3.5.1 Biosphere Reserves

Power projects which may be planned in/around areas which are designated as UN Biosphere Reserves, National Parks, Reserves and Conservation areas will be affected by this UN Charter. Nepal is a signatory to this agreement (1975) which classifies species according to criteria where access or control is important (e.g., I-species threatened with extinction; II-species which could become endangered; III- species that are protected; E- Endangered; V-Vulnerable, R- Rare).

3.5.2 International Tropical Timber Agreement

Nepal is a signatory to the Plant Protection Agreement for the Asia and Pacific Region (1956).

3.5.3 Ramsar Convention (Ramsar)

Nepal is an international flyway for migrating waterfowls in South Asia. Because of the region's importance to wildfowl, especially as waterfowl habitat, Nepal has signed the Convention on Wetlands of International Importance (1971). This agreement may have a

bearing on development potential of wetland areas as hydroelectric sites and transmission route.

3.5.4 World Heritage Site Convention

In recognition of its cultural heritage and the need to protect it antiquities, Nepal has signed the Convention Concerning the Protection of World Cultural and Natural Heritage in (Paris, 1972). This convention will affect any project which might be sited on lands containing cultural or heritage resources. The World Heritage Site of Nepal includes: Cultural sites; (2 Lumbini, Ktm-3D. Sqs., 2HT, 2BT) and Natural sites; 2 (Chitwan and Sagarmatha NP)

3.5.5 Convention on International trade in Endangered Species (CITIES)

CITIES is an international agreement in which Nepal is the party. Its aim to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Because the trade in wild animals and plants crosses borders between countries, the effort to regulate it requires international cooperation to safeguard certain species from over exploitation. CITIES was conceived in the spirit of such cooperation. Today, it accords varying degrees of protection to more than 30,000 species of animals and plants, whether they are traded as live specimens, fur coats and dried herbs.

CITIES was drafted as a result of a resolution adopted in 1963 at a meeting of members of IUCN (The world conservation Union). The test of the convention was finally agreed at a meeting of representative of 80 countries in Washington D.C., United States of America, on 3 March 1973, and on 1 July 1975 CITIES entered in force.

CITIES is an international agreement to which States (countries) adhere voluntarily. States that have agreed to be bound by the convention (joined CITIES) are known as Parties. Although CITIES is legally binding on the parties- in other words they have to implement the convention- it does not take the place of national laws. Rather it provides a framework to be respected by each party, which has to adopt its own domestic legislation to make sure that CITIES is implemented at the national level.

Nepal is the signatory to this agreement in 1975 that classifies species according to criteria where assess or control is important (eg, I Species threaten with extinction, II- Species which could become endangered, III- species that are protected CITIES,1983)

3.6 Related Environmental Assessment Studies

Bhattarai, 1994, stated that undertaking EA can mitigate adverse impact brought by water resources development. Its administrating in Nepal is new and to meet challenges of management more committed efforts are needed.

Dixit, 1994 stated that resettlement and rehabilitation of population affected by water projects have been generally unsatisfactory the world over. In Nepal too, though the affected population has been small, resettlement and rehabilitation of the population affected by water projects have been poorly managed. Reforms in planning and management of programme to resettle and rehabilitee displaced population are essential to avoid conflict and consequential high social stress.

Khadka, 1996 stated that a serious shortcoming of most EIA is the absence of baseline data and then impact monitoring during the construction, operation and completion phases of large development projects. Without such data and program it is impossible to test impact prediction and the success of mitigation measures. Furthermore, the lack of appropriate ecological monitoring impedes scientific progress in impact prediction and assessment and makes it difficult to learn from experiences.

Khudikhola Small Hydropower Project located in Annarpurna Conservation Area at Khudi VDC, Lamjung district is generating electricity since 2007. It is run of river type project with an installed capacity of 3.45 MW. The electricity generated from the project is synchronized in the national grid. The EIA study of the project had indicated beneficial and adverse environmental impacts, which are discussed below:

- By creating work opportunities, bringing new people into the area for the construction period and maintaining the road conditions to allow the good circulation of transport vehicles, the project is expected to positively influence the local market economy (agro-products, stores, restaurants, meat producers, etc) and to momentarily reduce out-migration of men from the area.
- The project however was designed so that no involuntary displacement of people will be necessary and that only 3.3 ha. of land will be permanently bought and 4 ha. will be rented for two years limiting impacts on the land and house holdings in the area. KHP recommends fair compensation for bought land or rented lands plus compensation packages to help affected landowners bear the consequences of the losing their land.
- The two first months of the 4 months fishing seasons will probably be impacted by diversion of the river for power generation, which would leave one stretch (2.5 km. stretch, the project will definitively have an impact on aquatic life downstream from the weir thus voluntary release of water by the project during the dryer months (10% of lean flow) is expected) of the river dewatered for those two months. Full time fishermen will be hired in priority by Project during Construction and Operation period to compensate for their loss in revenue (LEDCO, 2001).

NEA (1993) in proposed Arun III hydroelectric project where it is described about 30 ha of land including some patches of pristine forest that would be inundated by the construction of the project. The biodiversity of the area is under severe pressure due to peoples activities some 14 endangered, threatened or rare and one endangered species of butterfly and one rare species of fish are known or suspected to occur in the immediate vicinity of the access road and construction in vegetation will include loss of vegetation through the whole 30m right of way and the total forest area. But vegetation clearance within in this area will be strictly limited to the area of permanent work (NEA, 1993)

CIWEC, 1997, in Tamur Mewa hydropower project reported direct loss of 12 ha mixed hardwood type of forest during the construction phase of the project. It leads to the loss and fragmentation of vegetation cover as well as disturbance to the associate wildlife habitat common to the region, so it did not represent the unique habitat. Special provision was made for the six species of endeavored plant and the endangered wildlife species identified by the EIA team.

NEA, 1998 has carried out feasibility study of Kabeli Hydropower Project located in the area close to Hewa A Hydropower Project. The study has covered environmental information and possible impact with appropriate mitigation measure of the area. According to the study, the lands to be utilized for various construction and pounding coverage area do not fall under unique natural habitat of narrow distribution in the country or ecologically sensitive area. Neither protected area nor historical religio-cultural and heritage area fall in the project site.

DOED, (2004) studied the EIA of Mewa khola at Taplejung district and indicated beneficial and adverse environmental impacts and their mitigation measures, which are discussed below:

- The project will permanently acquire total area of 33ha out of which 14.7ha is agriculture and 15ha forest.
- About 3.6 km of the river will be dewatered.
- The major impact on vegetation and forest resources includes the loss of more than 550 trees of various sizes and their standing volume.
- No households are expected to be directly affected in terms of relocation. However in terms of the loss of land during construction activities 16HH will be affected due to land lake.
- Improper management of waste generated by the workforce and other people as well as muck disposal near the river bed may pollute the river water.
- Plantation of local trees along the river as a part of watershed management scheme, recruiting local people to minimize outside workforce, strict monitoring and law enforcement in poaching, over fishing destructing habitats and disturbing wildlife.

- Proper management of waste products and muck disposal have to be carried out.
- Proper dumping and disposal of excavated material, avoidance of clearing vegetation along the landslide areas.
- Proper land value will be given to compensate.

Chapter IV

MATERIALS AND METHOD

Environmental Assessment study of Hewa-A Small Hydropower Project was carried out adopting the following study methodology

2. Desk Study
3. Field Study
4. Laboratory Analysis
5. Data Processing and Analysis
6. Impact Identification and Prediction (Assessment) Method
7. Mitigation and Enhancement Measures

4.1 Desk Study

a. Physical Environment

Information on status of river morphology, drainage pattern, soil erosion and landslide in the area was carried through study of topographic maps, land system and land utilization maps prepared by Land resource Mapping Project (LRMP), Survey department, Nepal Government. Sheet No. 277816 A and 278716B is the main Topographic Map used in this study to align study sites. Similarly, secondary data were obtained from Department of Hydrology and Meteorology, Department of Electricity Development and from journals, books, previous studies and other related studies in order to gather more information about the project and to make the study convenient.

b. Biological Environment

Information on forest types and their composition as well as abundance of wildlife obtained through District Profile, District forest office records, community forest user committee and other published reports.

c. Socio-economic and Cultural Environment

Population literacy rate, occupation of project affected family obtained from books, publication published by Central Bureau of Statistics, District Development Committee, and Village Development Committee etc.

4.2 Field Study

a. Physical Environment

Field observation and walkover survey was adopted to verify information on the geological condition, drainage system, slope stability, land slide prone areas, work camp and labor camp, spoil disposal site and other construction-related environmental issues. Checklist was

used to generate information on erosion problem, landslide and slope failure and possible accumulation of construction wastes in the natural resources. Air and noise qualities were examined by field observation on the presence of industries, road head and other construction activities. Physical infrastructure was examined also by walk over survey of the project area. Survey data and necessary drawing of the alignment were provided by the company.

Water samples of Hewa Khola at the weir site and below power house site were collected and analyzed for the following physical and chemical parameters to determine the existing water quality: Temperature, pH, Color, Turbidity, Conductivity, Dissolved Oxygen, Dissolved solids, Total Hardness, Total Alkalinity etc.

b. Biological Environment

i) Vegetation:

A vegetation survey was conducted at the Hewa-A Hydro Power project proposed site in the month of November 2008. The proposed areas for intake, settlement tank, penstock alignment, powerhouse location were selected as sampling sites for vegetation study. A total of five sampling sites were surveyed for this study. Point centered quadrate (10m radius) was applied to obtain frequencies of tree species. Similarly for shrubs and herbs 3m*3m and 1m*1mquadrate used respectively (Zobel et al. 1987). A total of 5 sampling sites were surveyed.

An ethnobiological survey was conducted using questionnaires. Interviews, using Participatory Rural Appraisal (PRA) technique, were conducted with local residents of Yangnam, sidin, Memeng and Ektin VDC. This survey was conducted to understand the use of different plant species such as food, fodder and medicine and the general use pattern of forest and other vegetation in the project impact area. Endangered, threatened, rare and vulnerable plant species were identified by IUCN, CITIES, and Red Data Book of Government of Nepal list of legally protected plant species.

ii) Sample Collection

Sample collection was carried out for the authentic identification and recording of the flora of the project area. The collected samples were identified by the teacher of Central Department of environmental Science, Central Department of Botany TU and National Herbarium Department, Department of plant resources, Godavari.

iii) Wildlife

In order to collect information regarding the status of wildlife in the project area, a field survey was conducted on November, 2008. In case of animals (mammals, birds, and reptiles), PRA, RRA and Questionnaire Survey was carried out to the local people were used to collect

necessary information. Walkover survey was also done to see the pugmarks, hair, and dens of the wild animals to know about their occurrence.

Interviews were also conducted with local people in order to confirm the presence of certain fish species and evaluate their socio-economic and religious value. Information was also collected from the local people about seasonality and migratory tendencies of fish species. Fish sample was collected using cast net and hook to analyze their status, distribution and abundance. Endangered, threatened, rare and vulnerable species were identified by IUCN, CITIES, and Red Data Book of Government of Nepal list of legally protected fauna

c. Socio-economic and Cultural Environment

A combination of structured and informal research techniques were used to gather baseline information on the Socio-Economic and Cultural parameters. Primary data was collected through field observation, village and household-level survey questionnaires, interviews and Participatory Rural Appraisal (PRA) method. In the project area, 15 households from the Yangnam, Sidin, Memeng and Ektin V.D.C., the core affected community area was surveyed.

During the field study, the study team had number of consultative meeting with the local people and local leaders. The local people were contacted to offer their concerns and opinions on biological and socio-economic aspects and they have been duly documented in the report, at appropriate places.

4.3 Laboratory Analysis

The water sample of the project site also studied on the laboratory of the Central Department of Environmental Science, Kirtipur, Kathmandu. The parameters of study were microbiological analysis, BOD, COD, Nitrate, Phosphate, DO, Free CO_2.

4.4 Data Processing and Analysis

Primary and secondary information were analyzed and processed. Information on the physical environment was processed based on the secondary information and ground observation. Water quality analysis was carried out by standard methods (APHA, 1998).
For the standing wood volume of trees was calculated using the following quarter-girth formula (GoN, 1995).

$$\text{Volume} = (\text{Girth}^2/16) \times \text{height}$$

$$\text{Net Volume} = \text{Volume} \times 0.7854$$

Socio-Economic and Cultural information were crosschecked, analyzed and thoroughly edited and processed by using Statistical Program for Social Studies (SPSS 10.0). Processed information was incorporated text and illustrated adequately with tables and maps at

appropriate places in the Standard conversion tables were used to convert local units into metric system (Nepal and Weber, 1993).

4.5 Impact Identification and Prediction (Assessment) Method

There are three principal methods for identifying environmental impacts: Checklists, Matrices, and Flow diagram (Sorensen and Moss, 1973; Warner and Preston, 1973). But during the study two methods Checklists and Matrices were used.

Checklists: Checklists are comprehensive lists of environmental effects and impact indicators designed to stimulate the analyst to think broadly about possible consequences of contemplated actions. This method of impact identification is qualitative and subjective (AEC, 1973). Simple checklists and questionnaire checklists were used during this study.

Matrices: Matrices typically employ a list of human actions in addition to a list of impact indicators. The two are related in a matrix which can be used to identify (to a limited extent) cause-and-effect relationships. Simple matrix was used for this study.

In the whole process of *IEE*, the proper impact assessment exercise, that leaves us with the final evaluation of the **Magnitude, Extent and Duration** of all possible impacts of the project, is the last step. Based on the baseline data, checklists and Matrices the impact was predicted by using Expert judgment Method (NPC, 1993 and Khadka, 2002).

1. **Magnitude** is defined as the extent of each potential impact. It also indicates whether the impact is irreversible or reversible and the potential rate of recovery. The magnitude of an impact cannot be considered high if it can be mitigated. However, the magnitude of the impact is considered serious if the adverse impact cannot be mitigated. A major adverse impact would affect the potential subsistence, recreational or commercial use of biophysical resources by reducing the value of those resources far below a publicly acceptable level. Moderate to minor unmitigated impacts of a similar nature will result in resources still being usable, but as the cost of some inconvenience to the public. In impact prediction, the magnitude is often expressed as High (H), Medium (M) and Low (L).
2. The **Extent** (Punctual, local, regional) of the predicted impact, which refers to the spatial extent of the impact or to the proportion of the population (people, animals, plants) affected by the impacts. A punctual extent therefore refers to an impact affecting a limited number of subjects in the population or a limited area within the impact area (<30%) while a regional extent impact would be defined as affecting a great proportion or affecting the majority of the area of impact (>60%);
3. The **Duration** (short, medium, long) of the predicted impact, which refers to the length of time the affected component, will take to return to the initial recorded state. Short-term impact is defined as less than 5 years and a long-term impact refers to more than 10 years;

Using the Impact Evaluation Matrix as referred in the Scoping Report, the environmental specialists referred to the established Intensity, Extent and Duration of each impact to determine its **Magnitude** (high, medium or low). The impact's Magnitude is an absolute evaluation of its disrupting effect on a specific environmental component. The Significance of each of the impact can also be deducted by taking into account the Environmental value of each component, which was attributed by the specialists according to existing regulations (i.e. protected species or banned activity) and/or local people's appreciation of the component (religious, cultural or economic value).

4.6 Mitigation and Enhancement Measures

Based on the processed information, the impacts were identified and evaluated. Mitigation measures for the adverse impact were proposed based on expert perspective. Benefit augmentation measures were suggested to enhance the benefits. An EMP prepared which focused on the mitigation measures, environmental monitoring and auditing requirement including implementation responsibilities, staffing, reporting budget and co-ordination aspects.

Chapter V

BASELINE INFORMATION

5.1 Physical Environment

The Panchthar District is one of the hilly districts of Eastern Development Region of Nepal. It is boardered by Ilam District and India in the East, Terhathum in the West, Taplejung in the North and Morang and Dhankuta in the South. Ecologically, the district can be categorized into three regions – Midhill, Mountain and High Himalayas.

Mid-hills: Mid-hills are characterized by metamorphosed and weathered rocks. Tropical deciduous forests; sub- tropical shrub-land and subtropical evergreen forest dominate the vegetation in this region.

High mountains: High Mountains are characterized by rugged terrain and upland forests. Vegetation is of the temperate type.

High Himalayas: The peaks or high Himalayas of this region are perennially covered by snow and grassland and pasture cover the lower parts of the ridges for grazing.

The project area is located in Yangmang, Siding, Memeng and Ektin VDCs of Panchthar district. The headworks and powerhouse are proposed in the flat terrain land where as the project pipe alignments are proposed in steep terrain land. Ecologically, the project is located in mid hills region with sub tropical climate.

5.1.1 Geology

The project lies in midland Group of Nepal Himalyan characterized by the presence of rock like quartizite, phyllite, schist, slate etc. Quartzite and phyllite are the dominant rock type of the project area. Mica-schist and salty phyllite are also present at some places. The strike and dip of the rock varies from place to place. The variation in the orientation of the rock is mainly due to local minor folds.

The Headrace site is characterized by slightly weathered to fresh phyllite. The rocks in both banks have no fault. However, there is sliding mass in right bank upstream of headrace site. The power house will be located at the alluvium terrace near the left bank of Hewakhola, which is found strong enough to burden the powerhouse structure.

The detail of the geology of the project site is shown below;

a) Intake Area

The diversion weir Hewa-A Hydroelectric Project is located at an altitude of 1160 m. The left as well as right abutment is characterized by thick to massive bedded schist with gneiss. The intake area of the project site lies mainly on the thick-bedded gneiss of Calcareous schists and

phyllites with biotite-muscovite Formation. The exposure depicts the typical characteristics of this formation in the project area.

The proposed intake site lies on the left bank of Hewa Khola. The country rocks are highly dipping and jointed bedrock. The rock is made of quartz, feldspar and micas as essential minerals. The left and right top banks of the Hewa Khola consist of alluvial deposits deposited by Hewa Khola. The grain size distribution of the material comprising the left bank is as follows:

Table 5.1 Grain Size distribution of the material

Type of Material	Content
Boulders	30%
Cobbles	30%
Pebbles	30%
Fines	10%
Total	100%

(Source: Feasibility Study Report of Hewa- A Hydropower Project)

Past high floods laid down the large boulders around both banks. Therefore, it is recommended to design the intake taking into consideration the high water level and the bed load from the Hewa Khola during such eventsThe river gradient is relatively high in this area therefore. Hence, some river training and protection works may be required during the construction of the Project.

b) Desanding Basin Site

The desanding basin lies on the alluvial deposit on the left bank of Hewa Khola. The alluvial deposit is around 12 m in this area; predominantly consisting of sand particles with frequently huge sub-rounded up to 3 m wide boulders. Below the alluvial deposits schist with gneiss as bedrock can be found. The desanding terrace also comprises of boulder deposits of past high floods. The boulders are predominantly schist and gneiss with mica as dominant mineral. The scattered boulders of gneiss and schist are frequently observed and their average size ranges from 1 m to 5 m.

Detail examination of 1m x 1m x 1m test pit revealed rounded to sub-rounded pebbles, cobbles, and granules of the following proportions:

Table 5.2 Grain Size Distribution of the Material

Type of Material	Content
Boulders	30%
Cobbles	10%
Pebbles	15%
Fines	45%
Total	100%

(Source: Feasibility Study Report of Hewa- A Hydropower Project)

From the table above, it is evident that the materials are truly alluvial deposit with relatively high proportion of sand particles. Thus, permeability and compaction test should be done before construction and special care should be taken to prevent the leakage of water. Since the terrace of desanding basin lies on the high gradient area for the protection of toe cutting the banks, due care should be given to the engineering structures constructed.

c) Penstock Pipe Alignment

Examination of the penstock alignment shows that it passes through the Calcareous schist and phyllites with biotite-muscovite Formation. A brief description of the penstock alignment along with necessary slope stabilization measures is presented below:

Ch 0+000 to Ch 0+500

The penstock passes through the higher crystalline thick-bedded gneiss of the Calcareous schists and phyllites with biotite-muscovite gneiss formation. Mineral composition of this gneiss is similar to that of intake area i.e. quartz, feldspar and micas. Landslides and erosion is not observed along the alignment and thus no major stabilization measure is necessary.

Ch0+500 to Ch 0+1000

In this portion, the penstock alignment passes through the schist and gneiss bedrock and is geologically stable. This alignment passes through a well-vegetated and stable surface.

Ch 0+1000 to Ch 0+1500

The penstock alignment passes through gneiss bedrock with few inter-bedded grey colour schist. The area is geologically stable with gentle slope and is thus safe for the construction.

Ch 0+1500 to Ch 0+2000

The alignment largely passes through the lower portion of gneiss and schist cliff, which is stable for the construction but exhibit quite steep cliff. Retaining structures must be provided. The remaining portion of the penstock alignment is more or less stable.

Ch 0+2000 to Ch 0+2500

The penstock alignment passes through the schist with gneiss terrain. The alignment is stable surface despite the steep slope. It crosses one tributary, named Luwafu Khola, at 2100 m and due care must be taken for crossing this alignment. Construction of anchor blocks and saddle supports is necessary for stabilizing it.

Ch 0+2500 to Ch 0+3000

The alignment runs through stable geology, predominantly consisting of low slope. It is safe for construction and no major geological risks exist.

Ch 0+3000 to Ch 0+3500

The alignment passes through the schist bedrock with gneiss terrain. The slope is stable and does not possess any risk.

Ch 0+3500 to Ch 0+4000

Most part of the alignment runs essentially through the schist bedrock. The alignment passes through the monotonous sequence of stable bedrock. Retaining structures and anchor blocks need to be provided in the steep cliff.

Ch 0+4000 to Ch 0+4500

The alignment passes through the gentle slope. The penstock alignment passes through the thickly bedded schist with frequently inter bedded phyllites. The cliff above this area is well vegetated and the proposed alignment is sufficient for stabilization therefore no risk of failure.

Ch 0+4500 to Ch 0+5089

The alignment passes through the cultivated terrace just above the power house. The penstock alignment mostly passes through thick alluvial deposits. The slope is stable. Anchoring of the penstock pipe is necessary.

d) Powerhouse and Tailrace Site

The powerhouse of Hewa Khola hydropower project is located on the left bank of the river, about 8 m above the flowing river channel, on the alluvial terrace deposited by Hewa Khola. The alluvium near the axis at the river level is found to be 6 to 8 m thick. Thick-bedded higher crystalline schist Calcareous schists and phyllites are observed along the banks.

The deposit on the powerhouse area largely consists of boulders and rocks, thickly bedded schist and gneiss with more or less gentle slope covered by vegetation. Thus, the powerhouse site is stable and safely located.

Examination of 1m x 1m x 1m Test pit revealed that the soil material around the powerhouse is a colluvial deposit with sub-angular pebble, cobbles of gneiss fragments and quartz grain in the following proportion:

Table 5.3: Grain Size Distribution of the material

Type of Material	Content
Boulders	5%
Cobbles	12%
Pebbles	13%
Fines	70%
Total	**100%**

(Source: Feasibility report of Hewa- A Hydropower Project)

5.1.2 Meteorology and Hydrology

There are no meteorological records available for Hewa basin. According to the 'Climatological Records of Nepal' (GoN, DHM), the nearest hydro- meteorological station is at the Phidim Bazzar, the district headquarter of Panchthar District.

5.1.2.1 Temperature

The project area experiences a variety of climate ranging from subtropical to cool temperate climatic condition. Annual temperature data recorded at Phidim Bazzar shows the extreme maximum and minimum temperatures are31.0˚C and 1.1˚C respectively.

5.1.2.2 Rainfall

Precipitation plays an important role in generating flow in the river. Since there is no rainfall data available for the Hewa Basin, the average annual and monsoon basin precipitation have been estimated by constructing Theissen Polygon and Isohyetal map. Therefore, an average precipitation, according to the Theissen Polygon map, in Hewa catchment is 1315.26 mm annually.

5.1.2.3 River *Discharge*

In the headworks of Hewa Project, t the river discharge reaches highest at the month of August (33.06m^3/s) and lowest at the month of April 1.22m^3/s. The design discharge of Hewa Khola is 3.35m^3/s. There is provision of 10% minimum monthly discharge for downstream flow. The downstream release will be required particularly during the months from December to April whereas the river will give enough flow in other months.

5.1.3 Topography

Hewa Khola is one of the Tributaries of the Tamor River in the eastern Nepal. The basin draining to the project area lies in the elevation range of 1150m to 3500m. The major

tributaries of Tamor are Hewa Khola, Muwa Khola, Niwa Khola and Pheme khola. The basin is elongated in the east west direction draining towards the West. The catchment area of the Hewa Khola is *140sq* km. The project elevation ranges between 940m to 1260 m.

5.1.4 Land Use Pattern

The land use types around the project area include forest, cultivated land and government forest associated with river bank and river channel. The land required for the project is cultivated land and forested land. The connecting canal, desending basin and power house of the project lies on cultivated land. The water conveyance system lies on private forest area and cultivated land.

5.1.5 Watershed Condition

The watershed area of the Hewa Khola at headworks is 140sq. km. The upper reach of the basin is mainly covered by dense mixed forest. The lower part of the watershed mainly consists of scattered settlements and cultivable lands with open mixed forests boarders the river bank. The basin is rectangular in shape. Hewa Khola comprises of small and large tributaries upstream of the proposed headwork site. The major tributaries of the river are Hewa khola, Muwa khola, Niwa khola and Pheme Khola.

5.1.6 Sedimentation

The sediment yield in Hewa Khola is found almost insignificant because of the gentle slope of the river. No remarkable landslide has been observed in and above the site. Hewa khola very less sediments mainly consisting of silt boulder have been deposited by the river at the headwork site.

5.1.7 River Water Quality

The Hewa Khola water in the project area was found clean at the time of site visit. To investigate the river water quality, water sample were taken from the following locations: a) proposed intake site b) downstream of the proposed power house. The samples were studied at the field and in the laboratory of Central Department of Environmental Studies, Tribhuvan University, Nepal. On site analysis and laboratory analysis was performed on November, 2008. The investigation data is presented in Table 5.4.

Table 5.4: Water Quality analysis of Hewa Khola

S. No	Parameter	At Intake 11:00 AM	At Powerhouse 3:00 PM	WHO Guidelines
1.Physical	PH	6.7	6.7	6.5-8.5
	Turbidity			5 (max)
	Conductivity	60µs/sec	75µs/sec	

	Temperature	11^{o}c	12^{o}c	
	Total Solids	150mg/L	200mg/L	1000
	Dissolved Solids	9.7mg/L	9.8mg/L	
2.Chemical	Total Alkalinity	22.5 mg/L	22.7mg/L	500
	Chloride	25.56 mg/L	31.5mg/L	250 (max)
	Total Hardness	57 mg/L	52.3mg/L	500
	Calcium hardness	43 mg/L	40mg/L	
	Magnessium hardness	14 mg/L	12.3mg/L	
	Free CO_2	8.8mg/L	6mg/L	
	Nitrate	0.3mg/L	0.25mg/L	50
	Total Phosphate	0mg/L	0mg/L	
	Ammonium	0.012mg/L	0.01mg/L	1.5
	Iron	0.46mg/L	0.4mg/L	0.3
3.Biochemical	Dissolved Oxygen	9.7mg/L	9.8mg/L	
	BOD	3mg/L	4mg/L	
	COD	40mg/L	45mg/L	
4.Biological	Coliforms MPN/100ml	0	0	Nil
	E.coli	0	0	Nil
	Fecal streptococci	0	0	Nil
	Salmonella sps.	0	0	Nil

(Source: Lab analysis, Central Department of Environmental Science, 2008)

Physiochemical analysis of the water sample of Hewa khola was found to be within in the World Health Organization Guidelines values of Drinking water. With low population and the low development activities in the catchment area, water quality of the Hewa khola has not been polluted. The total solids (suspended and dissolved solids) measured at the site showed a value 150mg/l (intake) and 250mg/l (powerhouse). The Turbidity value during monsoon may exceed the WHO guidelines otherwise rest of the parameter may remain within small limit of fluctuation.

5.1.7 Air Quality and Vibration

Existing air quality and vibration of the project area during the study period was found to be normal. The project area does not fall under industrial area, major construction site and road

head area. Therefore, there are no other anthropogenic activities contributing to air pollution and vibration.

5.2 Biological Environment

5.2.1 Flora

Types of vegetation prevailing in the project area like proposed head works, descending basin, penstock alignment, access road and power house were noted. The head works and power house falls on private property whereas alignment falls on both private and public property.

Based on the composition of the plant species in the inventoried area, forest can be categorized as the mixed forest of Chilaune (*Schima wallichii*), Katush (*Castopsis indica*) and Uttis (*Alnus nepalensis*). Detailed of the vegetation is given in Annex 2.

5.2.2.1 Vegetation at Head Works and Desilting Basin

The common tree species along the headworks and desilting basin is *Alnus nepalensis*. In general, the height of the tree ranges from 6m to 45m and Diameter at Breast Height (dbH) from 10cm to 26.3cm. The common shrub species of this region are Alaichi, 'Latte'-(*Galium hirtiflorum)*; 'Niuro'-(*Dryopteris cochleata).* The common herbs were *Curculigo* sp.; *Carophyllas* sp. 'Tilchi'-(*Pilea symmeria)*; and 'Kharuko'-(*Pogonatherum incans)*. The proposed desilting basin doesn't contained forest, it is the paddy land.

5.2.2.2 Vegetation at Penstock Alignment and Powerhouse

The proposed penstock alignment is located on the right edge of the river. The alignment just after the Desilting basin contains uniform forest land. Scattered forest patches and patches of agricultural land up to power house site exists. In general, the height of tree ranges from 12 to 50m and dbH from 10cm to 49cm.

The first *1000m* section of the alignment is covered by sparse vegetation; some part of this section lies in the community forest. The species composition of *Alnus nepalensis, Schima wallichii* and *Castonopsis indica* are in higher density. Though the shrubs composition of this section is similar to the head works region further more species of Banmara, *Myrsine semiserrata* and *Artemisia indica* were encountered. Similarly, herb species like *Hydrocotyle nepalensis*; and *Centella asiatica* etc. were found.

Penstock pipe alignment between *1000m to 2200m* was covered by uniform tree patches of *Schima wallichii and Castonopsis indica.* The common shrubs were *Masea chisa; Colebrookea oppositifolia; Artemisia indica; Sida* sp. *Lindenbergia indica; Girardinia diversifolia* etc. Similarly, *Centella asiatica; Hydrocotyl nepalensis* etc. as herb species were found.

In penstock pipe alignment between 2200m to 3400m, the major tree species recorded are *Schima wallichi, Castonposis indica and Alnus nepalensis*. Some shrubs species like Banmara, Alaichi and *Artemesia ps*. has been observed in this section. The herbs are similar to with headworks area.

After *3400m pipe* alignment section, tree species like *Schima wallichii;* and *Castonopsis indica* were found. While major shrub species in this area were *Artemisia indica; Clematis gariana, Bidens sp*, *Pileasymmeria sp., Nyctanthes arbor, Dioscorea alata, D. bulbifera; Colebrookea oppositifolia; Strobilanthes atropurpureus,* etc. Similarly, major herb species were *Pogonatherum incans; Hydrocotyle nepalensis; Centella asiatica; Ageratum conyzoides*, *Cyperus* sp., *Themeda triandra/Andropogan spp*. etc. The powerhouse area is located on paddy land.

5.2.2.3 Vegetation in the Surrounding area

The plant species *Alnus nepalensis, Schima wallichii* and *Castonopsis indica* covered commonly in the surrounding area but species like *Engelhardia spicata, Shorea robusta, Quercus spp, Bauhinia malbarica, B. variegate, Litsea monoetala, Ficus semicordata, Atocarpous lokoocha, Pinus roxburghhi, Bombax ceiba, Macaranga indica, Sapium insigne, Castonopsis indica, Psidium guajava, Ficus carica, Erithrina stricta and Phyllanthus emblica* were recorded.

5.2.2.4 Standing Wood Volume

The forest area along the project corridor was inventoried to know the possible loss of exact area of forests and forest products. Height and girth of each tree within the sampled area was measured and standing wood volume was calculated by employing the methods as mentioned in the Forest Rues, 1995 (GoN, 1995). Vegetation sampling was done along the headworks to the powerhouse site. In these areas, a total 54 plants were counted; average standing wood volume of a species is calculated to 0.7646 m^3. The total standing wood volume of affected trees is 41.28 m^3 (Annex-3).

5.2.2.5 Ethnobotany

The local people have long tradition of cultivating fodder trees to feed their cattle especially during winter seasons when there are no grasses on the ground. Mainly these fodder trees are grown at the edges on the terraces or in the fallow lands. Some of the fodder trees that were found to be cultivated in the proposed project area are: *Ficus semicordata, Bauhinia variegate, Ficus carica etc. (*Annex-2).

5.2.2.6 Endangered and Threatened Plant Species

There are no rare or endemic plant species in the entire project area. However, *Bombax ceiba* and *Shorea robusta* found within project impact area belong to threatened category. These

species have a threatened status mainly due to habitat loss under human pressure and over exploitation for economic purposes.

5.2.3 Fauna

5.2.3.1 Mammals

The study area encompasses suitable habitat for very common wildlife rather than endangered, vulnerable and IUCN categories. A total of 16 mammalian species were confirmed from the study area. Some mammals, which are listed in CITES categories are Langur (*Presbytis entellus)* of Appendix I, Monkey (*Macaca sp*.) Ban biralo (*Felis sp*.) ofAppendix II and Syal (*Canis aureus)* of Appendix III are supposed to have their identity in the project impact area. Besides Dumshi (*Hystrix indica)*, Fyauro (*Vulpes vulpes*), Malsaproo species *(Mustela strigidorsa* and *Mustela kathiah)* Musa (*Rattus rattus*) are other commonly found mammals in the area. The list of mammals found in the project area is given in Annex-2.

5.2.3.2 Amphibians and Reptiles

From the inventoried made along the project impact area almost four species of reptiles and two species of amphibians were recorded. The common reptiles are green pit viper (Trimeresurus albolaris), house lizard (*Hemydactydactylus flavivirides)* Black-bellied rough side snake (*Trachichium fuscum)* and Black bellied rough side snake(*Asymblepharus sikkimensis*) and common amphibians are Frog (*Rana cyanophlyctus)* and Toad (*Bufo melanostictus).*

5.2.3.3 Fish

Hewa Khola along the project area is moderate gradient and chocked with many large boulders. Generally, the high velocity of this river with pool areas with fish sheltering rocks, stones and the river bed covered with gravel makes suitable ground for fish spawning activities. Water quality analysis shows the growth suitability of fish and aquatic life. The value of dissolved oxygen content (an important parameter for water quality in relation with flora and wildlife), was measured to be 8 and 10 mg/L. The pH value of water was also measured during fish sampling and was again analyzed in the lab and both measures indicated neutral characteristics of water, which is suitable for fish growth.

According to local Fisherman, major types of fish prevailing in the project area are Asala (common), Kabre (common), Katle (sparse). The common fishing method being used by fisherman in the project area was pole, cast net, loop and hook whereas using of latex from stem and leaves of Khirro plant as toxin to fish was also noted as alternative way of fishing. The productive fishing months are Jestha (May-June) and Asoj (September-October). The local market price of fish is 150 NRs/kg according to the market survey. Major uses of fish are for food.

5.2.3.4 Birds

The study area doesn't lies in the protected area but about 16 species of birds were confirmed at project area during the study period. Of the recorded bird species, the only species Kaliz (*Lophura leucomelana*) is found under protection of GoN. The list of bird species is given in Annex 2.

5.3 Socioeconomic and Cultural Environment

Implementing any type of construction activities will definitely bring changes to the existing environment, be it physical, biological or socio economic and cultural. If at present, the local communities are experiencing fairly stable communal interrelationships, based on years of adjustment/habits, after the project intrudes into the regional/local settings, the local people will be deprived of the rights enjoyed by them till now. Thus, it is essential to understand the present settings regarding the socio-economic and cultural environment of the project area. This subchapter deals with the baseline conditions/profiles from the regional/district and project impact area levels.

5.3.1 Demography in the Project Affected VDC.

People with different origins lives in this area. Population density in these villages is very low because of the scattered villages. Kirat has the dominant population. The demography of project affected VDCs is presented on Table 5.5.

Table 5.5: Demography of the Project Affected VDCs

S.No.	Name of VDC	HH No.	Male	Female	Total
1	Sidin	789	2670	2511	5181
2	Yangnam	1018	3231	3231	6462
3	Yektin	988	2986	2807	5790
4	Memeng	790	2769	2491	5260

(Source: District Development Programme, 2059-60, District Development Committee, Phidim, Panchthar.)

5.3.2 Demography of PAFs

The area is sparsely populated and economically downtrodden. The average population size of PAFs is 9.2. The project area is dominated by Rai and Limbu followed by Brahmin and chhetri. Demography of PAFs is shown on table 5.6.

Table 5.6: Demography of PAFs

Area	HH No.	Male	Female	Total	Average HH size
Project Affected Family	15	72	66	138	9.2

(Source: Field Survey, 2008)

5.3.3 Age Group of PAFs

Altogether 27 households in Yangnam, Sidin and Memeng and Yektin VDCs will be directly affected by the project due to acquisition of land, buildings and sheds. Out of these 27 households 15 households were surveyed. .The age group of project affected family (PAFs) is presented in Table 5.7.

Table 5.7: Population PAFs by Age Group

Age Group	Number	percentage
0-6 Years	25	18.11
6-18 Years	37	26.81
18-58 Years	58	42.02
58+ Years	18	13.04
Total	138	100

(Source: Household Survey 2008)

5.3.4 Ethnic Composition and Religion

The project area is dominated by Rai and Limbu caste followed by Brahmin, Chhettri and others. Among Rai and Limbu, Limbu are highly dominated. The population according to caste of project affected VDCs are presented on table 5.8.

Table 5.8: Population According to Caste

S. No	Name of VDC	Brahmin	Chhetri	Newar	Gurung	Magar	Tamang	Rai	Limbu
1	Sidin	26	7	0	17	75	31	292	337
2	Yangnam	49	31	2	0	5	0	64	385
3	Yektin	168	215	5	0	7	38	12	367
4	Memeng	68	49	0	32	0	2	236	183

(Source: First Period District development Programme, 2059-60, District Development Committee, Phidim, Panchthar.)

The Kirat are the predominant ethnic group followed by Brahmin and Chhetri. Rai and Limbu caste are called Kirat. Among the project affected VDCs, Yangnam VDC is exceptional in which Hindus are dominated whereas rest of the VDCs Kirats are dominated. Religious composition of each affected VDC is shown in Table 5.9.

Table 5.9: Population According to Religion

S.No	Name of VDC	Kirat	Hindu	Buddhist	Christian	Muslim
1	Sidin	606	129	53	1	0
2	Yangnam	806	208	2	0	2
3	Yektin	420	503	63	0	2
4	Memeng	632	124	33	1	0

(Source: District Development Programme, 2059-60, District Development Committee, Phidim, Panchthar.)

There is more or less equal number of Kirant and Hindus religious people among the project affected area. The distribution of religion among the project affected families is shown in Table 5.10.

Table 5.10: Distribution of Religion among PAFs

Ethnicity	No of Family	Percentage
Hindu	7	46.7
Kirat	8	53.3
Total	15	100.0

(Source: Household Survey 2008)

5.3.3 Education

The literacy level of PAFs is 49.65%, which is higher than the national average, 39.6%. Out of total population of PAFs, 24.11% attained primary level education, 9.92% have lower secondary level, 14.18% have secondary level, 0.70% attained intermediate level, and 0.70% attained bachelor level education.

Table 5.11: Education Status of PAFs

Level	% of Population
Primary	24.11
Lower secondary	9.92
Secondary	14.18
Intermediate	0.70
Bachelor	0.70
Illiterate	50.35

(Source: Household survey 2008)

5.3.4 Occupation

Majority members of PAFs are engaged in agriculture and animal husbandry. Of the surveyed households, 49.64% are engaged fulltime in agricultural and animal husbandry. A significant population, 34.04% are economically inactive population of age group below 6 years and above 58 years of age. Other occupations taken by PAFs are services (7.84%), armed force (2.83%) and Carpentry and Others (2.83%).

Table 5.12: Occupational Distribution of PAFs

Sector	% Population
Agriculture/Livestock	49.64
Service (Teaching)	7.84
Armed Force	2.83
Carpentry and Others	2.83
Incapable	34.04

(Source: Household Survey, 2008)

5.3.5 Land Holding

The size of land holding varies among PAFs and variation is between 0 to 60 Ropanis. An average size of land of PAF is 30.36 ropani, which includes 14.733 ropani paddy land, 6.633 ropani of non-irrigated upland and 9 ropani of pakho/grassland/ forests. The average land holding size of PAF is shown in table 5.13.

Table 5.13: Landholding by PAFs

Land/Land Holding	Minimum (Ropani)	Maximum (Ropani)	Average Land per Households (Ropani)
Paddy Land	0	60.00	14.73
Non Irrigated Upland	0	39.00	6.63
Pakho/Grassland/Forest	0	43.00	9.00

(*Source: Household survey, 2008*)

5.3.6 Irrigation

Hewa Khola flows from the deep valleys. The main sources of irrigation of this area are other small tributaries (Kholsa) of Hewa Khola. There is one irrigation canal at the downstream of the headworks using water of Hewakhola. The canal has capacity of 50l/sec discharge. About 40 ropani has been irrigated by this canal. Of the total household of PAFs, only 13% of the total PAF households use Hewa khola for irrigation. The irrigation source of project affected families is presented in Table 5.14.

Table: 5.14: Source of Irrigation

Source of Irrigation	% PAFs
Hewa Khola	13.3
Khola other than Hewa	66.7
Monsoon	20.0

(Source : Household Survey, 2008)

5.3.6 Agricultural Products and Productivity

Paddy, maize and millets are major cereal crops grown by PAFs. Vegetables, mustard and fruits are major cash crops grown by them just to satisfy their own needs. Recently cardamom farming has been popular in this area for commercial value. Villagers have planted cardamom in the paddy land. Agricultural types and productivity of PAFs is presented in Table 5.15.

Table 5.15: Agricultural Types and Productivity

Types of crops	Traditional Statistics Muri/HH	Standard Statics Kg/HHs
Cereal Crops		
Paddy	16.533	826.65
Maize	5.333	319.98
Millet	1.2667	76.002
Cash Crop		
Black Cardamom	10.1	603.5
Vegetable	Sustainable	Sustainable
Mustard	Sustainable	Sustainable
Fruits	Sustainable	Sustainable

(Source: Household Survey, 2008)

(Conversion for local unit into standard unit by Nepal and Weber, 1993)

5.3.7 Food Sufficiency

Of the total population of the PAFs, 26.66% produce enough food from their land for their annual requirement. Whereas, 46.66 % PAFs produce food for nine months and 6.66% of PAFs produce food enough for three months only. It was found that the higher percentages (73.34%) of PAFs produce food for less than 12 months. The food sufficiency of project affected families is presented in table 5.16.

Table 5.16: Food Sufficiency of PAFs.

Food Sufficiency	No of HH	%PAFs
Enough for three Month	1	6.66
Enough for six month	3	20.00
Enough for Nine month	7	46.66
Enough for Twelve month	4	26.66

(Source: Household Survey *2008)*

5.3.7 Income Source

The main source of income of PAFs is agriculture and animal husbandry. These days income from cash crop of black cardamom has been popular and is the main income generating source from the agriculture. Among the PAFs 59% of HH has agriculture as the main source of income, 13.3% HH have government service and 26.7% HH depends on daily wages.

Table 5.17 Main source of income of PAFs

Main Source of Income	No of HH	Percent
Employment	2	13.3
Agriculture	9	59
Daily Wages	4	26.7

(Source: Household Survey 2008*)*

5.3.8 Livestock Holding

Animal husbandry is a major contributor to the household income of PAFs. They rear cattle, buffalo, goats, pig, and poultry. Cattle and buffalo are kept for milk, ghee and manure, while goats and pig are kept for meat and for sale. Average number of livestock per household of PAFs is shown in Table 5.18.

Table 5.18: Average Livestock Holding of PAFs

Types of Livestock	Total No of Livestock	No of Livestock per HH
Cow	32	2.1333
Buffalo	16	1.067
Ox	14	0.9333
Goat	25	1.6667
Pig	6	0.4000

(Source: Household Survey, 2008)

5.3.9 Settlement Patterns

Household settlement at the project area is scattered. All the PAFs have their own house. Of the total household of PAFs, 86.67% have two storied houses and remaining 6.67% have one storied houses. All the houses are built with mud mortar stones and majority of houses are roofed by corrugated sheets. The number of house with different number of story is shown in Table 5.19.

Table 5.19: House with Different Number of Story

Description	% PAF
One Story	6.666667
Two Story	86.66667

(Source: Household Survey 2008)

5.3.10 Energy Use

Main source of energy of the PAFs is fuel wood. They obtained fuel wood from their nearest forest. Of the total PAFs, 73% obtain fuel wood from their own forest, 13.3 % obtain from the community forest and 13.3% obtain from other sources. Almost all the members of of PAF use fuel wood for cooking. Lightening in the house is done by kerosene and solar panel. Electricity connection is not available in the project area.

Table 5.20: Different Source of Fuelwood of PAFs for Cooking

Source of Fuel wood	No of HH	Percentage
Private Forest	11	73.3
Community Forest	2	13.3
Others	2	13.3
Total	15	100.0

(Source: Household Survey 2008)

5.3.11 Drinking Water

The PAFs are sustaining the purpose of drinking water with temporary pipe water supply which gets off during monsoon season, the season that needs quality drinkable water. Almost PAFs are fed by the spring water with or without tap water supply, though some of them are still dependent upon rivulets.

5.3.12 Social Service Facilities

The core project area lacks major basic infrastructure facilities. The nearest bazaar to the project area is Phidim, the district headquarter of Panchthar, which is away from one and half

hour walking distance. The social service facilities and their distance from the project area is shown in Table 5.21.

Table 5.21: Social Service Facilities and their Distance from Project site

Social Services	Minimum distances for Social Services **(Minutes)**	Maximum distances for Social Services **(Minutes)**	Mean distances for Social Services **(Minutes)**
Primary School	5.00	120.00	29.6667
Health post	30.00	200.00	98.6667
Bus stop	20.00	420.00	297.3333
Mettaled road	300.00	420.00	316.0000
Bank	90.00	420.00	288.0000
Co-operattive	90.00	420.00	206.0000
Bazzar	90.00	420.00	302.0000
Agriculture Centre	90.00	420.00	164.0000
NGO/INGO	300.00	420.00	316.0000

(Source: Household Survey 2008)

5.3.13 Communication Facilities

There is no cable network for communication system; however CDMA (Code Division Multiple Access) telephone system has been accessed at the project area for communication. Many people owned CDMA phone system. Likewise cellular mobile phone is also popular in the project area. Now a days, CDMA and cellular mobile phones are popular for communication in remote areas. There is also data transfer facility with CDMA telephone system.

5.3.14 Social Organizations

There are five social organizations working for the social welfare in the project affected VDCs. These organizations are in the form of club, cooperative and small association. . The list of social organization is presented in Table 5.22.

Table 5.22: Social Organizations on the Project Affected Area

S.No	Name of the NGO
1	Sunakhari Yuva Club, Memeng
2	Seseling Sana Krishak samuha, Yangnam- 7
3	Chhintapu Sana kishan Krishak Krishi Samuha, Yangnam
4	Laligurans Club, Sidin
5	Manab Bikash tatha Samudayik Sewa, Yangnam

(First Period District development Programme, 2059-60, District Development Committee, Phidim, Panchthar.)

5.3.15 Economic activities

Agriculture is the major source of income of the project affected families. Rice, maize and millet are the important crops. Goat and sheep farming are the additional income of agricultural production. Almost all PAFS have cardamom farming, which is one of the important source of income of the project area. Few family members of PAFs are engaged in the government services.

Pasu Sewa Kendra, Krishi Sewa Kendra and Krishak Samuha are local financial institutions that support for agricultural production and trade. Besides agricultural products there is no external trade of other products.

5.3.16 Status of Women

The general status and role of women among PAFs is also primarily that of bearing, rearing and caring of children and taking care of sick, elderly and other adult members of the family. They also have to be engaged in household works such as cooking, cleaning, washing, and food processing, household maintenance, hygiene and sanitation activities. As with the general status of Nepalese women, the women in PAFs have also no property in their name. Normally, the girls get married at 14-25 years of age. The average age of women at first delivery is 19 years. About 93.7% of deliveries are done at home through the traditional method with the help of local mid-wife (Sudeni). In the project area advice of the women is sought during the decision-makings for different activities such as health and sanitation, shopping and education of children, purchase and sale of commodities, borrowing money etc.

5.3.17 Gender

There is no discrimination between the son and daughter in terms of education and other households' works. The ratio of schooling of son and daughter in VDC is somehow equal. Culturally men are supposed to work outside the home and women are supposed to work inside the house. Father is dominant person of the house.

The average marriage age is 18-25years for boys and 14-20 years for girls. Family planning and contraceptives are not commonly used. The family generally becomes separated after the married of son.

5.3.18 Religious, Cultural Sites and Festivals

The project area is rich in culture and tradition. The culture and tradition differs among ethnicity. Rai and Limbu are the dominant and they have their own culture and religion. They have their own language. There is language different among Rai and Limbus. They believe on Kirat culture. The other ethnic groups like Brahmin, Chhetri, etc. are Hindus and they have adopted culture and festivals of Hindus. Nepali is the common language used to communicate with other communities. Ubhauli, Udhauliare the main festival of Kirat culture whereas Dashain, Tihar are the principal festivals of Hundus culture in the project area.

There is crematory site at the right bank of the Hewa Khola,, which lies 2 km below the diversion weir.

Chapter VI

RESULT

6.1 Impact Identification and Prediction

Implementation of any project in mountainous area is likely to produce environmental impacts on that area. The impacts may be beneficial or adverse, short term or long term, site specific or regional in nature. In hydropower the environmental implications will occur during the construction and operation stages.

Hewa-A Hydropower Project has approved the Terms of Reference (TOR) from the Ministry of Water Resources to carry out detail environmental study. In order to keep the stuffy as per the TOR of the study, impact on each issue has been discussed. Impacts are identified and predicted in terms of their magnitude, extent and duration. The possible environmental impacts has been identified and studied on physical, biological, and socioeconomic environment as per approved TOR. An environmental impact matrix (ANNEX-4.) is also prepared to illustrate the magnitude, extend and duration of the probable impacts.

6.1.1. Physical Impact

6.1.1.1 Meteorology and Hydrology

The Hewa-A is a small run-of-the river type hydroelectric project with no major poundage area. Therefore, Hewa-A is not expected to have any serious impact by meteorological and climatic events during construction and operation.

6.1.1.2 Land Use

a) Construction phase

By the construction and implementation of this project, the existing land use pattern will undergo some changes. During the implementation of the project, some part of the land will be acquired permanently and some part of the land will be acquired temporarily. The land acquired at headworks is flat terrace at left bank of Hewa Khola, whereas penstock alignment is flat, moderate and steep topographic terrain mainly covered by sparse vegetation and cultivation. Similarly, the land at powerhouse and tailrace area is alluvial terrace deposit of the Hewa River.

Temporary impact on land is caused by the construction of temporary buildings such as staff quarter, godown, office buildings, camp house and access road. The excavation work and other construction activities will also have impacts on upstream and downstream land during the construction phase. During construction phase about 5.262 ha. land is expected to be acquired. In terms of ownership, of the total temporary acquired land, 2.054 ha. is private

land, 3.208 ha. public land including 0.54ha. of Community Forest land. Impact on temporary use of land is site specific, short term and low in terms of magnitude.

Permanent impact on land is caused by the construction of permanent project structures such as power canal, desander, penstock pipe alignment, powerhouse, tailrace, etc. The project requires 3.92 ha land for project components. In terms of ownership, of the total permanent acquired land, 2.12 ha. is private land, 1.80 ha. public land including 0.36ha. of Community Forest land. Impact on permanent use of land is site specific, long term and medium in terms of magnitude. Impact on land use is presented in Table 6.1.

Table: 6.1 Land Use of Hewa Khola Hydropower Project

S.No.	Description of Chainage	Land use Category						Remark
		Private land (ha)			Public Land (ha)			
		Paddy Land	Upland	Forest Land	bare	Bushy	Forest	
Long Term Use (Permanent Use)								
1	Intake			0.1				forest
2	Connecting Canal	0.32						Cultivated
3	Desander	0.2						Cultivated
2	Painstock Alignment						0.36	Community Forest
3	Painstock Alignment		1.2					Cultivated upland
4	Painstock Alignment						1.44	Government forest
6	Ph+ Swithyard	0.3						Cultivated Land
	Total	0.82	1.2	0.1			1.80	3.92
Short Term use (Temporary Use)								
S.No.	Description of Chainage	Land use Category						Remark
		Private land (ha)			Public Land (ha)			
		Paddy Land	Upland	Forest Land	bare	Bushy	Forest	
1	Painstock Alignment		1.8				0.54+2.16	Community Forest and Government Forest
2	Powerhouse and labor Camp	0.254			0.508			
	Total	0.254	1.8		0.508		2.70	5.262

b) Operation Phase

During operation no further land use will be acquired. Therefore, there will be no impact on land use during operation phase.

6.1.1.3 River Morphology

a) Construction Phase

River morphology will be affected by the use of water and by aggravation and degradation processes of river. The construction of diversion weir generally started during the lean season in which the river discharge of water will be minimal. During that period water will be diverted at one side and intake work will be carried out. After completion of intake, the flow will be diverted into the intake and other side of the construction will be carried out. As the project lies between the two valleys, impact on river morphology is expected to be low in terms of magnitude, local in terms of extent and short in terms of duration.

b) Operation Phase

The project diversion weir will be laid across the river with a minimum height. The design discharge will be diverted into the intake and the remaining discharge will overflow from the weir. Thus, course of the water will remain same. The impact on river morphology is expected to be low in terms of magnitude, site specific in terms of extent and long term in terms of duration.

6.1.1.4 Water Quality

a) Construction Phase

Increase in population in the project area during construction will increase in organic pollution of the Hewa Khola. Indeed, poor sanitation practices (i.e. increased bathing and defecation in the river or outpouring of the waste water from workforce camps directly into the river) will increase the organic pollution of the rivers which could be dangerous to human health and aquatic life. Poor waste management may also result in accumulation of debris in river water.

Contamination by petroleum products and some metals (i.e. Lead) may also be poured during construction if vehicles are cleaned or repaired in or close to the river or if petroleum products are accidentally spilled in the river course. Color and turbidity of the water will also be modified when sediments are put in suspension by activities in the river. By being of low intensity, regional extent and short-term duration, the impact of project activities on river quality is expected to be of low magnitude.

b) Operation Phase

The project will utilize 3.35 cumecs water to run the project in full capacity, which is available for seven months. Hydrological data shows that more than 3.35 cumecs water is

available for seven months (June – December) and the remaining months the water level goes down. So, for these months there will be less impacts on aquatic life. However, for the remaining months there will be a minimum dry flow at a stretch of about 4.5 kilometers from the headworks to the powerhouse site during operation phase. This will have impact on water quality. Long-term changes in water parameters due to flow reduction in Hewa Khola are expected to be of low intensity mainly due to the renewing process that will take place in flood season each year. However, due to its low intensity, local extent and long-term duration, the impact of modified hydrology below weir on water quality is expected to be of medium magnitude.

6.1.1.5 Landslide and Soil Erosion

a) Construction Phase

Geological study of Hewa-A Hydropower Project confirms that the intake and powerhouse sites are safe from landside and soil erosion. Regarding the penstock alignment, 80 percent of the alignment runs on the colluvium and alluvium soils; the remaining portion is on the rock exposure. The study indicates that the majority of the slopes along the proposed penstock alignment are stable.

By the excavation of land for anchor block and saddle supports at the penstock alignment, small landslide may appear and cause damage to the low land. Similarly, small landslide and soil erosion might occur along penstock alignment during excavation and installation. The impact on landslide and soil erosion is expected to be low in terms of magnitude, site specific in terms of extent and short in terms of duration.

b) Operation Phase

No impact on land slide and soil erosion is expected to occur during the operation phase.

6.1.1.6 Slope Stability

a) Construction Phase

The excavation of land for construction work will have impact on the slope stability at the adjoining area of the construction site. The slope instability will also be created by the blasting activities and high traffic load. The impact of slope stability is expected to be low in terms of magnitude, site specific in terms of extent and short in terms of duration.

b) Operation Phase

No further impact on slope stability is expected to occur during the operation phase.

6.1.1.7 Muck Disposal and Stock Piling

a) Construction Phase

During the construction period, excavation work at diversion weir, intake, gravel trap, desander, saddle support, penstock alignment, powerhouse and tailrace canal will generate soil and debris. It creates impacts on surrounding crops and changes the stability of upstream and downstream land. The excavation of river bed materials from weir construction and powerhouse disposal increases the turbidity and sediment in the river. The disposed muck might create impact on drainage system. The impact on muck disposal and stock piling is expected to be local in terms of extent, low in terms of magnitude and short in terms of duration.

b) Operation Phase

The impact on muck disposal during operation period may occur for the first couple of years. The impact is expected to be low in terms of magnitude, site specific in terms of extent and short in terms of duration.

6.1.1.8 Quarry Sites

a) Construction Phase

The project area has sufficient construction materials at the riverside. For a small-scale project, construction materials available in the riverside will be sufficient to build the project structures. The excavation of construction materials from river bed may change the river morphology. The impact on quarry site is expected to be site specific, low in terms of magnitude and short in terms of duration.

b) Operation Phase

No impact is envisaged to occur during the operation phase.

6.1.1.9 Waste Disposal

a) Construction Phase

During the construction work, the influx of worker will be high. They will generate solid food waste products daily. Similarly, there may have haphazardly disposal of construction waster such as sacks, form works, rods, etc. The muck and unmanaged solid waste will generate on health hazard and has possibility to spread in the local area. The impact of waste disposal is expected to be site specific in terms of location, short term in terms of duration and local in terms of extent.

b) Operation Phase

No impact is envisaged to occur during the operation phase.

6.1.1.10 Air, Noise Pollution and Vibration

a) Construction Phase

Use of blasting materials, excavation of land and rocks, operation of machinery and vehicular movement will affect the air quality, noise pollution and vibration in and around the project area. Use of backup generators will also have air as well as noise pollution. The impact of air and noise pollution is expected to be site specific, low in terms of magnitude and short in terms of duration.

b) Operation Phase

Hydropower is considered as clean renewable energy, air will not be polluted by the project during operation phase. Also noise pollution and vibration is not envisaged to occur during operation phase.

6.1.2 Biological Impacts

The biological impacts are caused by human activities, use of land and natural resources for construction work. The impacts are direct or indirect. The direct impacts are by utilization of land, natural resources such as fuel wood, water and other forest products. Indirect impacts are caused by human interference, loss of habitat, etc.; as a result wildlife will be migrated from their habitat. Therefore, the size of impact is directly associated with the mass of working people and their settlement.

6.1.2.1 Flora

a) Construction Phase

More significant impact on the natural vegetation will be in the area located for construction of temporary and permanent camps. Due to excavation, headworks and powerhouse significant number of trees loss occur. There will be loss of vegetation cover will be nominal due to Penstock alignment. The penstock alignment passes through the sparse sub tropical mixed hard wood forest. Demand for fuel wood will increase. Large no of human resources temporarily migrate to the project site during the construction period will create extra pressure on local forest resources. The impact on flora will be moderate, short duration, and site specific. No of tree cut down is shown on table 6.2.

Table 6.2: No of Tree Cut Down During Project Construction

Project Location	Type of Forest	No of trees cut down	ASWV (m^3)	SWV
Penstock alignment and access road	Community and Private and Government	374	17.37	158.

(Source: Field Survey, 2008)

(ASWV =Average Standing Wood Volume, SWV= Standing Wood Volume)

b) Operation Phase

During the operation phase no further tree fell down will occur. Therefore, no impact is envisaged to occur during the operation phase.

6.1.2.2 Fauna

a) Construction Phase

The clearance of forest, its fragmentation and construction activities will cause impact on wildlife, avifauna and their habitat. During construction at the forest area, impacts on wildlife habitat, feeding, hatching will take place. The influx of people and workforce will create disturbance to the wild habitants. Similarly, poaching activities may arise by the workforce. Blasting and heavy vehicular movements may enforce avifauna to change their habitats. The impact on fauna is expected to be site specific in terms extent, medium in terms of magnitude and short in terms of duration.

b) Operation Phase

No serious impact is envisaged to occur during the operation phase; however, the vehicular movement on road and penstock alignment may create some disturbance for the movement of wildlife. The impact on fauna during operation phase is expected to be site specific in terms extent, low in terms of magnitude and long in terms of duration.

6.1.2.3 Fish and Aquatic life

a) Construction Phase

Higher sediment concentration could result during project construction period by the following project activities: project activities in river bed, unplanned spoil disposal, discharge in the river of sediment loaded water such as surface runoff from work areas and waste water from crusher or other land based project activity. Suspended particles can alter the physical properties of aquatic habitats (spawning and rearing beds, food and oxygen availability, reduced visibility) and can harm fish, fingerlings, fry and eggs directly (plug and abrade gill tissue, cement surface of eggs, etc). The project structures except the headwork are away from the river bank the impact is expected to be low. By possibly being of low intensity, local extent and short-term duration, the impact of increase in suspended solids concentration by project activities on fish population is said to be of medium magnitude during construction.

b) Operation Phase

During operation phase the flow of water will be diverted into the intake to run the project and water greater than design discharge will be spilled out during seven wet month and remaining five dry months (Poush to Baisakh) the lower discharge of water may have impact to modify certain water parameters in reduced flow section.

Water quality parameters are closely interrelated and a modification of one usually results in changes of many others. For example, a lower water flow will probably result in a lower

content of Dissolved Oxygen and in a higher water temperature, the two parameters to which fish are the most sensitive.

During dry months, the water temperature rise up and food availability in the river might be reduced and will overall cause the reduction of fish productivity. Aquatic environment of Hewa will be affected by the deterioration of water quality and quantity, loss of spawning grounds and interruption of migratory route of the many mid and long distance migratory fishes.

The diversion weir constructed across the river at headwork will disturb fish movement at upstream.

The long term impact of seasonal reduction of flow in the 4.5 km section of the Hewa Khola is difficult to evaluate. However, if dry out of the river occur, high intensity, local extent and long term duration, the impact on fish resources in the impact area is expected to be high even if seasonal.

6.1.2.4 Rare, Endangered and Threatened Species

a) Construction Phase

Rare, endangered and vulnerable species have not found in the project area, however, *Bombax ceiba* and *Shorea robusta* are found as threatened species close to the project area. Likewise, fauna listed in CITES categories are Langur (*Presbytis entellus)* of Appendix I, Monkey (*Macaca sp*.) Ban biralo (*Felis sp*.) of Appendix II and Syal (*Canis aureus)* of Appendix III are found in the project `area. By the habitat fragmentation at the penstock alignment, some impact may occur on the wild species. The impact on rare, endangered, threatened species is expected as site specific in site specific in terms extent, low in terms of magnitude and regional in terms of duration.

b) Operation Phase

No impact on rare, endangered and threatened species is expected to occur during the operation phase.

6.1.3 Socio-economic and Cultural Environment

6.1.3.1 Demography

a) Construction Phase

The increase in number of workers and their dependents in the impact area will likely make the area overcrowded during construction period. The workers are also expected to be mainly composed of men (Anti-social behaviors like: Drunkenness, Prostitution and Gambling during project implementation is a severe case to be noted). This may lead the change in social behavior. By being of low intensity, regional extent and short-term duration, the impact

of increase and change in population structure on demographic characteristics in the area is expected to be medium.

b) Operation Phase

No negative impact on demography has been envisaged during the operational phase.

6.1.3.2 Land Acquisition

a) Construction Phase

Land use changes will occur due to acquisition of land for the construction and erection of project structures. A total of 9.18ha of private and government land under different uses will be affected by the proposed project. Of the total estimated land, only 3.92 ha land will be occupied and used for the construction of headworks, penstock pipes and their supports, power house, etc. resulting permanent change in land use. The remaining 5.26 land will be occupied for the temporary purpose for the labor camp, godown and dumping purpose and that can be restored after the completion of construction work.

The construction and layout of penstock pipe will defragment land into many pieces. The anticipated effects of fragmentation and change in land use are largely limited to construction period. The permanent use of land for head works, pipe alignment and powerhouse will lose crop productively permanently and this process is irreversible. So the impact on land use is expected high intensity, local extent and long-term duration, the impact of land buying transactions on land holding is expected to be of high magnitude.

b) Operation Phase

No further land will be occupied by the project. Thus, no impact on land use is expected to occur during the operation phase.

6.1.3.3 Loss of Standing crop

a) Construction Phase

The construction of this project will lose standing crops for one crop year. The paddy crop will be lost from 1.07 ha. irrigated land. Similarly, maize and millet will be lost from 3 hectare non irrigated upland. An average one crop rice production per ropani at the project area is 150 kg. Similarly, an average on crop production of maize and millet per ropani at the project area is 120kg. Therefore 3.15 tones of paddy and 14.15 tones of millet and 14.15 tones of maize will be lost from 1.07ha irrigated land and 6 hectare non irrigated upland will be lost from this project. By the loss of standing crop the production of remaining crop will be inadequate to the affected families and have to buy from the market for their annual requirement. Thus, impact of loss of standing crop will have site specific medium in magnitude and medium in terms of duration.

b) Operation Phase

No impact on loss of standing crop is expected to occur during the operation phase.

6.1.3.4 Occupational Health Hazard and Safety

a) Construction Phase

Construction activities such as blasting, heavy equipments movement, river diversion, wielding, x-ray, acid bath, working in cliff might cause accidents and injuries to the workers as well as the local people. Lack of adequate training and unavailability of safety equipments might cause serious injuries to the workers. Excavation of penstock alignment generates small landslide and a gap between the two edges, may causes disturbance for the movement of the local people, cattle and wildlife. Working in diversion weir or collection of construction materials from the river may cause accidents to the workers during the unpredictable monsoon season. The impact on occupational health hazard and safety is expected to be site specific, low in terms of magnitude and short in terms of duration.

b) Operation Phase

The occupational health hazard and safety will have less impact. However, operation of intake and flushing during monsoon season might cause accidents to the workers.

6.1.3.5 Gender Issues

a) Construction Phase

There is no gender discrimination by law in Nepal; however, there are many cases of gender discrimination in construction field. Thus, the contractor might discriminate between male and female. The wage rate and employment opportunities might be unequal. The impact on gender issues is expected to be site specific, low in terms of magnitude and short in terms of duration.

b) Operation Phase

The company will hire permanent employees to run the project. They will be treated according to the rules and regulation of the company. Therefore, no impact is expected to occur during the operation Phase.

6.1.3.6 Impact on Law and Order

a) Construction Phase

Influx of workforce may create pressure to the local government due to internal conflict among the workers. Also the workforce might be unable to maintain cordial relationship with the local people. This might create incidents and disturb the project activities. As the project site is small and located far to the residence area, impact on law and order is expected to be site specific, low in terms of magnitude and short in terms of duration.

b) Operation Phase

During operational phase the things will be settled and there will be less probability of occurrence of impact on law and order.

6.1.3.7 Impact on People's Behavior due to Increased Economic Activities

a) Construction Phase

During the construction phase many people work at the same time. It will create demand to the local products like vegetables, cereals, flesh milk and milk products etc. the high demand will hike the existing prices. On one hand local people will be benefitted by selling their local products, on the other hand local people who used to buy the local products from their daily earning will be affected by the price hike. As the project size is small and short term in nature the impact on increased economic activities is expected to be site specific, medium in terms of magnitude and short in terms of duration.

b) Operation Phase

At operation phase the market and employment will be reduced. A limited number of people have permanent employment and limited people stayed there to continue their business. So majority of the people will be without job and business opportunity. This will lead the local people to search market and employment opportunity for another place to maintain previous income. The impact on decreased economic activities is expected to be site specific, medium in term of magnitude and long in terms of duration.

6.1.3.8 Impacts on Communal Resources

a) Construction Phase

Due to presence of large scale outside worker the pressure communal resources will be occurred. Health system and drinking water supply might be stress due to additional people in the project area. The impact on communal resource is expected to be site specific, low in terms of magnitude and short in terms of duration.

b) Operation Phase

After the construction work only limited people will present to operate the project and additional resources has already been built to fulfill the construction workers. Thus no impact is expected to occur during the operation phase.

6.1.3.9 Child labor

a) Construction phase

As for any project in Nepal, the risk of having contractors hiring children less than 16 years of age at low wage to work for the project is very high. Despite GoN ban on child labor, it remains a potential temptation in an economically poor region such as the proposed Hewa-A area. The Labor Act of 1991 defines "child" as 'a person who has not attained the age of 14

years', and in section 2.5.1 it is explicitly states that "no child shall be engaged in work in any enterprises" (GoN, 1991). Therefore, it must be made clear to the contractor that no children are to be hired for the project. By being of low intensity, local extent and short- term duration, the impact of project's hiring on local child labor practices could be expected to be of low magnitude during construction period.

b) Operation phase

During operation period, by being of low intensity, regional extent and long-term duration the impact of Hewa-A on local child labor practices could be of low magnitude.

6.1.3.10 Sudden Release of Water Downstream of Weir

a) Construction Phase

During Construction period water in the river not used, so natural flow of water occurs. No impact is expected to occur during the construction phase.

b) Operation phase

During operation there are chances of sudden release of water at downstream to the river due to various mechanical and electrical failure of the system. That may affect people and cattle on downstream. As the design discharge of river is low, impact on sudden release of water downstream of weir is expected to long duration, medium in terms of magnitude and site specific in terms of extent.

6.1.4 Beneficial Impacts

The construction of the project is for the benefit of the people and the country. The project will generate 34422522 KWh annually. Apart from the direct benefit of generating hydroelectricity, the project will have number of other benefits during the construction and operational stage. This section of the report has tried to enumerate the beneficial impact from the project and suggest the possible augmentation measures to enhance the benefit.

6.1.4.1 Employment Opportunities

The increase in work availability within the impact area during construction is expected to reduce seasonal work migration from the impact area. Those who, generally go outside the area, to seek for work during some time of the year will likely stay in the area to work for Hewa-A during construction. During construction, operation and maintenance phase of the project, local people have temporary and permanent job opportunities, which will help to increase their income level. Job opportunities for the local people will be higher during the construction phase. Also local people have permanent employment opportunities throughout the project cycle. About 400 people will worked temporarily during the construction phase of the project.

6.1.4.2 Income Generation

By the influx of the people during the construction period, there will be extra demand of local items like milk, ghee, butter, flesh, vegetables, fruits, bamboo and wood etc. . Thus, the villagers have opportunities to sell their local products in their area. This will help to generate extra income from their products. This will continue during operation and maintenance period, however, the demand will be low.

6.1.4.3 Development Activities

There is no electricity facility at the project area. By the implementation of the project, electricity extension will be done at the project area and the villagers have opportunities to extend the electricity to the surrounding areas. This will help to raise the social development (education, communication, small industry, etc) in the project area. Agriculture production and horticulture development activities will be enhanced in the project area. Tourism related business would flourish in the project area.

6.1.4.4 Infrastructure and Social Service Facilities

As the project area is deprived of basic infrastructure facilities, the construction activities of this project will construct and enhance basic infrastructure facilities such as road, telephone, electricity, etc. at the project area. The construction of motorable road up to the intake wil be a big achievement of the local people. The motor able road up to intake site will help the villagers to extend the road to other villages. Health clinics shall be established at construction sites during the construction phase. This will help to provide facilities to the local resident as well.

6.1.4.5 Royalty Benefit

After commercial operation of the project the company will pay annual royalty to the government of Nepal. According to electricity Act 1992, the company have to pay royalty at a rate of Rs. 100 for each installed kilowatt of electricity per year plus 2 percent of the average tariff per unit (per kilo watt hour) for a term of upto fifteen years from the date of generation of electricity for commercial purpose. After fifteen years, the company shall have to pay royalty at a rate of Rs. 1000 for each installed kilowatt of electricity per year plus 10 percent of the average tariff per unit (per kilowatt hour). Thus, after the commercial operation, the project will pay a around NRs 3,770,441.31 to the government for the first 15 years and NRs. 21352207.00 after 15 years of commercial operation date.

As per the Self Governance Regulation (second amendment), 2061, 50% of the royalty shall be utilized in the project development region and 12% of the 50% royalty shall be provided to the project district and 38% in the project development region. Thus, the project development district will receive NRs 226226.47 annually for the first 15 years of plant operation and NRs 12811324 after 15 years of operation. The royalty calculation is shown in table below.

Table 6.3: Projected Royalty Amount of the Project

Time	Installed Capacity (KW)	Deemed Energy (KWh)	Rate of Royalty per installed capacity	Royalty from Installed Capacity (Rs.)	Royalty Rate from Energy Sale	Total Royalty From Energy Sales (Rs.)	Total Royalty (Rs.)	50% of Total Royalty (Rs.)	12 % to Project Affected DDC (Rs.)
First 15 years	5000	34422522	Rs. 100/kWh	500000	2 % of total energy	3270441.3	3770441.3	1885220.7	**226226.47**
After 15 years	5000	34422522	Rs. 1000/kWh	5000000	10 % of total Energy	16352207	21352207	10676103	**1281132.4**

6.1.4.5 Transformation of Technology

Construction and implementation of hydropower in that local area is also a major part of technology transformation. Local people who work as labor or helper will be Masonry, carpenter at the end. Similarly, masonry will change into small contractor. Introduction of new technology is beneficial for students to learn hydropower at their village or at vicinity. People may have idea to develop similar type of project in other places. Thus, introduction of hydropower is an ample opportunity in the case of transformation technology.

6.2 Mitigation and Enhancement Measures

Mitigation measures will help to minimize the adverse environmental impacts and maximize the environmental benefits. Thus, mitigation and enhancement measures are proposed to minimize the impacts caused by the construction and implementation of this project. Similarly, cost required for mitigation and enhancement measures is proposed in this chapter. The prescribed mitigation and enhancement measures should be implemented during various stages of project development. The Impact-Mitigation Matrix of Hewa Khola Hydropower Project is shown in Annex 5.

6.2.1 Physical Environment

Mitigation measures are discussed with reference to the proposed impact parameters on physical environment of Hewa-A Hydropower Project.

6.2.1.1 Meteorology and Hydrology

a) Construction Phase

The Hewa-A is a run-of-the river type hydropower project with no major poundage area. Therefore, it is not expected to have any impact on meteorology and climate in the project area. Thus no mitigation and enhancement measures are needed.

b) Operation Phase

At the dewatered zone, a minimum biological flow ($0.122 m^3/s$) should be continuously released during the dry months whereas there will be enough water at downstream release. Other small tributaries mainly Muwa Khola joining at the downstream of the headwork will additional flow for aquatic life.

6.2.1.2 Land Use Change

a) Construction Phase

It is estimated that a total of 9.18 ha. (3.92 ha. permanent and 5.26ha temporary) land under different uses will be required for the project. The majority of the area along the labor camp will be acquired temporarily during construction phase, whereas, the 3.92 ha. land is required for head works, alignment and powerhouse construction. The permanent land use for the construction of structures cannot be mitigated. The land use impacted by the facility sitting temporarily will be reinstated to the present condition after the construction is over.

b) Operation phase

During operation, no further land acquisition will be done. Therefore, no mitigation measure is proposed during operation phase.

6.2.1.3 River Morphology

a) Construction Phase

- Gabion and retention walls will be built upstream and downstream of the diversion weir to protect structures as well as to maintain the river morphology.
- Minimize and control the release of sediments and extraction of boulders /from the river/bed.

b) Operation Phase

- After the construction of the protection structures at the probable impact area during the construction phase, no impact on river morphology is envisaged during operation. However, if there exists any changes in river morphology by the flood at any year and will have impact, the company will do maintenance work throughout the project life.

6.2.1.4 Water Quality

a) Construction Phase

- The main issues on water quality is associated with any hydropower construction is wastes (solid and liquid) generated in workforce campsites and their discharged into the natural water bodies. The onsite sanitation facilities shall present in the work camps. Open defecation and littering of camp and construction waste shall be fully managed.
- To maintain the water quality in the river the company will prohibit spilling chemicals, acids, garbage and construction materials etc. into the river
- Side casting of the excavated soil around head works, anchor blocks, and other foundation into the surface water may result water pollution. Such actions shall be fully controlled.

b) Operation Phase

- To maintain water quality, a minimum discharge of 0.122m^3/s will be maintained in the river. Water polluting chemicals, oils, grease, construction materials, etc will not be spilled into the water

6.2.1.5 Landslide and Soil Erosion

a) Construction Phase

The possibility of landslide and soil erosion is envisaged in and around the alignment construction sites, and trail construction sites. Following mitigation measures will be adopted to minimize landslide and soil erosion:

- Minimize cutting of land to the extent possible for head works, alignment and other foundation;
- Minimize side casting of the excavated ground of the head works, alignment and other foundation area;
- Reuse of the excavated soil (top soil as well as others) in back filling and filling of the depressed area;
- Construct retaining, breast, and toe walls as per the requirements in the head works, alignment areas in unstable zone;
- Apply suitable bioengineering measures to stabilize the unstable slope disturbed by project;
- Use existing trails and access roads for material transportation and minimize the construction of the new trails to the possible extent;
- Avoid disposal of unused soils or excavated earth in the agricultural land, and water ways;
- Prohibit disturbance to natural drainage; and
- Establish surface drain structures around head works, alignment and other foundations and pass the surface drain to stable natural drainage.

b) Operation Phase

- Bio engineering practice will be continued during operational phase to stabilize the unstable land.
- Drainage system will be made more effective.

6.2.1.6 Soil Stability

a) Construction Phase

- Minimize cutting of land to the extent possible for head works, alignment and other foundation;
- Apply suitable bioengineering measures to stabilize the unstable slope disturbed by project;
- Placement of gabion boxes at the stability risk area.

b) Operation Phase

- Bio engineering practice will be continued during operational phase to stabilize the unstable land.
- Drainage system will be made more effective.

6.2.1.7 Muck Disposal and Stock Piling

a) Construction Phase

Following mitigation measures will be adopted to minimize muck disposal and stock piling:

- Adequate selection of the site for spoil disposal and stock piling and their management;
- Stock filling with appropriate slopes;
- Re-use of excavated material where ever possible;
- Fencing will be done;
- Effective mitigation measures will be adopted to minimize the leakage from the stock pilings stored for construction purpose.

b) Operation Phase

- Dumping of the remaining waste matters will be properly managed;
- Clearing the stock piling areas will be done;

6.2.1.8 Quarry Sites

a) Construction Phase

The local construction material like sand, aggregate, pebbles and gravel are easily available at the bank of the river. So, construction material will be collected from the river bed materials along the river.

- The company shall pay the royalties to the local government for the collection of construction materials from the river.
- Regular sprinkle shall be done if crusher plant is established and the crusher plant shall be installed away from the community.

b) Operation Phase

- Appropriate rehabilitation of the degraded land will be done.

6.2.1.9 Air, Noise Pollution and Vibration

a) Construction Phase

The following mitigation measures will be adopted during the construction phase:

- Use of explosives at the construction site and constant observation of any such activities that create air pollution will be minimized.
- Masks will be made available for the labor during working hour.
- Other sources of air pollution are vehicular emission, which shall be controlled with timely maintenance. Use of heavy vehicles and power plant vehicles should be limited to avoid the noise pollution.
- Construction activities should be limited only during the day time for the safety of the people living near and around the project sites.
- Any damage/crack at the structures and houses due to vibration will be repaired to the satisfaction of the owner.

b) Operation Phase

- No more air pollution is expected during the operation phase though proper maintenance of the machinery goods is to be maintained to minimize the air pollution.
- There will be minimum noise pollution during the operation phase, though effective mitigation regarding the condition of labor activities will be considered. This includes the ear-plugs, timely lubricating the old machinery goods and routinely changing the working hours.

6.2.2 Biological Impacts

6.2.2.1 Flora

a) Construction Phase

Considering the loss of vegetation, an appropriate mitigation measure will be developed and implemented to maintain the bio-diversity. The compensation shall be paid for the loss of trees. Compensatory plantation as per the prevailing law shall be done at the open places and along the penstock alignment. To restore the loss of natural vegetation, the following mitigation measures will be followed:

i) Improvement of Vegetation:

- Excavated spoil will be dumped in access road and disposed slopes to avoid excessive loss of vegetation.
- Forest User's Group will be trained and an awareness programme will be conducted for the improvement of local vegetation.

- Special knowledge for conservation of rare, endangered and threatened species will be provided for the local people.
- Improved varieties of seeds of grasses and fodder will be introduced and local people will be encouraged to grow such grasses. Local people will be involved for tree plantation and natural conservation activities.

ii) Replantation

For every tree felled down for the project implementation, twenty-five saplings will be planted in nearby areas to maintain the loss of vegetation. Local plant species will be encouraged to apply for plantation. Based on the government's recent policy decision of 1:25 (i.e., plantation of 25 trees for each tree felled down for hydroelectric project, and management of plantation area for 5 years in its own cost and handover the plantation forests to the community or the local forest office), the proponent will plant a total of, at least, 9339 (for the cutting of the 373 species) saplings at appropriate places in and around the project corridor and manage for 5 years in its own cost. Concerned Forest User's Group/forest office will be consulted for area plantation and type of sapling to be planted. Priority of plantation will be given at the project alignment where excavation and soil erosion will occur. The project will depute watchman to look after the sapling for the first 5 years and after that period the responsibility will be handover to the community forest users group.

iii) Prevention of Soil Erosion and Landslide Hazards

Retaining wall will be constructed in landslide and inclined areas. Agriculture lands will be protected from spoil disposal through construction of fencing, retaining walls or gabion. Standard bio-engineering practices will be adopted for the prevention of soil erosion and landslide hazards.

iv) Minimize Fuel Wood Consumption

Use of fuel wood will be minimized and kerosene or bio-gas cooking stoves will be made compulsory during construction for non-residential labor lightening and cooking stoves to the contractors and consultants.

b) Operation Phase

- Continuation of plantation and the awareness program regarding the conservation schemes shall be continued during the operation.
- Extensive plantation shall be continued for the first few years. Protection of sapling will be carried out during operation period.

6.2.2.3 Fauna

a) Construction Phase

During construction, blasting and human activities are the main causes for disturbance of fauna. This will force the terrestrial wildlife to migrate towards less disturbed areas. The following mitigation measures shall be adopted for this project.

i) Protection and Conservation of Wildlife Habitat

- The forest zone and wildlife habitat will be protected by increasing awareness of the local people. Fuel wood consumption will be minimized. Aforestation program will be applied through forest user's group and local people.
- Blasting of rocky area shall be minimized to the possible extent. Similarly, other chemicals for breaking rocks will be checked in the market instead of blasting materials.

ii) Punishment for Poaching and Killing

- Punishment will be enforced to the workers and local people who hunt or trap wildlife and birds. For this, monitoring team, community forest users group and local people will be activated to monitor such activities.

iii) Fragmentation of Habitat

- Crossing will be construction above the ditches of excavated land at the penstock alignment for the movement of wildlife.

b) Operation phase

More awareness programs regarding the wild-life value will be organized at the local area.

- Plantation work will be carried out to maintain the forest which finally reduce fragmentation loss and resumed wildlife habitat.

6.2.2.1 Fish

a) Construction Phase

Use of natural water resources for development purposes will cause imbalance in the aquatic environment. This will adversely affect the aquatic life specifically the native fish, fauna, and flora in the inland water bodies. The following activities will be followed for mitigation measures for aquatic life and fish:

i) Maintain Water Quality

Water quality plays an important role for the protection of aquatic life and fish. For this possible spoilage of chemicals and toxic materials, construction materials etc. will not be allowed into the river.

ii) Proper Disposal of Spoil Materials

Spoil materials and construction materials will be properly managed. Spoil materials that are generated during the excavation will be readily utilized to build the project structure such as saddle supports and anchor blocks if they are technically good to use. At the same time, some construction materials will be utilized in backfilling. Spoiling of construction and harmful materials into the river will be highly prohibited.

iii) Fish Net and Passage

A fish net is proposed at the mouth of penstock at forebay to avoid fish passage into the penstock. A fish passage shall be constructed across the river for the movement of the fish.

b) Operation phase

During wet months there will be enough discharge in the river to generate electricity and for the survival of aquatic life. The discharge from the river will decline from January, which ultimately decline the power generation and lower the water level. There are a numbers of rivulets at the downstream of the headwork which will help to maintain sufficient water availability for aquatic life.

Additionally, a minimum 10 percent average discharge of dry flow at the headwork i.e. $0.122 m^3/s$ will be released from the weir throughout the year in the river to maintain the river water ecosystem.

6.2.2.4 Rare, Endangered and Threatened Species

a) Construction phase

- Protection and conservation of rare species recorded at the project site will be done. Poaching and killing of these species by labor force will be prohibited. Replantation for every tree fell down for the project implementation; twenty-five saplings will be planted in nearby areas to maintain the loss of vegetation.

b) Operation Phase

- Awareness for conservation and protection of rare, endangered and threatened species will be continued.

6.2.3 Socio-Economic and Cultural Environment

6.2.3.1 Demography

a) Construction Phase

- Local as well as the residential form other project affected VDCs and surrounding of the project area will have priority for the employment based on their qualification and interest to work. This will limit the external workers in the area during construction period.

b) Operation Phase

- Local people will be given priority to in the project.

6.2.3.2 Land Acquisition and Compensation

a) Construction Phase

Of the total land required, 1.07 ha is paddy land, 3 ha is non irrigated upland and 4.6 ha bare, bushy and forestland. Land losses in desander and powerhouse area are paddy land with irrigation facility. The other areas are upland called bari with no irrigation facilities.

Land required for this project will be acquired with the consent of landowners. Private land will be procured at the price mutually agreed on by both the parties. Government land will be obtained on lease agreement for the period of generation by paying annual lease rent. Compensation for rented lands (eg for the construction of the temporary labor camps.) will be given based on estimation of income lost due to land inaccessibility (i.e. agricultural yield) during the construction period. At the time land is returned, it will be reinstated to a quality equal or better than that of the time of initial lease. The construction of the project will lose standing crop of one year. By the construction period of the project 3.15 tones of paddy and 28.30 tones of maize, millet, and wheat will be lost in one crop year. The company will provide cash for the loss of the standing crops.

b) Operation Phase

As there is no additional land required for the project, no mitigation measures is required during operational phase.

6.2.3.3 Health and sanitation

a) Construction Phase

- An adequate number of simple pit toilets will be constructed at a safe distance.
- Biodegradable solid wastes will be buried or converted into compost, whereas non biodegradable products (e.g. plastics, rubber) will be recycled and discouraged in application as far as possible.
- Drinking water will be arranged from the spring source at the residential area.
- Project based medical clinic has to be established to treat construction related accidents and casual illness of labor force and staff.
- Accidental insurance will be made compulsory for the workers for big injuries.

b) Operation Phase

Medical facility and accidental insurance should be made compulsory for the project staffs.

6.2.3.4 Occupational Health Hazard and Safety

The civil and metal contractor should adopt safe construction practices to minimize construction related accidents. The following safety measures are advised.

- The contractor should inform local people in potential hazardous area,
- They should inform local people at the construction time in path crossing area,
- The heavy equipments and vehicles should be operated by authorized person only
- Protection clothing such as gloves, boots and mask should be provided to workers while handling acid, paints and welding,
- Adequate training should be provided to all construction workers
- Construction of temporary toilet should be built in the construction area.
- First aid kits should be made available to the workers at the construction sites.

6.2.3.5 Law and Order Situation

a) Construction phase

- Strict code of conduct for the work force will be instituted and enforced to maintain law and order situation.
- Workers found soliciting prostitution, gambling, or demonstrating excessive public drunkenness will be fire without warning.
- Cooperation with the local government will be obtained for this purpose.

6.2.3.6 Development of Economy Activities

a) Construction phase

- Enterprise enhancement program will be initiated in the project area so that local people will be able to take benefits from the construction of the project.
- Local shops, hotels and market places will be developed surrounding the project site will be permanent in nature due to the site condition.

b) Operation phase

- Small entrepreneurship development program will be conducted for the development of the society.

6.2.3.7 Child Labor

a) Construction phase

- A specific clause in contract documents should prohibit the hiring of children less than 14 years of age and the prohibition should be enforced by including a contract termination penalty for any sub-contractor for which a child under 14 was caught working.
- There should be implementation of effective surveillance mechanism to detect and report child labor offenders.

b) Operation phase

- Effective surveillance mechanism to detect and report child labor offenders should be continued during the operation and maintenance work.

6.2.3.8 Sudden Release of Water Downstream of Weir

a) Construction phase

- No any problem will occur in the construction phase.

b) Operation phase

- The hydropower company should install siren for the sudden release of the water into the river

6.2.3.9 Employment

a) Construction Phase

- Priority should be given to the local people for non skilled, semi skilled and technicians.
- There should not be political affiliation and other discriminatory during selection and hiring process.
- Community Guidance Committee composed of local will help the hiring process in order to ensure its impartiality.

b) Operation Phase

- Priority should be given for the local people during recruitment in the various posts regarding the operation of the project**.**

6.2.4 Budgets for Mitigation and Enhancement Measures

An amount of Rs 10684391.00 should be allocated to the mitigation and enhancement of the project impact. The main units of budget allocation are land acquisition and electricity connection. The detail breakdown of the mitigation and enhancement costs has been showing in the table below.

Table 6.4: Details Breakdown of the Mitigation and Enhancement Costs

S.No.	Activities	Unit	Rate	Total (Rs.)	Amount (Rs)
1	Land Acquisition	4.274ha	Rs 115000 /Ropani	4365400	4365400
2	Standing Crops	31.45 Tn	Rs.3500/Tn	1100750	1100750
3	Forest Land Lease	L.S.		200000	200000
4	Temporary land Lease	35.91 Ropani	Rs. 10000/Ropani	351291	351291
5	Trees Plantation and Protection	9339no.	50/number	466950	466950
6	Land Reclamation	L.S.		500000	500000
7	Protection/Gabion Works	L.S.		2000000	2000000
8	Health Facility	L.S.	100000/yr		200000
9	Road Development	L.S.			300000
10	Drinking Water	L.S.			500000
11	Electricity Connection	L.S.			500000
12	Irrigation Canal Maintenance				200000
	Total (Rs.)				10684391

6.3 Environmental Management Plan

Environmental Management Plan (EMP) is a tool for identifying and quantifying the impacts to formulate the mitigation strategies and to minimize adverse impacts caused by the implementation of the project. EMP refers to the documentation pertaining to project management, monitoring and auditing of the execution of mitigation measures and also the verification of the predicted impacts in the project cycle. National EIA guidelines 2050, and Environmental Protection Regulation (EPR) 2054, provide some guidance on the requirement of monitoring and auditing. However, environmental auditing has been limited for EIA study only by the first amendment of EPR 2054. The EMP will help to formulate a monitoring plan for baseline, impact and compliance monitoring.

6.3.1 Environmental Monitoring

An environmental monitoring schedule is a must to run the project. It is scheduled during the project prior construction, during construction and implementation phase. A detail monitoring plan is designed in such a way that it will help to fulfill the required parameters stated in national environmental impact assessment guidelines, 2050, environmental Protection Act 2054, and other relevant acts, Rules, regulation and guidelines of Nepal. The national

environmental impact assessment guidelines, 2050, by Government of Nepal and IUCN have pointed the following objectives for monitoring to run the project.

- Ensure that the impact does not exceed legal standards.
- Check the implementation of mitigation measure to see whether it is in conformity with the environmental impact assessment report.
- Provide timely warning of potential environmental damage.

To fulfill the above objectives, the monitoring team should focus on the following three types of monitoring. 1. Baseline Monitoring 2. Impact Monitoring 3. Compliance Monitoring

Baseline monitoring is one of the important monitoring practices. Prior to the construction activities, the team should check whether the proposed baseline information provided by the proponent has been developed properly or not. This monitoring will be sensitive in order to identify the consequent changes by the implementation of the project. The important physical parameters of baseline monitoring are river hydrology, water quality, slopes. Flow rate of the river is the indicator of the river hydrology and it is schedules to monitoring continuous during dry season, likewise water quality has schedules to monitoring prior to construction at upstream and downstream of diversion weir and tailrace. Slope stability should be monitored at unstable area. The parameters of biological environments are wildlife and fisheries. Field observation, discussion with local people, FUG and DFO should be done twice of a year for wildlife and fish sampling at upstream and downstream of the project site at twice of the year for fisheries. In socio economic and cultural environments settlements, public health, law and order situation should be monitored.

The impact monitoring focuses on the key indicators to assess whether the impacts caused by the implementation of the project have been accurately predicted and whether the mitigation measures are scientific and effective. Impact monitoring should be done during the period of project construction and operation in order to detect environmental changes which may have occurred as a result of project implementation. The important parameters for physical environment are slope, water quality. Slope stability should be monitored during construction at unstable site by using baseline data and water quality should be done during construction and after operation at upstream and downstream of the diversion weir and tailrace. Wildlife and fisheries are the parameter for biological environments. In socio economic and cultural environments, water supply and sanitation, public health, economy, and infrastructure are important parameter. Water supply and sanitation should be monitored at the camp site during construction and discussion with local people, worker and consults for public health about type of disease.

This form of monitoring employs a periodic sampling method or a continuous recording of specific environmental quality indicators or pollution levels, to ensure project compliance with recommended environmental protection standards. In this monitoring the GoN licensing

entity oversees and ensures the implementation of the required mitigation measures, according to GoN guidelines. Implementation of IEE recommendations, incorporation of the environmental consideration from the tender documents into the contractor proposed work plan, construction logistics, implementation of environmental conditions mentions in the tender documents, property, cleanup and reinstatement of the project area should be done during construction and maintenance period of the project in compliance monitoring.

This form of monitoring employs a periodic sampling method or a continuous recording of specific environmental quality indicators or pollution levels, to ensure project compliance with recommended environmental protection standards. In this monitoring the GoN licensing entity oversees and ensures the implementation of the required mitigation measures, according to GoN guidelines.

Environmental monitoring plan with parameter, indicators, method and schedule (EMP) is shown in following table.

Table 6.5: Environmental Monitoring Plan

Baseline Monitoring				
Parameters	Indicators	Method	Location	Schedule
Physical Environment				
River Hydrology	Flow rate of the river	Gauging Station	Upstream of diversion dam, and downstream of diversion dam	Continuous during dry season and regularly during other season
Water Quality	Turbidity, oil and grease, DO, BOD	Water sampling and lab testing	Upstream and downstream of diversion weir, and tailrace	Prior to construction
Slopes	Stability and Degrees of slopes	Site observation, pillars	At unstable area	Prior to construction
Biological Environment				
Forest and Wildlife	Forest management and animal	Discussion with FUG, local people and DFO	Along the Penstock Alignment	Prior to construction
Fisheries	Size of fish population and migratory habit	Fish sampling and discussion with local	Upstream of the project and downstream of Powerhouse	Prior to construction

		fisherman		
Socio-Economic and Cultural Environment				
Settlements	Growth of settlement Patterns	Discussion with local people, VDC, site observation	At intake site, penstock alignment and PH area	Prior to construction
Public health	Types of diseases and incidence of disease in the project area and community	Discussion with the local people, workers and health professionals	Project affected area	Prior to construction
Law and order	Level of crimes, prostitutes, etc. in the project area	Discussion with the local people and local police	Project affected VDCs	Prior to construction
Compliance Monitoring				
Parameter	Indicator		Method	Schedule
Implementation of IEE recommendations	Incorporation of IEE documents into project documents		Review of project design, tender documents	Following completion of tender documents
Incorporation of the environmental consideration from the tender documents into the contractor's proposed work plan	The presence in the constrictor's work plan, of each of the environmental consideration from the tender documents		Review of the proposed plans submitted by contractor	During contract negotiation
Construction logistics	Contractors' arrangements regarding labor camps materials storage and construction activities		Site observation	Beginning of the construction period
Property	Land/ property acquisition procedure		Discussion with PAF and local People	At the time of land acquisition
Implementation of environmental conditions mentions in the tender documents	Arrangements of slope protection, pollution prevention, protection of vegetation, wildlife and fish, use of local labors, safe construction, public		Site observation, discussion with project management and local people using a checklist	Throughout the construction phase

	health and public relation			
Cleanup and reinstatement of the project area	Completion of the different aspects of project cleanup		Site observation	At the end of the construction period, before operation
Impact Monitoring				
Parameters	Indicators	Method	Location	Schedule
Physical Environment				
Slope	Degrees and stability of slopes, change from baseline data	Site observation	At unstable Area	Continious during construction
Water quality	Turbidity, oil and grease, DO,BOD, toxicity	Water sampling and lab testing, comparisons to ambient standards	Upstream and downstream of the diversion weir and tailrace	Prior to construction, during construction and after operation
Biological Environment				
Forest and Wildlife	Number of trees, presence of wildlife	Field observation, discussion with FUG, local people and DFO	At the penstock alignment and its surroundings	Twice of year during construction
Fisheries	Size of fish population, change in spawning and migratory habits	Fish sampling and discussions with local fisherman	Upstream and downstream of the project site	At least twice of year
Socio economic and cultural Environment				
Water supply and sanitation in the project area	Presence quality of water supply in local homes, construction area, adequacy of sewerage system	Site observation, water testing and interview with local people	Yangnam and sidin and camp area	Continuous during construction
Public health	Types of disease and frequency of disease in the project and local area	Discussion with local people, workers and consults to local health post	Affected villages and camp areas	Monthly during construction

Economy	Number of local people employed by people, development of local market	Record from project management, site observation	Project site	Once a year during construction and after operation
Infrastructure	Condition of local road, telephone facilities to the local local people, drinking water irrigation canal	Discussion with local people, site observation and project record	Affected villages	Twice a year during construction and after operation

6.3.2 Organization Setup and EMP plan

To fulfill the objectives of environmental monitoring the proponent shall carry out the daily, monthly and annual review of monitoring activities. The company should setup environmental unit at the project site. The environmental unit should comprise of the following professionals.

Table 6.6 List of Professional of Environmental Unit

S. No.	Professional	No
1.	Environmentalist (Coordinator)	1
2.	Physical Environmental Engineer	1
3.	Biologist/Tree Specialist	1
4.	Nursery Man	2

6.3.4 Estimated Budget

A total of Rs. 300 thousand each year is allocated for environmental monitoring activities. The breakdown cost of monitoring budget is given in the following table.

Table 6.7: Annual Budgeting for Monitoring Activities

S. No.	Activities	Unit	Rate	Total Days	Amount (Rs.)
1	Professional Fees	5	1000 /day	150	150000.00
2	Lodging, Fooding, Transportation and lab testing	L/S			100000.00
3	Report Preparation	L/S			50000.00
	Total				**300000.00**

Chapter VII

DISCUSSION

Environmental Assessment (EA) for the development projects of Nepal was started in early 1980s particularly in the donor-assisted projects. Environmental Impact Study Project (EISP) was established in 1982 under the Ministry of Forests and Soil Conservation to initiate activities for the formulation of necessary policies and laws and create public awareness on the environmental matters. It has carried out EA of some projects. A number of reviews and case histories for hydropower projects in Nepal have also been completed in recent years (Garcia and Garcia 2000; Garcia et al 2005a, b; Garcia 1999; ADB 1999; SEATEC et al 2000a,b,c,d and 2001; Upadhaya and Shrestha 2002; Onta, 1998; Pandey 2001). These reviews focus on environmental impacts, mitigation measure, problem and opportunities.

7.1 Impacts Identification and Mitigation Measures

Hydropower project has both beneficial and adverse environmental impacts. The adverse impacts caused by hydropower development are documented in the published literature (World Bank 1996; WWF 1999; Scudder 1997), as well as addressed by the World Commission on Dams which commissioned a world-wide comprehensive review of impacts and mitigation (WCD 2000). The beneficial impacts caused by hydropower development are documented on published document (RSHDC, 2004, Khadka, 2008).

Hydropower projects are not created equal. Runoff- the-river projects with high head and small reservoirs typically have a much smaller footprint and have fewer adverse environmental impacts on the social, biological and physical environments than large reservoirs in lower elevations that can require the dislocation of people and loss of productive lands and major ecological changes. However, in some cases, larger reservoirs can provide additional benefits such as flood-control, irrigation, aquaculture and recreation/tourism opportunities. Projects need to be considered on a project-specific basis and be fully committed to the premise that affected people will be at least as well off with the project as they would be without the project (Garcia, 2008). Adverse impacts related to hydropower development can be serious and significant, leading to increased poverty, social dislocation, losses in fishery resources and declines in biodiversity among a host of other associated impacts. Adverse impacts are project-specific and are related to project design and the social, physical and biological environments of the project site as well as the mitigation measures implemented during both construction and operational phases of the project.

Impact of the project studied on the basis of physical, biological, socioeconomic, and cultural impacts of the ongoing project. Various sub heading are proposed for these heading on the based on construction and mitigation phase (Khadka, 2008; UPHCL, 2005; RSHDC, 2004). Mitigation and beneficial measures are proposed to reduce the adverse impact and make

better environment in the project area. All of the parameters of physical, biological and socio economic and cultural environment are important, however; more serious parameters caused by the implementation of the project are discussed.

7.1.1 Physical Environment

Of the different parameters on physical environment land use and water quality are the major parameter found serious and irreversible impact caused by the implementation of the project.

a) Land Use

Hydropower construction activities have high impact on land. The impact occurs due to construction activities and quarrying sites. According to the size and type of the project, its buffering impact on the land varies. A comparison of land use of Hewa-A (5MW), Ridikhola (2.4MW), Upper Marshyangdi Project (50 MW) and Khudi Hydropower Project (3.4MW) is presented in Chart 7.1. The chart shows that Hewa-A requires a total of 9.18 ha land out of which 3.92 ha. as permanent and 5.26 ha. as temporary purpose, while Upper Marshyangdi 'A' (50MW) hydroelectric project requires 22.65 ha temporary land and 8.38 ha permanent land (GEOCE, 2005). Likewise in 2.4MW capacity Ridikhola Small Hydropower Project 2.77 ha of land for permanent use and 7.16 ha for temporary use (RSHDC, 2004), in Khudi Hydropower Project 4 ha for temporary use and 3.3 ha for permanent use (LEDCO, 2001). The comparison shows that the land requirement does not increase by same proportionally by increase in capacity of the project. To mitigate this impact cash compensation is proposed by each project.

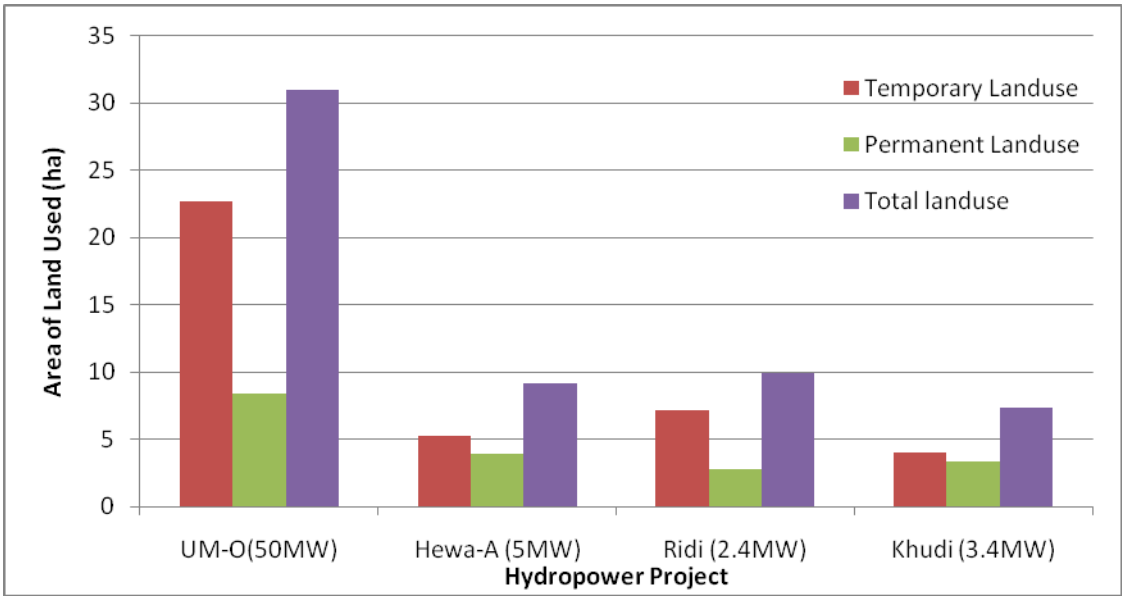


Figure 7.1: Comparison of Land Use in Hydropower Project

Land use changes and displacement of the people are the environmental impacts of hydropower project (Joshi *et. al*, 2003). A hydropower project requires significant amount of construction materials, which needs to be extracted from various quarry sites in and around

the project area (Peirce *et al.*, 2004). Normally quarrying is done along the hill face and left untreated after extraction of the required construction material. These sites can become permanent scar on the hill face and become potential source of landslides (Kumar and Rao, 2008). So, suitable measures should be provided for quarry site stabilization. In this project the quarrying site will be bank of the river so some landslide problem may occur. Bioengineering technique was used to stabilize the area and preventive measure like: avoid unnecessarily blasting cutting and excavation was taken in (UPHCL, 2005). In this project also minimization of cutting, use of bioengineering during construction phase and operation phase, prohibit destruction of natural drainage is proposed.

b) Water Quality

The total increase in population during construction phase can be expected to be around 1000 to 1500 for a medium to minor project (Razzaque, 2004). Increase in population in area during construction will arise Organic Pollution likewise contamination by petroleum products and some metals (i.e. lead) during Vehicles cleaning and repairing. The availability of nutrients resulting from decomposition of vegetative matter enrichment of impounded water with organic and inorganic nutrients becomes a major water quality problem immediately and commencement of the operation (Marriott, 1977). In this project also organic and inorganic pollution of water will occur. Detailed dissolved oxygen (DO) modeling is to be done to estimate the DO level as also other physiochemical and biological parameters in the nearby stream during its initial years of operation and thereafter too.

Water quality parameters are however very closely interrelated and a modification of one usually results in changes of many others. For example, a lower water flow will probably result in a lower content of dissolved oxygen and in a higher water temperature, the two parameters to which fish are the most sensitive (Khadka, 2008). Also, as temperature rises, more non-ionized ammonia, this is toxic to fish, moves into solution.

Reductions in flow can result in increased concentrations of pollutants already discharged into the water course such as pathogens and/or nutrients from natural or chemical fertilizers and animal waste or of sediments from soil erosion. The construction of diversion weirs and storage dams for diversion of discharge of hydropower generation would lead to reduction in flow downstream of the weirs and dam sites up to confluence point of tailrace discharge. However, reduction in flow is likely to have marginal impact, as the discharge during the lean season may be low, but the same is supplemented by contributing from intervening streams (Gilpin, 2006).

7.1.2 Biological Environment

During the construction, huge quantity of muck is generated at various construction sites which if not properly disposed off, invariable would flow down the river during the heavy precipitation. Such condition can lead to adverse impacts on the development of aquatic life,

which needs to be avoided. Among the aquatic habitants, it is the fish which would be most affected. The migratory fish species are likely to be affected due to obstruction to their migratory route when any diversion structure is created (Kumar sand Rao, 2008). About 5 km of river stretch dewater due to Hewa-A . This problem has occurred in Kiche Khola where 1.2 km of the river stretch up to the confluence of Kiche and Khudi Khola is dewatered from diversion weir sustain some dewatering problem of the River (Khadka, 2008) , While 2.5 km of the river stretch is presently being dewatered due to implementation of Khudi Hydropower Project (LEDCO, 2001). Likewise in Upper Marsyangdi Hydropower Project (UM-O) 7 km river strech dewatered (GEOCE,2005) and in the case of Kaligandaki Hydropower project 13 km river streach has been dewatered (Thanju, 2007). This dewatering problem affects aquatic life in the dewatered zones. The analysis shows that dewatering zone generally increase with the increase of the project but depend on the local topography.

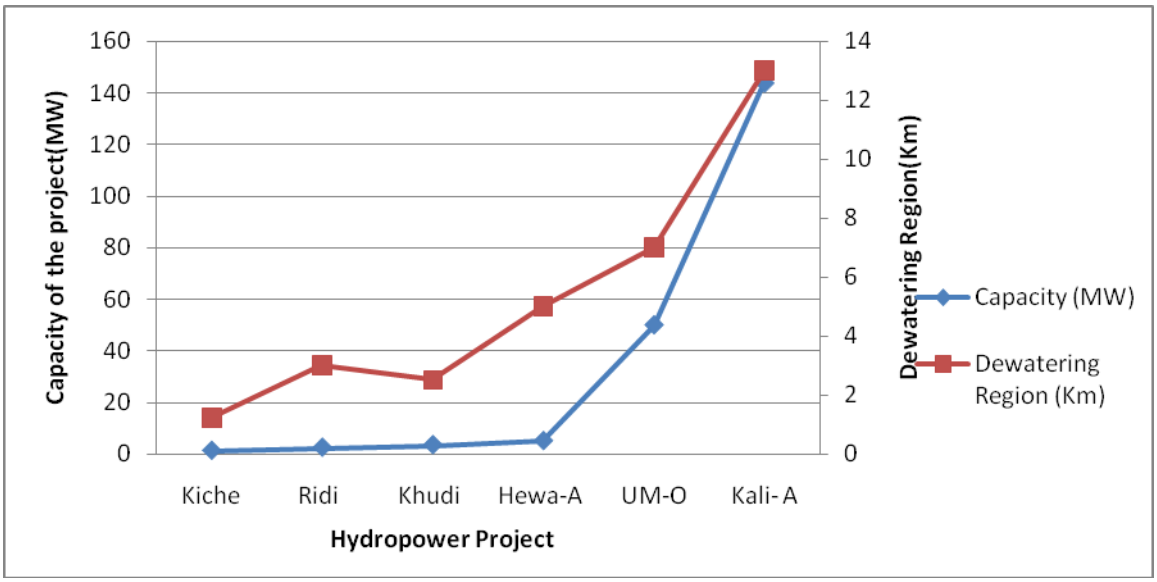


Figure 7.2: Capacity and Dewatering region of the Hydropower Project

Movement will be obstructed for long range migratory fish species. Though fish ladder has been proposed in most of the recently developed HEPs, effectiveness of such fish ladder has not been tested yet (GEOCE, 2005). Each fish has its own behavior. A particular type of fish ladder may not be suitable for all types of migratory fishes. A fish net is proposed at the mouth of penstock at fore bay to avoid fish passage into the penstock. No rare and endangered fish species had not found in this project site but for sustaining the aquatic life fish ladder is proposed. Only 10 % of water flow is proposed as the minimum downstream release. This is substantially low discharge compared to the normal flow condition. The aquatic invertebrates would die out during the dry condition because of low quantity of water.

Wildlife is one of the important natural resources and most important natural resources in Nepal. Forest depletion has direct impact on local environment degradation and contributes landslides, soil erosion, floods, soil depletion, loss of biodiversity, reduction on water flow

from upstream areas, and increasing siltation of water bodies in low lying area (ADB/ICIMOD, 2006). Kaligandaki-A have adverse impacts on wildlife, There are localized disturbances related to construction activities, loss of habitat, project-related 'takes' (kills of individual specimens), migration impediment, secondary impacts related to forest impacts and improved human access (Garcia, 2007). No of tree cut down for project activity differ in project to project. In Kiche khola hydropower project (1.2MW) 49 trees will cut down (Khadka, 2008), likewise in Ridi hydropower (2.4MW) 263 trees will cut down (RHDCL, 2004). In upper Piluwakhola hydropower project (4.5MW) 164 trees will cut down (UPHCL, 2005) and in Upeer Marsyangdi hydropower Project (UM-O, 50MW) 183 trees will cut down (GEOCE, 2005) and in this project Hewa-A 374 trees will be cut down during the project construction. No of tree cutting depend on the land cover of the project site.

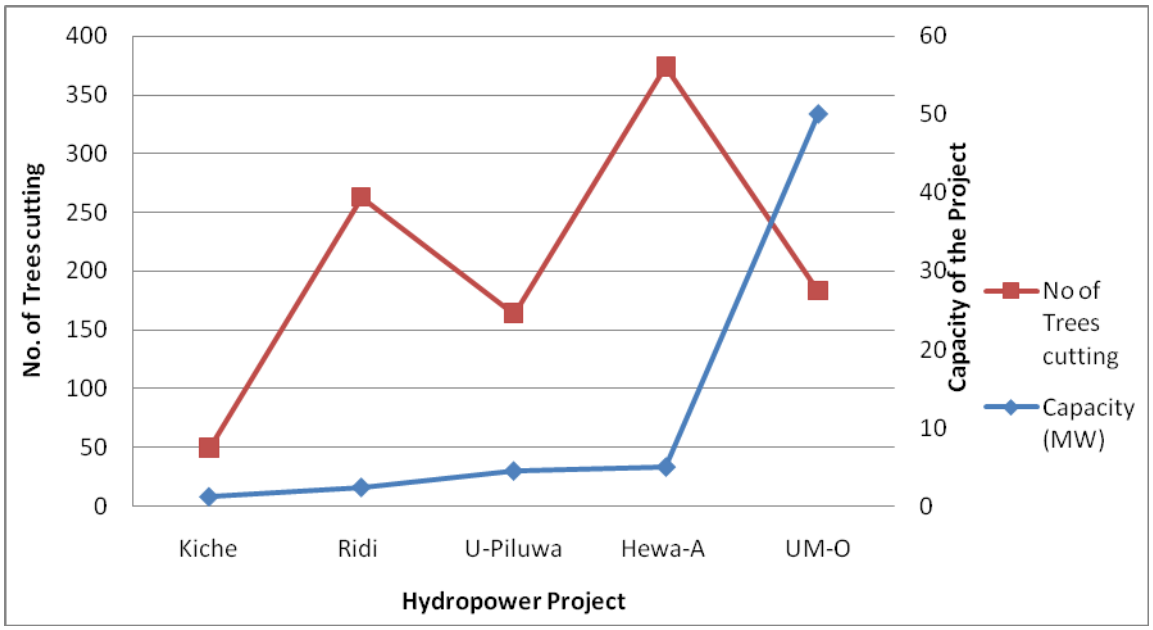


Figure 7.3: No of Trees cutting during Hydropower Project Construction

Due to the encroachment of the project on the forest area of the project various environmental problem will occur on the project area. So improvement of vegetation, replantation of the plant (in the rate of 1:25), minimize the fuel wood consumption is proposed for mitigation measure.

7.1.3 Socio-economic and Cultural Environment

The constructions will generally last for about 2-3 years. Those who would migrate to the project area are likely to come from various other parts mainly having different cultural, ethnic and social backgrounds. Due to longer residence in one place, a new culture, having a distinct socio-economic similarity would develop which will have its own entity (Gilland, 1995).

Job opportunities will improve significantly in the surrounding area. Any infrastructure projects are significant parts of socioeconomic development in every nation, even though it is still a controversial issue because of large displacement of the local inhabitants. Lack of proper resettlement leads to impoverished situations of displaced people and this will constrain society's development (Cernea and Gugeenheim, 1993). Number of employee depends upon the project site. Generally larger the project higher will be employee. In hydropower Hewa-A (5MW), Ridikhola (2.4MW) and Upper Piluwakhola (4.5MW) have 400, 300 and 400 no. of employee respectively.

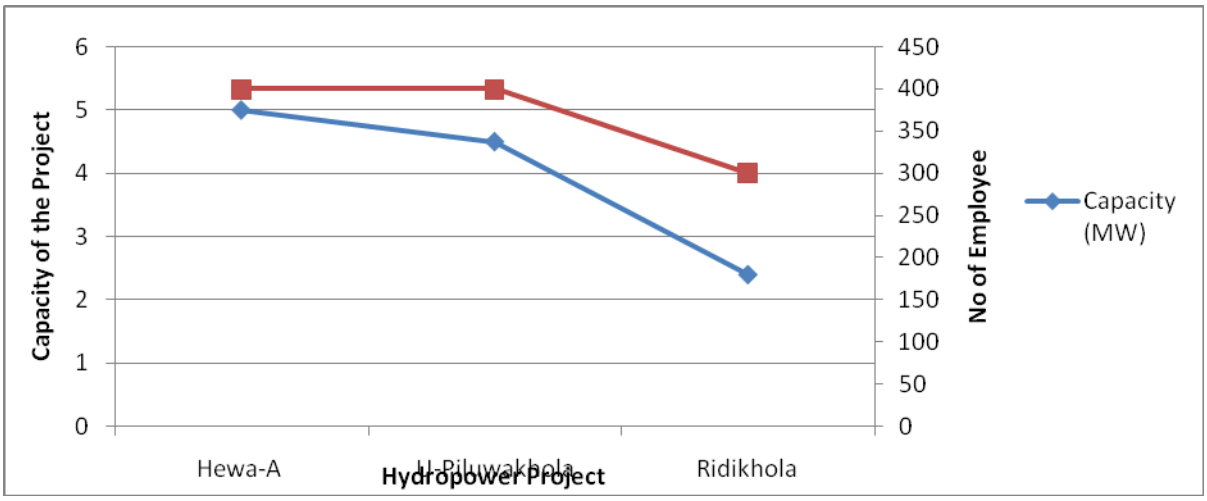


Figure: 7.4 No of Employee in Hydropower Project

Hewa-A had committed not to use the child labor, if found in near future during its implementation will be against Child Labor Prohibition and Regulation Act 2000. Due to temporary influx of male laborers typical to hydropower development projects, STDs, HIV/AIDs etc are common problems arising (DOED 2001).

The construction of the project makes temporary and permanent impact on cultivated crops. Standing crop will be losses by the temporary use of land for staff quarter building, labor camp house, loading and uploading station, excavation of land, etc. as well as during structure construction. The amount of standing crop loss depends upon the location of the project. If the project lies on the cultivated land much amount of the crop is destroyed. In Hewa-A 31.45 tones of standing crop loses. Upper Piluwakhola 25.68 tones (UPHCL, 2005) and in Ridikhola 49.2 tones (RSHCL, 2004) of standing crop loses. Cash compensation is proposed by each project for the loss of standing crop during the project construction.

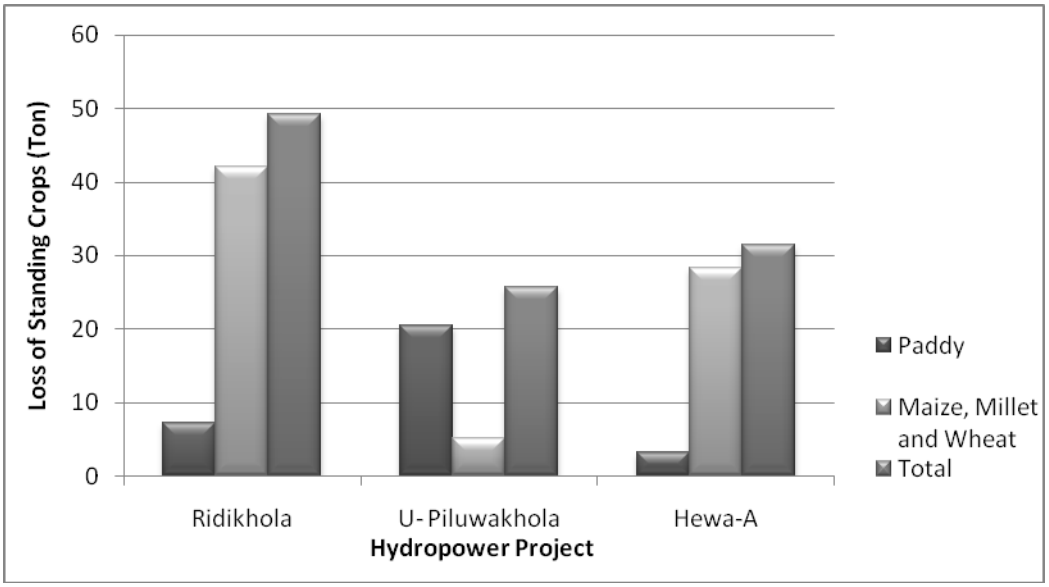


Figure 7.5: Loses of Standing Crops

The hydropower projects have positive impact and give opportunities to the project site. The royalties of the project depends upon the net energy production of the project. Hewa A hydropower project generate 34.42 GWh energy and royalty before 15 year to the project affected DDC is Rs 226226.5 and after 15 years is Rs.1281132. But in the case of Ridi Hydropower Project annual energy generates is 15.40 GWh and revenue before 15 year is Rs. 30577.35 and after 15 years is Rs. 364224 (RHDCL, 2004) and in the case of Upper Piluwakhola hydropower Project have annual energy production is 31.71GWh and royalty before 15 years is Rs. 171598.2 and after 15 years is Rs. 1096275 (UPHCL, 2005).

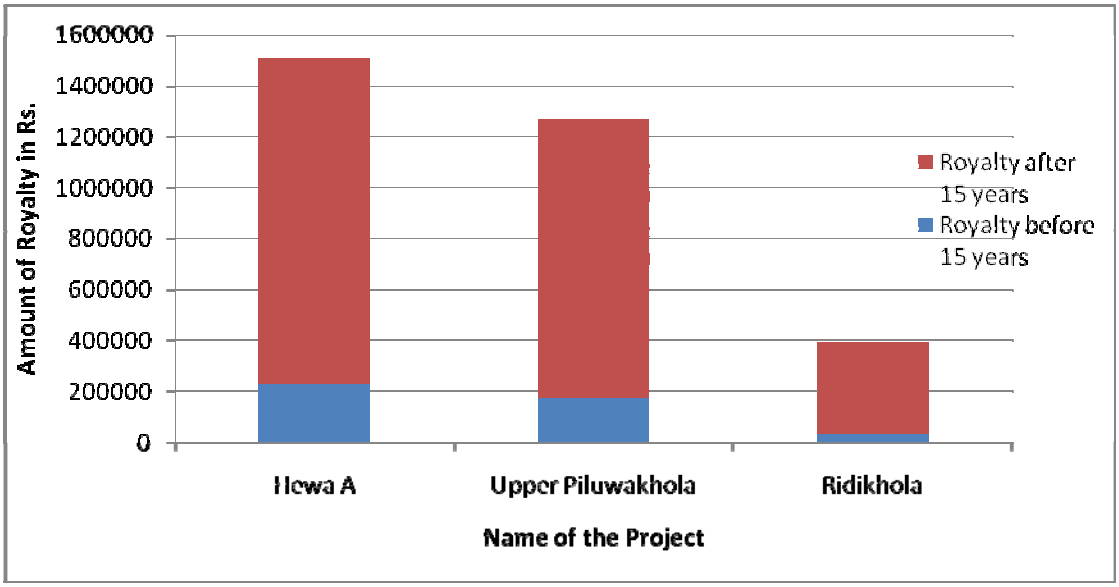


Figure 7.6: Annual Energy Productions and Revenue of the Project

EA particularly aims to optimize a trade-off between developmental activities and socio-ecological losses. It is a management tool to be linked closely to the project life cycle to

ensure that appropriate environmental information is provided at the correct time. The overall objective of the EA is to design developmental projects and activities taking into consideration the environmental perspective. (Kumar and Ramakrishna, 2008). The improvement of public infrastructure such as access roads, rural electrification, telecommunications and health services, enhanced educational facilities and employment of local population, including project affected families during the project construction stage and operation phase, have benefited local communities by enhancing their quality of life.

EMP includes project management, monitoring and auditing, it is most appropriate to provide some introduction to the types of monitoring and auditing (in EIA) which should be prepared for the EMP within an EA Study, and should be conducted during project implementation. Most of EIA reports related to hydropower projects or others contain a chapter on EMP as per the requirement of EPR 1997. However, the contents are only concentrated on monitoring and auditing activities. Some cases, as for example, EIA of Middle Marsyangdi Hydropower project, and in west Seti Hydropower project have Environmental Management Action Plan (EMAP) supplementing EMP. However, in most of EIA reports of hydropower project, EMP has been categorized to include: monitoring program, auditing program, project management, and cost for implementation of project management, monitoring and auditing (MOPE, 2004). In Hewa- A hydropower also monitoring program, project management and cost of implementation of project management and monitoring is included in its EMP.

Chapter VIII

CONCLUSION AND RECOMMENDATION

8.1 Conclusion

Hydropower is environmental friendly with very little adverse impacts on the environment. Nepal has not been able to tap oil and natural gas and other natural resources. So in Nepalese context hydropower seems to be the most promising energy source to meet the future energy demands. The environmental impacts of hydropower generation are relatively less; these impacts cannot be totally ignored. The beneficial impacts must be augmented while the adverse impacts should be mitigated, to the extent possible. Basically the impacts of hydropower generation occur mostly on Physical, Biological and Socioeconomic and Cultural environment in the construction phase and some of them persist till the operation and post operation phase too.

In the present environmental study of Hewa-A hydropower Project, a number of significant impacts have been identified and their appropriate mitigation measure is proposed. The project will require 3.92 ha of land permanently and 5.26 ha of land temporarily, and compensation should be given to the people for land acquisition. Impact on river morphology, Landslide and soil erosion, quarry sites, waste disposal problem and air, noise and vibration by the project is identified as the physical impact of the project. Adequate selection of the site for spoil disposal and stock piling and their management and for quarry site is proposed. Bioengineering practice in landslide area is proposed. About 5 km of the river stretch will be dewatered. As, there is a small perennial River Muwa Khola just below the headworks with considerable flow will recompense even in dry season. The compensatory release of water by the project during the dryer months (10% of lean flow) 0.122m^3/s is expected to reduce the impact on aquatic life.

In Biological Environment, the major impacts of Hewa-A include the felling of about 374 plant species from natural and private forests, changing wildlife habitats, and reduction of flow of water in the river. Compensatory plantation as per the prevailing law at the open places (i.e. 1:25) and improvement of the vegetation, minimizing fuel consumption is proposed for mitigation measure. The project will clear 1.92 ha of forest land permanently. Most of the construction components of the project do not fall under the areas with unique ecological diversity of habitat of narrow distribution in the ecologically sensitive area.

No household is directly affected in terms of relocation. Further detailed examination of individual household conditions before determining compensation packages for the permanent land take will be done during detailed design phase. By the land acquisition and temporary use land about 3.15 tones of paddy and 14.15 tones of millet and 14.15 tones of

maize will be loss. Likewise other socio-economic and cultural impacts are occupation health hazard and safety, impact on resources, child labor, etc. and their mitigation measure and enhancement measure are identified.

The implementation of this project will be able to furnish the local people with reliable electric power. The project will also mount up direct economic benefit to GoN from royalties and revenues. By this project development Panchthar district will receive NRs 226226.47 annually for the first 15 years of plant operation and NRs 12811324 after 15 years of operation. Other direct benefit of the project will be from employment of local people, rural electrification transformation of technology and improvement of infrastructures in the project impact area. No historical religio-cultural and heritage sites and protected areas lie within in the project site and its immediate vicinity.

Environmental Management Plan (EMP) is a tool for identifying and quantifying the impacts to formulate the mitigation strategies and to minimize adverse impacts caused by the implementation of the project. In this study, Environmental Management Plan is proposed based on three types of monitoring.

8.2 Recommendation

- In the landslide prone zone of the project area during its construction bioengineering and slope stabilizing work will be undertaken.
- A compensation flow of (10% of minimum flow) should have to be released downstream of the diversion weir at any time of the year for the survival of aquatic ecosystem.
- Replantation of the trees should be done as (25 tree saplings planted for each tree) felled for the project implementation.
- The contractor and labor force should use Kerosene or LPG gas as fuel sources for cooking and other purpose.
- Security measures and infrastructures will be put in place by the project to protect local people from any artificial or natural hazards brought by the construction work.
- During the design, the amount of excess and waste materials especially from the penstock alignment should be estimated and safe disposal area of for excess and waste material should be designed on the project drawings. The excess and waste material can be used to sidetrack road construction along the penstock alignment
- Necessary consultation with CFUG should be made for the construction of the project.
- Monitoring EMP should be done as proposed,
- Further study is needed before the construction of the project.

References:

ADB/ICIMOD, 2006. Environmental Assessment of Nepal: Emerging Issues and Challenges. Asian Development Bank/ International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Ames P.L. and Buetlkofer L.B., 2003. Environmental Audit: Estimating Hydroelectric Project. MWH Americas Inc. Broomfield, CO, United States.

APHA, 1998. Standard Methods for the Examination of Water and Wastewater, 20th edition. American Public Health Association, Washington D. C.

Duah A., 1996. Managing Contaminated Sites-Problem Diagnosis and the Development of Site Restoration, John Wiley & Sons Ltd. England.

Bhattarai, T.N., 1994. Environmental Impact Assessment in Water Resources Development in Nepal, *Water Nepal*, 4 (10):50-55, Nepal Water Conservation Foundation, Kathmandu, Nepal.

Brismar, A., 2003. Environmental Consideration in the Planning of Large dam projects, Linköping University, Sweden.

Cernea M.M., Guggeenheim S.E., 1993. Anthropological Approaches to Resettlement., West view Press, USA

Chaudhary, R.P., 1998. Biodiversity in Nepal: Status and Conservation, S.Devi, Sharahanpur, India and Tecpress books, Bangkok, Thailand.

CBS, 2002. Nepal District Profile, Central Beaureu of Statistics, Kathmandu Nepal.

DDC, 2004. First Period District development Programme, 2059-60, District Development Committee, Phidim, Panchthar, Nepal.

CIWEC, 1997. Environmental Impact Assessment of Tamur Mewa hydropower project, Canadian International Water and Energy consultants, Kathmandu, Nepal

Dixit, A., 1994. Water Projects in Nepal: Lesson From Displacement and Rehabilitation, *Water Nepal* 4(1): 74-85, Nepal Water Conservation Foundation, Kathmandu Nepal

DOED, 2001. Manual for public involvement in the EIA process of Hydropower projects, Private Sector Hydropower Development project, Department of Electricity Development, GoN in collaboration with US Agency for international Development and International Resources Group, Kathmandu, Nepal.

DOED, 2002. Manual for preparing Environmental management plan (EMP) for hydropower projects, private sector Hydropower Development project, Department of Electricity Development GoN in collaboration with USAID and International Resources Group, Kathmandu, Nepal

DOED, 2004. Environmental Impact Assessment, final report of the Mewa khola small hydropower project, Water Resources consults P Ltd, Kathmandu Nepal.

Garcia John C., 2008. Hydropower, a Good Alternative for Nepal: Challenges and Approaches, Hydro Nepal: Journal of water energy and Environment, Vol 1,No.1, Kathmandu, Nepal.

Garcia, John C. and Garcia, Carole T., 2000. *A Review of Environmental Impacts of Hydroelectric Projects in Asia* (prepared for the HydroVision conference held in Raleigh, NC, August).

Garcia, John C., 1999, *A Regional Review of the Environmental and Social Impacts of Hydroelectric Projects*: *Environmental Component* (prepared for the Operations Evaluation Office, Asian Development Bank), San Anselmo, CA: Garcia and Associates.

Garcia, John C., Garcia, Carole T., Devkota, Salil and Thanju, Rajendra P., 2005. Resettlement: lessons learned at Kali Gandaki A in Nepal, *HRW Magazine,* 13(1): 32-37.

Garcia, John C.2005. Environmental mitigation: Lessons learned at Kali Gandaki A, *HRW Magazine*, 13(3): 20-27.

GEOCE, 2005. Environmental Impact Assessment of Upper Marshyangdi "A" (UM-O) Hydroelectric Project, GEOCE consultants (P) Ltd.

Gilland B., 1995. World Population, Economic Growth, and Energy Demand, 1990-2100; A Review of Projections*, Population and Development Review,* 21(3), 507-539.

Gilpin A., 2006. Environmental Impact Assessment, Cutting Edge for the 21st Century., Cambridge university Press.

Gilpin, 1995. Environmental Impact Assessment (EIA): cutting Edge for the twenty first century, Cambridge University Press, USA.

GoN 1969. Explosive Substance Act 2018. Government of Nepal, Kathmandu, Nepal.

GoN 1977. Land Acquisition Act 2034. Government of Nepal, Kathmandu, Nepal.

GoN 1991. Labour Act 2048. Government of Nepal, Kathmandu, Nepal.

GoN 1992. Forest Act 2049. Government of Nepal, Kathmandu, Nepal.

GoN 1992. Water Resource Act 2049. Government of Nepal, Kathmandu, Nepal.

GoN 1993. Electricity Act 2049. Government of Nepal, Kathmandu, Nepal.

GoN 1993. Water Resource EIA Guidelines 2050. Government of Nepal, Kathmandu, Nepal.

GoN 1995. EIA Guidelines for industry Sector. Government of Nepal, Kathmandu,Nepal.

GoN 1995. EIA Guidelines for the forestry Sector. Government of Nepal, Kathmandu, Nepal.

GoN 1995. Forest Act, Rules and Regulation 2052. Government of Nepal, Kathmandu, Nepal.

GoN 1999. Environment Protection Regulations. First Amendment 2055. Government of Nepal, Kathmandu, Nepal.

GoN and IUCN 1993. National Conservation Strategy Implementation Project, 1994 National Environmental Impact Assessment Guidelines 1993, Kathamndu, Nepal.

GoN, 2002. Forestry Sector Policy, Ministry of Forest Conservation and Soil Conservation, Government of Nepal, Kathmandu, Nepal.

GoN, Ministry of Environment, Science and Technology. 1998. Environment Protection Act, 2054. Government of Nepal, Kathmandu, Nepal.

GoN/ADB/IUCN/SRD. 1996. *EIA Training Manual for Senior Government Officials and Policy Makers*. Government of Nepal/Asian Development Bank/IUCN-Nepal/Sustainable Resource Development Inc., Kathamndu, Nepal.

GoN/IUCN, 1993. National EIA Guidelines, national Conservation Strategy Implementation Project, National Planning Commission, GoN with Collaboration with IUCN, Kathmandu, Nepal.

Joshi, A.R., Shrestha, S.L. and Joshi, kunjini, 2003. Hydro-resources for Energy Development : Policy Program and Performance, Environmental Development and sustainable development at the cross road:68-91, AnKuS, Kathmandu, Nepal.

Khadka, B., 2008. Environmental Impact assessment of Kichhekhola Hydropower Project, A dissertation Submitted to the Central Dpartment of Environmental Science, Kirtipur, Kathmandu Nepal.

Khadka, R. B., 2002. Environmental Impact Assessment: Concept, Procedures and Application, School Environmental Management and Sustainable Development, Kathmandu, Nepal

Khadka, R.B. (ed), 1996. EIA training Mannual for Professionals and managers, Asian Regional Environmental Assessment Program, IUCN Nepal, Kathmandu, Nepal.

Kumar, B., Rao, A.R, 2008. Environmental impact assessment: A case study of hydropower project, *Environmental Policy Analysis, Volume 3 Issue 1,* Trade Science Inc. India.

LEDCO, 2001. Environmental Impact Assessment of Khudi Hydropower Project. Besishahar, LEDCO, Nepal

Marriott B.B., 1997. Environmental Impact Assessment: A Practical Guide, McGraw-Hill Professional.

MOPE, 2004. Guidelines for Environmental Management Plan, Nepal, Ministry of Population and Environment, Kathmandu Nepal.

Hartley N., Wood C., 2005. Public participation in environmental impact assessment—implementing the Aarhus Convention. Environmental Impact Assessment Review, 25. Pp (319-340).

Lee N. and George C., 2002. Environmental Assessment in Developing and Transitional Countries, John Wiley & sons Ltd, Chichester, England.

NPC, 1980. The Sixth Pan (1980-1985), GoN/ National Planning Commission, Kathmandu, Nepal.

NPC,1985. The Seventh Plan (1985-1900), GoN/ National Planning Commission, Kathmandu, Nepal.

NPC, 1992. The Eighth Plan (1992-1997), GoN/ National Planning Commission, Kathmandu, Nepal.

NPC, 1997. The Ninth Plan (1997-2002), GoN/ National Planning Commission, Kathmandu, Nepal.

NPC, 2002, The Tenth Plan (2002-2007), GoN/ National Planning Commission, Kathmandu, Nepal.

NPC/NCS, 1993. National Environmental Impact assessment Guidelines, National Planning Commission and International Union for conservation of nature, Kathmandu, Nepal.

Peirce J.J., Vesilind A., Weiner R., 2004. Environmental: Pollution and Control, 4th Edition, John-Wiley & Sons.

Petr T. and Swar D.B. (eds.), 1996. *FAO Fisheries Technical Paper 431*, Rome: UN Food and Agriculture Organization.

RSHDC, 2004. Initial Environmental Examination Report, Ridikhola Small Hydropower Development Company, Kathmandu, Nepal.

Shrestha A.P., 1991. Hydropower in Nepal: Issues and Concept of Development, Resources Nepal, Kathmandu, Nepal.

Shrestha, D.L., and Shrestha, K., 1994. Sustainable Small Hydropower Development in the Rural Areas in Nepal, Procedings of the fourth National convention of Engineers on sustainable Infrastructure Development (May 15-16, 1994), Nepal Engineers Association, Kathmandu, Nepal.

Sinha, S.P. 1995. Sustainability of Small Hydropower Hydel Projects in Sustainable Development of Nepal (Ed, H.B. Jha), Centre for Economic and Technical Studies (CETS)/ Frediach Ebert Stifung, Modern Printing Press, Kathmandu, Nepal pp 84-87

Subba, R.R., 2001. Himalayan waters, Promise and Potential, problem and politics, The panos Institute, South Asia Kathmandu Nepal.

Thanju, R.P., 2007. Kali Gandaki 'A' Hydroelectric Project in Environmental Perspectives, *Hydro Nepal,* Vol 1, Issue 1, e-RG Nepal, pp11-17.

Upadhaya, K.K. and Shrestha, B.C., 2002. Project induced impacts on fisheries esource and their mitigation approach in the Kali Gandaki 'A' hydroelectric project, Nepal, in *Cold Water Fisheries in the Trans-Himalayan Countries*.

UPHCL, 2005. IEE of Upper Piluwakhola Hydropower, Upper piluwakhola Hydropower Project Company Limited, Kathmandu, Nepal,

Uprety, B.K., 2003. Environmental Impact Assessment: Process and Practices, Mrs Uttara Upreti, Kathmandu, Nepal.

World Bank, 1996. *The World Bank's Experience with Large Dams*: *A Preliminary Review of Impacts. Profiles of Large Dams* (background document), Washington DC: Operations Evaluation Office, The World Bank.

World Commission on Dams, 2000. *Dams and Development*: *A New Framework for Decision-Making, the Report of the World Commission on Dams*, London, UK and Sterling, VA: Earthscan Publications.

WWF, 1999. *A Place for Dams in the 21st Century,* World Wildlife Fund International, Gland, Switzerland:

Zobel, D.B., Jha, P.K., Behan, M.J. and Yadav,U.K.R. 1987. A Practical manual for ecology. Ratna Book Distributor, Kathmandu, Nepal.

Annex 1: Questionnaire of Baseline Study

x]jf P ;fgf hnljB't cfof]hgf

;fdflhs–;f+:s[lts tyf cfly{s jftfj/0fLo k|efj cWoog k|ZgfjnL

-kl/of]hgfaf6 k|efljt kl/jf/x?;+u ;f]Wg]_

!= ;fdfGo hfgsf/L

(क) सर्भेक्षण गरिएको गाँउ विकास समितिको नाम : .....

(ख) वडा नं. ..... गाँऊ : ..... घर नं. .....

(ग) घरमूलीको नाम, थर .....

(घ) परिवारमा बस्ने सदस्यको संख्या ..... (क) पुरुष ..... (ख) महिला .....

(ङ) परिवारमा बस्ने सदस्यहरुको विवरण :

	नाम	परिवारको मूलीसंगको नाता	लिंग	उमेर	शिक्षा	पेशा
१						
२						
३						
४						
५						
६						
७						
८						
९						
१०						

बोल्ने भाषा : धर्म :

प्रमुख धार्मिक पर्वहरु : सर्भेक्षण क्षेत्रका धार्मिक तथा साँस्कृतिक ठाउँहरु .....

प्रमुख चाडपर्वहरुको नाम :

(च) घर जग्गा भएको/नभएको

(१) घर तथा जग्गा दुबै भएको .....

(२) जग्गा भए प्रकार

	सिंचाई सुविधा भएको	सिंचाई सुविधा नभएको	आफैले गरेको	अरुलाई कमाउन दिएको	कैफियत

खेत(रोपनीमा)					
बारी					
पाखो					

(३) सिंचाईको स्रोत .....

(४) घर मात्र भएको जग्गा नभएको .....

(५) घर जग्गा केहि नभएको .....

(छ) परिवार बस्ने घरको प्रकार

(१) पक्की .....

(२) कच्ची .....

(ज) पशुपंछी पालन गर्ने गोठ/खोर आदि भए/नभएको (भएमा प्रकार खुलाउने) .....

(झ) घरमा शौचालयको व्यवस्था छ/छैन (भएमा शौचालयको प्रकार खुलाउने) .....

(ञ) खाना पकाउनको लागि प्रयोग गर्ने चुलोको प्रकार .....१)साधारण २)सुधारिएको ३) गोवर ग्यास ४) अन्य .....

(ट) खाना पकाउनको लागि प्रयोग गर्न इन्धनको प्रकार १)दाउरा २) गोवर गोइठा ३) गोवर ग्यास ४) एल.पी.जी ५)अन्य.....

(ठ) इन्धनको श्रोत के हो ? र कहाँबाट प्राप्त गर्नु हुन्छ ? .....

(ड) गाईबस्तुको गोवर के काममा प्रयोग हुन्छ ? .....

ढ) तपाईको परिवारले कहाँको पानी पिउनु हुन्छ र पानीको गुणस्तर कस्तो छ ? १)मूल २) खोला ३) अन्य .....

(ण) तपाईको घरबाट तल उल्लेख गरिएका नजिकका श्रोतहरुसम्म पुग्न कति समय लाग्छ ?

	सुविधाको किसिम	लाग्ने समय	कैफियत
१	प्राथमिक विद्यालय		
२	स्वास्थ्य केन्द्र		
३	बस स्टप		
४	पक्की सडक		
५	बाणिज्य बैंक		
६	सहकारी संस्था		
७	साना किसान बिकास आयोजना		
८	हाट बजार		
९	कृषि केन्द्र		
१०	गैर सरकारी संस्था		

@= kz'k+5Lsf] ;e]{lf0f

-s_ ;e]{lf0f ul/Psf] s[ifs kl/jf/;+u /x]sf] kz'k+5Lsf] ljj/0f

विवरण	संख्या	जात (स्थानीय/उन्नत)	कैफियत
गाई			गाईले दिने दुध औसत लिटर.....
गोरु			
बाछा-बाछी			
भैसी			भैसीले दिने दूध औसत लिटरमा.....
पाडा-पाडी			
बाख्रा			
खसी तथा बोका			
हांस /कुखुरा			
स्थानीय जातको सुंगुर			
बंगुर			

#= vfBfGg tyf gub]jfnL

(क) तपाइले गर्ने प्रमुख खाद्यान्न बालीहरु :

खद्यान्न तथा नगदे वाली	लगाउने महिना	औसत उत्पादन	विक्री गर्ने भए परिमाण	बिक्री गर्ने बजार	रासायनिक मलको प्रयोग छ/छैन
धान					
मकै					
गहुँ					
कोदो					
तोरी					

(ख) तपाईको आर्जनबाट वर्षभरी खान लाउन पुग्छ ? १) पुग्छ २) पुग्दैन

पुग्दैन भने सो परिपूर्ति गर्ने स्रोत के हो बताउनु होस ?.....

बचत हुन्छ भने बचत के गर्नु हुन्छ ?.....

(ग) तरकारी खेती

(१) के तपाई तरकारी खेती गर्नु हुन्छ ?

यदि गर्नुहुन्छ भने.....

तरकारीको नाम	लगाउने महिना	औसत उत्पादन	तरकारी बेच्ने बजार	समस्याहरु

(३) यो गाउंमा बेमौसमको तरकारी खेती गर्ने प्रचलन छ ? १)छ २)छैन

(४) तपाई वर्षभरी अथवा मौसमीरुपमा मात्र तरकारी खेती गर्नु हुन्छ ? १)गर्छु २) गर्दिन

(५) तरकारी खेती गर्ने शिप कहाँबाट प्राप्त गर्नु भयो ? .....

(६) तरकारीको वीउ अथवा बेर्ना कहाँबाट प्राप्त गर्नुहुन्छ ?.....

७) यो गाँउमा कति तरकारी बिक्री हुन्छ ? .....

(८) तरकारी बेच्ने ठुलो बजार कुन हो ? .....

(९) तरकारी खेतीमा रासायनिक मलको प्रयोग गर्नु हुन्छ ? १) हुन्छ २)हुँदैन

(१०) तरकारी खेतीमा तपाईले भोग्न भएका समस्याहरु के के हुन् ?

.....

च) फलफूल खेती

फलफूलको नाम	बोटको संख्या	वार्षिक उत्पादन परिमाण	घरमा खपत	विक्री गर्ने परिमाण	कैफियत

भरिया दर प्रति दिन प्रति किलो ग्राम ..... देखि ..... सम्म

कृषि ज्याला दर प्रतिदिन .....

बन-जंगलको प्रकार बारे:.

सामुदायिक वनको विवरण

.....

.....

$= /f]huf/L l:ylt ;DaGwL laj/0fx?

(क) तपाईको परिवारको हालको रोजगारीको स्थितिको बारेमा बताई दिनु होस ।

	नाम	ज्यालादारी रोजगारी		अन्य रोजगरी	
		कृषि क्षेत्र	गैरकृषि क्षेत्र	स्वयं रोजगारी	बेरोजगारी
१					
२					
३					
४					
५					

(ख) खेतीपातीमा तपाईको परिवारका सदस्यहरु वर्षमा कति दिन काम गर्दछन् ?

कामको प्रकार	संलग्न हुने दिन	कैफियत
खेत जोत्ने		
बाली लगाउने		
गोडमेल गर्ने		
बाली भित्राउने		
अन्य कामहरु		

(ग) फूर्सतको समयमा तपाई र तपाईको परिवारका सदस्यहरु के काम गर्दछन ?

.....
.....

(घ) महिला भेदभाव छ ? १) छ २) छैन

यदी छ भने :

(क) शिक्षा क्षेत्रमा (ख) पैत्रिक सम्पत्तिमा (ग) खाना (घ) लुगाफाटो (ङ) कामको बाँडफाडँमा च) अन्य.....

%= kl/jf/sf] aflif{s cfo–Joo ljj/0f -cfly{s jif{ @)^$÷^% sf] ljj/0f_

	परिवारका आयका स्रोतहरु	उत्पादन परिमाण	बिक्रीयोग्य बचत परिमाण	परिवारका खर्चका प्रकारहरु	
	(क) खेतीबाट हुने आम्दानी				
२	धान			खानपिनमा हुने खर्च	
३	मकै			लुगाफाटोमा हुने खर्च	
४	गहुँ			छोरा-छोरीको शिक्षामा हुने खर्च	
५	(ख) नगदेवालीबाट हुने आम्दानी			ओषधोपचार	
६	घ्याल			तीर्थ भ्रमण	
७	तोरी			यातायात	
८	आलस			हाटबजारमा फर्मायसी खर्च	
९	तरकारी खेतीबाट हुने आम्दानी			बिडि चुरोट	
				घर मर्मत	
	पशुपालनबाट हुने आम्दानी			भाडा बर्तन खरीद	
	गाई विक्री			गर गहना खरीद	
	गोरु बिक्री			गाई बस्तु खरीद	
				बंगुर खरीद	
				कृषि औजार खरीद	
				साबुन तेल आदि	

				हजाम खर्च	
				वीउ खरीद	

नोट : माथिको तालिका तयारगर्दा कृषकले उत्पादन गरेर बिक्रीयोग्य बचत अथवा उत्पादनले खान पुग्ने अथवा नपुग्ने मात्र राख्ने ।

(१) यस गाँउका प्रमुख समस्याहरु के के हुन ?

(क)

(ख)

(ग)

यो परियोजनाको निर्माण भएमा गाँउलाई हुने लाभहरु के के हुन् ?

(क)

(ख)

(ग)

हानीहरु के के हुन ?

(क)

(ख)

(ग)

यो परियोजनाले तपाईलाई के सुविधा उपलब्ध गराईदियोस जस्तो लाग्छ ?

.....
.....
.....
.....

^= ahf/efp ;j]{lf0f M

बस्तुको नाम	ईकाई	खुद्रा बजार भाउ	थोक बजार भाउ
खाद्यान्न			
चामल मोटो			
चामल मसिनो			
मकै			
गहुँ			
गहुँको पिठो			
तोरीको तेल			
घ्यू			
मट्टीतेल			
साबून			

यातायात खर्च			
दुग्ध पदार्थ			
दुध भैंसिको	प्रति लिटर		
दुध गाईको			
दहि प्रतिलिटर			
घ्यू खारेको	प्रति किलोग्राम		
मासू/माछा			
खसीको मासु	प्रति किलोग्राम		
बंगुरको मासु	प्रति किलोग्राम		
कुखुराको मासु	प्रति किलोग्राम		
माछा	प्रति किलोग्राम		

ज्यालादर

(क) कृषि

(ख) अन्य मजदुरी

(ग) भरिया

(घ) डकर्मी

(ङ) सिकर्मी

निर्माण सामाग्रीको दर

(क) ढुंगा...../डोको वा क्यू.मि. वा क्यू. फिट

(ख) बालुवा ..... /डोको वा क्यू.मि. वा क्यू. फिट

(ग) सिमेण्ट ...../ बोरा

Annex 2: Species found in Studied Area

List of Tree Species

S.No	Local Name	Scientific Name
1	Mauwa	*Englehardtia spicataLeschen.(Juglandaceae)*
2	Sal	*Shorea robusta Gaertn.(Dipterocarpeceae)*
3	Jaamun	*Syzigium cumini(L.)Skeels(Myrtaceae)*
4	Phalat	*Quercus sps*
5	Tanki	*Bauhinia purpurea L.(Caesalpiniaceae)*
6	Koiralo	*Bauhinia variegata L.(Caesalpinaceae)*
7	Kutmiro	*Litsea monopotala (Roxb.)Pers.(Lauraceae).*
8	Khaniu	*Ficus semicordataBuch.-Ham ex. Sm(Moraceae)*
9	Badahar	*Artocarpus lakoochaWall.ex.Roxb.(Moraceae)*
10	Uttis	*Alnus nepalensisD.Don(Betulaceae)*
11	Salla	*pinus roxburghhi*
12	Simal	*Bombax ceibaL.(Bombacaceae)*
13	Majito	Rubia majith Roxg.ex. fleming(Rubiaceae)
14	Khirro	*Sapium insigne(Royle)Benth ex. Hook f.(Euphorbiaceae)*
15	Nigalo	*Arandianaria falcate Ness*
16	Katush	*Castonopsis indica*
17	Chilaune	*Schima wallichi*
18	Amba	*Psidium guajava L.(Crassulaceae)*
19	Nibaro	*Ficus auriculataLour.(Moraceae)*
20	Phaledo	*Erythrina stricta Roxb. Merr and Perry(Myrtaceae)*
21	Dhasur	*Colebrookea oppositeafoliaSm(Labiatea)*

(Field Survey,2008)

NTFPs in the surrounding area

S.No	Common Name	Scientific name
1	Chiraito	Swertia chirata (Roxb. Ex. Flem.) Karst.
2	Majito	Rubia majith Roxg.ex. fleming(Rubiaceae)
3	Daruhaldi	Mahonia nepalensis DC.(Berberidaceae)
4	Bojho	Acorus calamus L.(Araceae)
5	Kurilo	Asparagus afficinalis L.(Liliaceae)
6	Nagbeli	Lycopodium clavatum L.(Lycopodiaceae)
7	Lokta	Daphne bholua Buch-Ham ex. D.Don.(Thymelaeceae)
8	Bikhma	Aconitum ferox Wall. ex. Seringe
9	Boketimbur	Zanthozylem acanthopodium DC.(Rutaceae)
10	Pinus	Pinus wallichiana A.B. Jacson(Pinaceae)
11	Jivanti	Desmotricum fimbriatum Bl.(Orchidaceae)
12	Ritha	Sapindus mukorossi Gaertn(Sapindaceae)
13	Jhyau	Lichen(Spergula arvensis L.(Caryophylaceae)
14	Siltimur	Zanthoxylem oxyphyllum Edgew.(Rutaceae)
15	Argeli	Daphne sureil W.W.Sm ex. Cave(Thymelaeaceae)Argale
16	Loth salla	*Taxus baccata* L.(Dhyangre salla)

(First Period District development Programme,2059-60, District Development Committee, Phidim, Panchthar.)

List of Bird found in studied area

S.No	Local Name	Scientific name
1	kaliz	*Lophura leucomelana*
2	tirta	*Francolinus francolinus*
3	lampuchhre	*Urocissa sps*
4	Bhangera	*Passer domesticus*
5	Kag	*Corvus splendens*(Corvidea)
6	Koili	
7	Hunchil	*Buteo buteo* (Accipitridae)
8	Jureli	*Pycnonotus cafer*(Picnonotidae)
9	Dhukur	*Chalcophaps indica*(Columbidae)
10	Ruppi	
11	Gauthheli	*Hirundo daurica*(Hirundinidae)
12	Kalbudhe	
13	Kokule	
14	Bakulla	
15	Kalkale	*Dendrocitta formosae himalayansis*(Corvidae) Kokale
16	Mayur	*Pavo cristatus*(Phasianidae)

(Field Survey,2008)

List of Fishes

S.No	Local Name	Scientific Name
1	Asala	
2	Katle	

(Field Survey,2008)

List of Reptile, Amphibian and Fishes

S.No.	Local name	Scientific name
Reptiles		
1	Green pit viper	*Trimeresurus albolaris*
2	Black-bellied rough side snake	*Trachischium fuscum*
3	Black-bellied rough side snake	*Asymblepharus sikkimensis*
4	house lizard	*Hemydactylus flavivirides*
Amphibian		
1	Frog	*Rana cyanophlyctus*
2	Toad	*Bufo melanostictus*
Fishes		
1	Asala	*Schizothorax plagiostomus*
2	Katle	*Accrocheilus sps*
3	Kabre	*Pseudogmeis sps*

(Field Survey,2008)

List of Mammals

S.No.	Local Name	Scientific Name	Status
1	Syal	*Canis aureus*	CITIES-III
2	Kharayo	*Caprolagus sps*	CITIES
3	Bandar	*Macaca sps*	CITIES-II
4	Dumsi	*Hystrix indica*	
5	Malsapro	*Mustela strigidorsa*	
6	malsapro	*Mustela strrigidorsa*	
7	Salak		
8	Mirga		
9	Kala		
10	Chituwa	*Neofelis nebulosa*	GoN, Protected
11	Ghoral	*Naemorhedus goral*	
12	Ban Dhade	*Felis sps.*	CITIES
13	Fyauro	*Vulpes vulpes*	
14	Musa	*Rattus rattus*	
15	Chhuchundro	*Soriculus baileyi*	
16	Langur		

(Field Survey,2008)

Annex: 3 Analysis of Vegetation

Name of the Species	DBH (cm)	DBH (m)	Height (m)	Basal Area (cm^2)	Basal Area Ratio	Volume (m^3)	Net Volume (m^3)
Quadrate No.: 1 At the Head works							
Alnus nepalensis	23.4	0.234	45	429.8346	1.3689	0.154001	0.120953
Alnus nepalensis	24	0.24	19	452.16	1.44	0.0684	0.053721
Alnus nepalensis	26.3	0.263	15	542.9767	1.729225	0.064846	0.05093
Alnus nepalensis	18	0.18	19	254.34	0.81	0.038475	0.030218
Alnus nepalensis	21	0.21	27	346.185	1.1025	0.074419	0.058448
Alnus nepalensis	14	0.14	18	153.86	0.49	0.02205	0.017318
Alnus nepalensis	13	0.13	8.5	132.665	0.4225	0.008978	0.007051
Alnus nepalensis	11.2	0.112	15	98.4704	0.3136	0.01176	0.009236
Alnus nepalensis	10	0.1	6	78.5	0.25	0.00375	0.002945
Alnus nepalensis	10.1	0.101	11	80.07785	0.255025	0.007013	0.005508
Majito	23	0.23	25	415.265	1.3225	0.082656	0.064918
Quadrate No.: 2 At the Alignment just after the Descending basin							
Alnus nepalensis	13	0.13	21.3	132.665	0.4225	0.022498	0.01767
Schima wallichi	12.1	0.121	18	114.9319	0.366025	0.016471	0.012936
Schima wallichi	18	0.18	25	254.34	0.81	0.050625	0.039761
Castonopsis indica	17.1	0.171	23.5	229.5419	0.731025	0.042948	0.033731
Schima wallichi	13	0.13	20	132.665	0.4225	0.021125	0.016592
Jamun	15	0.15	18	176.625	0.5625	0.025313	0.01988
Phalant	15.4	0.154	17	186.1706	0.5929	0.025198	0.019791
Castonopsis indica	13.2	0.132	21.5	136.7784	0.4356	0.023414	0.018389
Schima wallichi	12.5	0.125	19	122.6563	0.390625	0.018555	0.014573
Bombax ceiba	16.3	0.163	22	208.5667	0.664225	0.036532	0.028693
Quadrate No:3 At The Alignment Below the Luwafu Khola							
Schima wallichi	15.5	0.155	18.5	188.5963	0.600625	0.027779	0.021818
Schima wallichi	14.3	0.143	14	160.5247	0.511225	0.017893	0.014053
Castonopsis indica	21	0.21	20	346.185	1.1025	0.055125	0.043295
Castonopsis indica	22	0.22	20	379.94	1.21	0.0605	0.047517
Alnus nepalensis	17.2	0.172	20.5	232.2344	0.7396	0.037905	0.02977
pinus roxburghii	25	0.25	32	490.625	1.5625	0.125	0.098175
Shorea robusta	16	0.16	21	200.96	0.64	0.0336	0.026389
Schima wallichi	18.1	0.181	24	257.1739	0.819025	0.049142	0.038596
Schima wallichi	12	0.12	18	113.04	0.36	0.0162	0.012723
Schima wallichi	14.8	0.148	16	171.9464	0.5476	0.021904	0.017203
Schima wallichi	14	0.14	12	153.86	0.49	0.0147	0.011545
Quadrate No 4 At The Alignment							
Alnus nepalensis	18.5	0.185	18	268.6663	0.855625	0.038503	0.03024
Schima wallichi	20	0.2	23	314	1	0.0575	0.045161
Schima wallichi	10.8	0.108	9	91.5624	0.2916	0.006561	0.005153
Pinus	49	0.49	50	1884.785	6.0025	0.750313	0.589295
Castonopsis indica	13.1	0.131	17	134.7139	0.429025	0.018234	0.014321

Amala	12	0.12	18	113.04	0.36	0.0162	0.012723
Schima wallichi	10	0.1	14	78.5	0.25	0.00875	0.006872
Castonopsis indica	14	0.14	24	153.86	0.49	0.0294	0.023091
Quadrate No.: 5 At the Alignment Near The Powerhouse							
Castonopsis indica	16	0.16	15	200.96	0.64	0.024	0.01885
Unknown A	12	0.12	17	113.04	0.36	0.0153	0.012017
Schima wallichi	16.5	0.165	16	213.7163	0.680625	0.027225	0.021383
Castonopsis indica	13.4	0.134	19.5	140.9546	0.4489	0.021884	0.017188
Schima wallichi	18	0.18	13.7	254.34	0.81	0.027743	0.021789
Schima wallichi	11.1	0.111	18	96.71985	0.308025	0.013861	0.010887
Alnus nepalensis	10.2	0.102	12	81.6714	0.2601	0.007803	0.006128
Schima wallichi	17	0.17	24	226.865	0.7225	0.04335	0.034047
Castonopsis indica	18	0.18	17	254.34	0.81	0.034425	0.027037
Castonopsis indica	16.1	0.161	13	203.4799	0.648025	0.021061	0.016541
Schima wallichi	18	0.18	15	254.34	0.81	0.030375	0.023857

Annex 4: Matrix of Probable Environmental Impacts

	S. N.	Potential Impacts Requiring Mitigation	Magnitude			Extent			Duration		
			H	M	L	SS	L	R	S	M	L
Physical	1	Meteorology and Hydrology		✓		✓					✓
	2	Land Utilize		✓		✓					✓
	3	River Morphology			✓	✓					✓
	4	Water Quality	✓			✓				✓	
	5	Land Slide & Soil Erosion			✓	✓			✓		
	6	Slope Stability			✓	✓			✓		
	7	Muck Disposal and Stock Pilling			✓	✓			✓		
	8	Quarry Sites			✓	✓			✓		
	9	Waste Disposal			✓	✓			✓		
	10	Air, Noise Pollution and vibration			✓	✓			✓		
Biological	1	Forest/Vegetation Clearing Loss		✓		✓					✓
	2	Wildlife Habitat (Fragmentation/Loss)			✓	✓				✓	
	3	Rare/Endangered Species Affected			✓	✓			✓		
	4	Aquatic Habitat Altered	✓			✓					✓
	5	Fish Passage Restriction/Effect	✓				✓				✓
	6	Water Pollution Potential			✓	✓			✓		
	7	Adverse Bio-diversity Impacts			✓	✓			✓		
Socio-economic and Cultural	1	Loss of Agriculture Lands/Production		✓		✓					✓
	2	Loss of Standing Crop		✓		✓				✓	
	3	Occupational Health Hazard and Safety			✓	✓			✓		
	4	Health and Sanitation			✓	✓			✓		
	5	Gender Issues			✓	✓			✓		
	6	Impact on Law and Order			✓	✓			✓		
	7	Impact on Social Values			✓	✓				✓	
	8	Impacts due to Increase Economic Activities During Construction Phase		✓			✓				✓
	9	Impacts due to Increase Economic Activities During Construction Phase		✓			✓			✓	
	10	Local Job Creating Opportunities		✓				✓		✓	
	11	Local/Regional Economic Impacts	✓				✓				✓
	12	Development Activities		✓			✓				✓
	13	Infrastructure and Social Service Facilities		✓				✓			✓
	14	Impact on Communal & Religious Resources			✓		✓	✓			

Note:

Magnitude	Extend	Duration
H = High	SS = Site Specific	S = Short Term
M = Medium	L = Local	M = Mid Term
L = Low	R = Regional	L = Long Term

Annex 5: Impact-Mitigation Matrix of Hewa Khola Hydropower Project

Project Activities	Impacts	Impact prediction			Mitigation	Responsibility	Agencies to be Consulted
		Magnitude	Extent	Duration			
Physical Factors							
Land Utilization	Change in land use pattern	M	S S	L	Minimization of land use for permanent purpose	Hewa- A	Affected HHs
Construction Activities (e.g. diversion weir, head works, canal, access road, etc.)	Landslides and soil erosion Air, noise and vibration	L L	L L	S S	Standard engineering and bioengineering practices Regular sprinkling of water, Proper maintenance of machines and equipment, minimization of blasting.	Contractor, Hewa- A	
Earth Works	Spoil deposits Land Slides Soil erosion and landslide	L L	L L	S S	Embanking on the sides of the alignment, Back Filling along the road Plantation of anchoring plants.	Contractor, Hewa- A Contractor / Hewa- A	Land Holders
Biological Factors							
Flora							
Earth Excavation	Loss of Vegetation Loss of bio-diversity	M L	L L	S M	Strengthened of user groups to maintain community forest Compensatory Plantation. Awareness through education and training for local people	Hewa- A Hewa- A	Forest Users Group/ Owner Local People, Forest Users Group
Hiring of work force	Increase housing demand Increase fuelwood demand Increase in solid wastes	M M L	R L L	S S S	Priority goes to local labor Use of kerosene, electricity, gas stove and heaters. Preparation of temporary pits and latrines.	Contractors / Hewa- A Contractors Contractors	DDC/VDCs

Fauna							
Construction of Project Structures	Loss of habitats Disturbances and interruption of movements	M	L	M	Minimize Blasting Implement forest management program and immediately reforest the fast growing trees in disturbed sites.	Hewa- A /Contractors	Forest Users Group
Hiring of labour force	Increase hunting and poaching pressure	L	L	S	Implement forest management, and apply strict rules for hunting and poaching.	Hewa- A, Contractors	Forest Users Group
Fish and Aquatic Life							
Construction of a diversion weir	Change in flow regime Removal of boulders which would affect spawning ground and migratory snow trout and Catfish	H L	L L	L S	Release minimum riparian flow/Construction of Fish Passage Minimize the use of river boulders	Hewa- A Contractors	

Socio-economic and Cultural Factor							
Project Activities	**Impacts**	**Impact prediction**			**Mitigation**	**Responsibility**	**Consulted Agency**
		Magnitude	Extent	Duration			
Land acquisition	Financial hardship from loss of property.	M	L	L	Fair financial compensation to be provided so that the affected families can buy new pieces of land.	Hewa- A	DDC/VDC /affected HHs
Land Rental	Loss of agricultural crops.	L	L	S	Fair financial compensation to be provided so that the affected families can maintain their requirements.	Hewa- A /Contractors	Affected HHs
Earth Works	Spoil deposits	M	L	L	Spoils deposits in gullies and access road	Hewa- A Contractors	VDC
	Landslides	L	L	M	Re-vegetation program & Construction of retaining walls.	Hewa- A Contractors	

Demographic Pressures	Labour competition	L	L	S	Provide skills training to local labour.	Hewa- A Contractor	CDO/DDC/VDC/Local People
	Stress on local resources	L	L	S	Tap new markets. Market economy development programs.	Hewa- A	
	Inflation	L	L	M	Import food items from Phidim.	Hewa- A /Contractors	
	Solid wastes production	L	L	S	Burial pit system		
	Human sanitation problems	L	L	S	Camp toilets and showers. Arrangement of portable drinking water.	Hewa- A / contractors	
	Increased fuel demands	L	L	S	Import kerosene, bio-gas, electricity etc.	Civil Contractors	
	Anti-social behavior	M	L	M	Strict behavioral regulations. Strict policing and punishment system. Regular meetings with residents of affected communities.	Hewa- A Civil Contractor, CDO, Hewa- A	
Labour	Child labour	L	L	S	Set minimum age at 15.	Hewa- A	
	Accident potentials	M	L	S	Health clinics/evacuation Safety measures/Insurance Policy	Hewa- A, Contractors	

Note:

Magnitude	**Extent**	**Duration**
L = Low M = Medium H = High	SS = Site Specific L = Local R = Regional	S = Short term M = Medium term L = Long term

Some Snaps

Photo No 1.View of Proposed Head Works Area Photo No 2. View of proposed desilting Basin Area

Photo No 3.View of proposed desilting Basin Area

Photo No 4. Proposed Powerhouse site

Photo No 5. Questionnaire survey

Photo No. 6. Alignment passing