KABELI ENERGY LIMITED

Buddha Nagar, Kathmandu, Nepal

Kabeli-A Hydroelectric Project

ENVIRONMENTAL IMPACT ASSESSMENT

July, 2013

(Updated October 2013)

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Acronyms and Abbreviations

AAPA	Aquatic Animals Protection Act
AAS	Atomic Absorption Spectrophotometer
AEMP	Aquatic Ecology Management Plan
AEPC	Alternative Energy Promotion Center
BOD	biological oxygen demand
BOOT	build, own, operate and transfer
BPC	Butwal Power Company Limited
BS	Bikram Sambat
CAO	Comprehensive Assessment of Option
CAR	Catchment Area Ratio
CAT	Catchment Area Treatment
CBO	Community Based Organization
CCCP	Canada Climate Change Program
CDO	Chief District Officer
CF	Community Forest
CFUG	Community Forest User Group
CIA	Cumulative Impact Assessment
CITES	Convention on International Trade in Endangered Species
cm	Centimeter
CPUE`	Catch per Unit Effort
CSR	Corporate Social Responsibility
DBH	Diameter at Breast Height
DDC	District Development Committee
DFO	District Forest Office
DLRO	District Land Revenue Office
DO	Dissolved Oxygen
DoED	Department of Electricity Development
DoLIDAR	Department of Local Infrastructure Development and Agriculture Roads
DSCO	District Soil Conservation Office
DSPR	Dam Safety Plan Report
E	East
EEC	Environmental Enhancement committees
EF	Environmental Flow
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMEP	Environmental Management and Execution Plan
EMP	Environmental Management Plan
EPA	Environment Protection Act

EPP	Emergency Preparedness Plan
EPR	Environment Protection Rules
FGD	Focus Group Discussions
FPICon	Free Prior and Informed Consultation
GC	Grievances Committee
GDP	Gross Domestic Product
GLOF	glacial lake outburst flood
GMF	Government Managed Forest
GoN	Government of Nepal
GRC	Grievance Redress Committee
GRO	Grievance Redress Officer
GWh	Giga Watt hours
Ha	Hectare
HCE	Hydro-Consult Engineering Limited
HCPL	Hydro-Consult Private Limited
HEP	Hydro Electric Project
HIDCL	Hydropower Investment and Development Company Limited
HPP	Hydro Power Project
ICIMOD	International Centre for Integrated Mountain Development
ICP	Informed Consultation and Participation
IDA	International Development Association
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IFI	International Funding Institutions
IFIM	In stream Flow Incremental Methodology
ILO	International Labour Organization
IP	Indigenous People
IPPAN	Independent Power Producers' Association of Nepal
IUCN	International Union for Conservation of Nature
IVCDP	Indigenous and Vulnerable Community Development Plan
JOR	Joint Operation Rule
JV	Joint Venture
KAECDU	Kabeli-A Environment and Community Development Unit
KAHEP	Kabeli-A Hydroelectric Project
KCA	Kanchanjunga Conservation Area
KCC	Kabeli Concern Committee
KCTLP	Kabeli Corridor Transmission Line Project
KEL	Kabeli Energy Limited
kg	Kilogram
kV	Kilo volt
kW	Kilo Watt

kWh	Kilo Watt hours
LF	Leasehold Forest
LFUG	Leasehold Forest User Group
LPG	Liquefied Petroleum Gas
m	Meter
masl	Meters Above Sea Level
MBNP	Makalu-Barun National Park
MCT	Main Central Thrust
MDG	Millennium Development Goals
mg/l	Milligram per liter
mm	Millimeter
MOE	Ministry of Energy
MOFSC	Ministry of Forest and Soil Conservation
MOSTE	Ministry of Science, Technology and Environment
MSHP	Medium Scale Hydroelectric Project
MW	Mega Watt
MWI	Monsoon Wetness Index
N	North
NEA	Nepal Electricity Authority
NESS	Nepal Environmental and Scientific Service
NGO	Non-Governmental Organization
NPWCA	National Parks and Wildlife Conservation Act
NRs	Nepalese Rupees
NTFP	Non-Timber Forest Product
O&MP	Operation and Maintenance Plan
ºC	Degree Centigrade
OHS	Occupational Health and Safety
OP	Operation Policy
PAP	Project Affected Persons
PDA	Project Development Agreement
PDF	Power Development Fund
PHABSIM	Physical Habitat Simulation Model
PIC	Project Information Center
PM_{10}	Particulate Matter
PMO	Project Management Office
PoE	Panel of Experts
PPA	Power Purchase Agreement
PRA	Public Relation Assistant
PROR	Peaking Run-Of-River
PS	Performance Standard
RCIA	Rapid Cumulative Impact Assessment

RCLAP	Resettlement Compensation and Livelihood Assistance Plan
RMR	Rock Mass Rating
RoR	Run-of-River
RoW	Right of Way
S	South
s	Second
SA	Social Assessment
SAP	Social Action Plan
SEA	Sectoral Environmental Assessment
SHOP	Short-term Hydro Operation Planning
SHS	Solar Home System
STD	Sexually Transmitted Disease
SWCA	Soil and Watershed Conservation Act
TDS	Total Dissolved Solids
TMJ	Tinjure Milke Jaljale
ToR	Terms of Reference
TSP	Total Suspended Particles
TSS	Total Suspended Solids
UNCHS	United Nations Centre for Human Settlements
UNDP	United Notations Development Program
UNEP	United Notations Environment Program
USFR	Updated Feasibility Study Report
VDC	Village Development Committee
W	West
WBG	World Bank Group

EXECUTIVE SUMMARY

The proposed Kabeli A Hydroelectric Project (KAHEP) is a 37.6 MW greenfield peaking run-of-the-river hydroelectric power project located on the Kabeli River, a tributary of the Tamor River, in the Taplejung and Panchthar districts in Eastern Nepal (the “project”).

Kabeli Energy Limited (KEL), a subsidiary of Butwal Power Company (BPC), is implementing the project. KEL has signed a Project Development Agreement (PDA) with the Department of Electricity Development (DOED) for the development of KAHEP. KEL has requested a total of US$75 million in financing from the World Bank Group (WBG), consisting of a US$35 million senior debt from the International Finance Corporation (IFC) and a US$40 million subordinated debt from the International Development Association (IDA), on-lent through the Hydropower Investment and Development Company Limited (HIDCL).

The power shortage in the country is crippling its economy. While power sector development is urgently needed, it is constrained by a shortage of funds for public and private projects and a lack of transmission lines. KAHEP, through a blend of private (IFC, CCCP, KEL) and public (IDA) funding will help develop this new generation capacity through a public-private partnership. IDA is also helping power evacuation from this and other projects in the Kabeli corridor through the ongoing IDA-financed Kabeli Transmission Project. The project is expected to contribute to positive socioeconomic development in the local areas.

Project specific environmental assessment studies were undertaken from April 2010 through August 2011. These studies resulted in the first Initial Environmental Examination (IEE)[1] report as per Nepal’s environmental legislation, approved by the Ministry of Energy, Government of Nepal (GoN) on November 13, 2011. The project has been classified by the WBG as a “Category A” project. Therefore, a project specific Environmental Impact Assessment (EIA) was prepared in August 2011 within the framework of the World Bank Safeguard Policies and IFC Policy and Performance Standards on Environmental and Social Sustainability.

A Social Assessment (SA) was conducted during 2010 and 2011. On the basis of the SA, various social interventions were designed in line with GoN and WBG policies and performance standards related to Involuntary Resettlement, Indigenous Peoples, and Gender. These include a Resettlement Compensation and Livelihood Assistance Plan (RCLAP), Indigenous and Vulnerable Community Development Plan (IVCDP), Resettlement Policy Framework, Gender Action Plan, Public Consultation and Consultation, as well as benefit sharing mechanisms. These are contained in a project Social Action Plan (SAP) for ease of implementation.

[1] Initial Environmental Examination (IEE) is used in Nepal legislation for a limited Environmental Assessment. Local legislation requires a full scale EIA for a hydropower project larger than 50 MW, a project lying within officially declared protected areas, or a project requiring clearance of more than 5 ha of forest land. The Ministry of Energy (MOE) has the authority to approve IEEs and the Ministry of Science, Technology and Environment (MOSTE) has the authority to approve hydropower project EIAs.

Considering the poverty in the project areas and the general expectations of local communities, the SAP designed by KEL goes beyond mitigation of adverse impacts and includes measures to support and promote socioeconomic development in the project areas. These measures include income generating programs, vocational skill training, and provision of and improvement in basic community infrastructure, such as drinking water, health services, schools and roads. A major measure, responding to local community request, is to provide grid-electricity to the project Village Development Committees (VDCs), under the ongoing Kabeli Transmission Line Project managed by Nepal Electricity Authority (NEA). The project will create employment opportunities for the local population during its construction period and vocational training schemes will be designed to prepare people for these employment opportunities.

Additional studies were conducted in 2011 and 2013 to obtain local and international experts' opinion on the adequacy of the downstream ecological flow in the dewatered stretch of Kabeli River and to identify potential risks of fish entrapment at the head works and the impacts related to fluctuating daily flow during peak operation downstream of the tailrace. Also, additional consultations were carried out in the project area to check and confirm the findings and conclusions of the SA, particularly expectations and broad support from local communities, including vulnerable groups potentially affected by the project, namely women, *Dalits* (or "untouchables," those who are religiously, culturally, socially, economically and historically oppressed and excluded) and Indigenous Peoples. The EIA, SA and SAP were updated in February 2012, April 2013 and July 2013 to incorporate information from the various studies, field surveys and consultations completed to date. Furthermore, Chapter V on Analysis of Alternatives was significantly strengthened.

Fundamentals of the project have not changed since the original design. The project's environmental and social impacts and risks as well as conclusions regarding their assessment also remain the same. All the additional studies mentioned above have concluded that the environmental and social interventions as designed are adequate to address the adverse environmental and social impacts and risks identified under the project and that the local stakeholders, including vulnerable groups, maintain the same view regarding the KAHEP, which continues to enjoy Broad Community Support (BCS).

As per WBG procedures, the sponsors engaged a panel of experts (POE) to review technical (dam safety and civil works, underground works and sediments) aspects and environmental and social safeguards, including the cumulative effects of the project. After reviewing the EIA, the environmental and social experts of the POE, concluded that the KAHEP was environmentally sound, with minor impacts that can be effectively mitigated, and recommended some specific measures for the Environmental Management Plan (EMP) and monitoring.

Public Consultation and Disclosure

As part of the EIA, SA and SAP planning processes, KEL undertook extensive public consultation from 2010 to 2012 with potentially affected communities and other relevant stakeholders (Table E.1). The EIA (including the EMP, SA and SAP) was subjected to and benefitted from formal and intense community and public consultation meetings, which included briefings with interested district and local governmental institutions and NGOs.

The main objectives of the consultation process were to ensure effective and meaningful consultation with and participation by project affected persons (PAP) in project design decisions, in line with the principle of free, prior and informed consultation (FPICon), as stated in relevant GoN policies and WBG safeguard policies.

The first round of consultations was carried out during the EIA scoping exercise from April 22 to May 1, 2010. Fourteen focus group discussions with community forest user groups (CFUGs), women, *Dalits*, and Indigenous Peoples groups were held in October-November 2010 in different locations in the project area. District level stakeholders such as the District Development Committee (DDC) and District Forest Office (DFO) were also consulted. To ensure FPICon (or ICP)[2] with PAP, the SA and development of the SAP followed a highly participatory planning process. Local stakeholders, affected population, and various cultural and ethnic groups in the project area, including indigenous and vulnerable groups, were identified and engaged in a culturally sensitive and appropriate fashion throughout the planning process. During these meetings, KEL planning teams worked with the affected communities and other stakeholders and developed measures to minimize and address any negative project impacts as well as initiatives to maximize project benefits to those directly affected, particularly to vulnerable groups, namely women, Dalits and Indigenous Peoples

Comments and suggestions from different stakeholders, including vulnerable groups, were incorporated into the EIA, SA and SAP. Findings and recommendations of the EIA, SA and SAP were disseminated and discussed locally, and affected communities and other stakeholders provided their further feedback, which was also incorporated. Additional public consultation meetings took place at the project site on July 24, 2011, to share findings, explain how communities' concerns had been incorporated and obtain any further feedback from the project affected communities and other stakeholders. As noted above, further consultations were carried out in the project area in 2012 and early 2013, and the EIA, SA and SAP have been updated based on these consultations.

The EIA and SA findings were also presented in two district level consultations organized on July 25-26, 2011 at Phungling Bazar, district headquarter of Taplejung and at Phidim, district headquarter of Panchthar. These meetings were attended by government officials, political parties, NGOs, and representatives from public media. A national level consultation at Kathmandu was held on August 1, 2011.

WBG safeguard staff and consultants also carried out five different project site visits and consultations from 2010 to 2013 during preparation and disclosure of the EIA, SA and SAP reports. The latest site visit by the WBG Social Development Consultant was in May 2013 to assess the status of the project, to note the changes in the design, if any, with resultant impacts on PAP, and to keep a record of the key findings. During this visit, the

[2] The acronym FPICon was used to refer to *Free, Prior and Informed Consultation* with project affected communities by IDA and IFC. However, under the 2012 IFC Sustainability Framework this process is now referred to in IFC as *Informed Consultation and Participation– ICP* to differentiate it from *Free, Prior and Informed Consent – FPIC –* only applicable where Indigenous People are involved and when significantly adverse impacts upon them are expected as a result of the project.

Consultant also met with project staff, affected people and representatives from the affected VDCs.

As can be seen from the above, consultations have been carried out as part of the project planning stages, and local people have been involved from the initial phases of the EIA and SA. KEL has specific plans to continue this engagement process throughout construction and project implementation. For example, in order to ensure regular engagement with local communities, Community Guidance Committees (CGC), comprised of KEL representatives and elected/confirmed representatives of each of the directly affected VDCs, will be formed to ensure close and ongoing engagement during early works and project construction. The CGCs will be supported by the project and will work in close co-operation with the DDCs, VDCs, DFOs, CFUGs and NGOs during the implementation phase. The Kabeli-A Environmental and Community Development Unit (KAECDU) will liaise with all relevant local Government organizations, NGOs and Community Based Organizations (CBOs). KEL maintains a Public Relations Office (PRO) in the project area, opened and fully staffed since early 2012. KEL intends to continue open lines of communication and permanent engagement with affected communities.

KEL disclosed the EIA, SA and SAP through its public website, http://www.kel.com.np on February 8, 2011, and has continued uploading the updated versions, including the latest version updated in July 2013. The executive summaries of the EIA and SAP have been translated into Nepali, Limbu, Bantawa Rai, Khaling Rai and Tamang languages and are also disclosed on the KEL website. Project information is also available at the Project Information Center in Amarpur, Panchthar district. These documents were originally disclosed on the World Bank's Info Shop and IFC's website on April 8 and December 8, 2011, respectively. The World Bank and the IFC also disclosed updated versions of these documents and studies as they became available.

KEL has established a robust system for handling communications with project communities and the broad public at the local as well as national levels. An officer has been posted in the PRO and oversees a team of Public Relations Assistants (PRAs) who were recruited from local communities. The team includes a female PRA to address the communication needs of women in the project area. In addition, a Corporate Social Responsibility (CSR) officer is posted at the site.

Grievance Redress Mechanism: Under a system set up by KEL, local communities have established a committee for interacting with KEL that includes representatives of all affected VDCs, all political parties in the area, women's empowerment groups, Dalits and youth. A grievance redress mechanism also has been established under the project. All grievances, whether oral or written, will be recorded at the Project Information Center (PIC) on the project site. The grievance redress mechanism consists of three tiers: (i) a Grievance Redress Cell on site; (ii) local Grievance Redress Committees (GRCs); and (iii) a Project Grievance Committee. The GRCs include representatives from local communities, district government, the project and contractors (as appropriate). The grievance redress setup, composition and operational mechanisms are described in the SAP.

Table E.1. Summary of Highlights of the Community Consultation and Engagement Activities Performed as Part of the EIA and SA Processes to Date

Community Engagement Activities	Time Period
Intensive, culturally sensitive consultations were carried out in all communities in the project area of influence during the EIA, SA and SAP preparation. Governmental organizations and NGOs were also consulted in public meetings.	
Extensive, multi-stakeholder engagement process at national and sector levels as part of the Medium Hydropower Study and Hydropower sector SEA	Over 14 months, late 1990s
Consultations with affected communities	April – May 2010 (scoping stage of EIA and SA)
46 sampled household surveys and 14 focus group discussions with Community Forest Users Groups, women, Dalits, Indigenous Peoples held in different locations in the project area of influence	October- November 2010
KEL disseminated and made the initial EIA and SIA copies available on www.kel.com.np. The Executive Summary, SAP and project brochure were translated to 4 local languages and are available at the project's Public Relations Office	July 2011
Public consultation and hearing at the project site to share the findings of the assessment, collect feedback, etc.	July 2011
Two district-level multi-stakeholder consultations to present EIA and SA findings at Phungling Bazaar and at Phidim	July 25-26, 2011
National level consultations at Kathmandu	August 1, 2011
CGCs formed to ensure regular engagement with local communities during project's early works and project construction	January, 2012
Dedicated PRO (or Public Information Center) at the project area is maintained to ensure permanent engagement with affected communities	Fully staffed and operational since January 2012
KEL developed a CSR/Benefit Sharing Strategy describing multiple community investment and engagement activities to benefit local governments and communities, including the benefits from KEL's support to the Government's Rural Electrification Program	Condition of SAP
KEL to develop Stakeholder Engagement Plan with clear activities and timeline, including detailing a robust Grievance Redress Mechanism	Condition of SAP

Chapter I – Introduction

This chapter provides a general background of the KAHEP, its purpose, and a brief description of the project proponents. Under GoN's environmental requirements,[3] the KAHEP is subjected to an IEE because: (i) its size is under 50 MW; (ii) it does not affect more than 5 ha of forestland; and (iii) its area of impact lies outside the limits of any officially declared protected area. However, because the KAHEP is seeking joint financing from both IDA and IFC, KEL performed full Environmental and Social Impact Assessments (EIA and SA) to assure compliance with the World Bank's Environmental and Social

[3] The Nepali Environmental Protection Act (EPA,1997) and Environmental Protection Rules (EPR, 1997).

Safeguard Policies and IFC Performance Standards on Environmental and Social Sustainability.

This chapter also briefly describes the objectives and the methodology of the EIA study.

Chapter II – Project Description

This chapter describes in detail the project location, access, and components as well as ancillary and associated facilities. It also broadly describes the project material, land and human resources requirements, and the expected implementation schedule.

The KAHEP is located in the Middle Mountains about 800 kilometers east of Kathmandu (see Figure E.1). This project utilizes a more than 15-km long loop of the Kabeli River formed with the Tamor River. At completion, the project is expected to produce an average of 215.4 GWh (including outage) of electricity per year. During the dry months, from November to May, the KAHEP will be operated as a peaking plant, and thus will be expected to generate electricity only during the six hours of peaking energy demand: 2 hours in the morning and 4 hours in the evening.

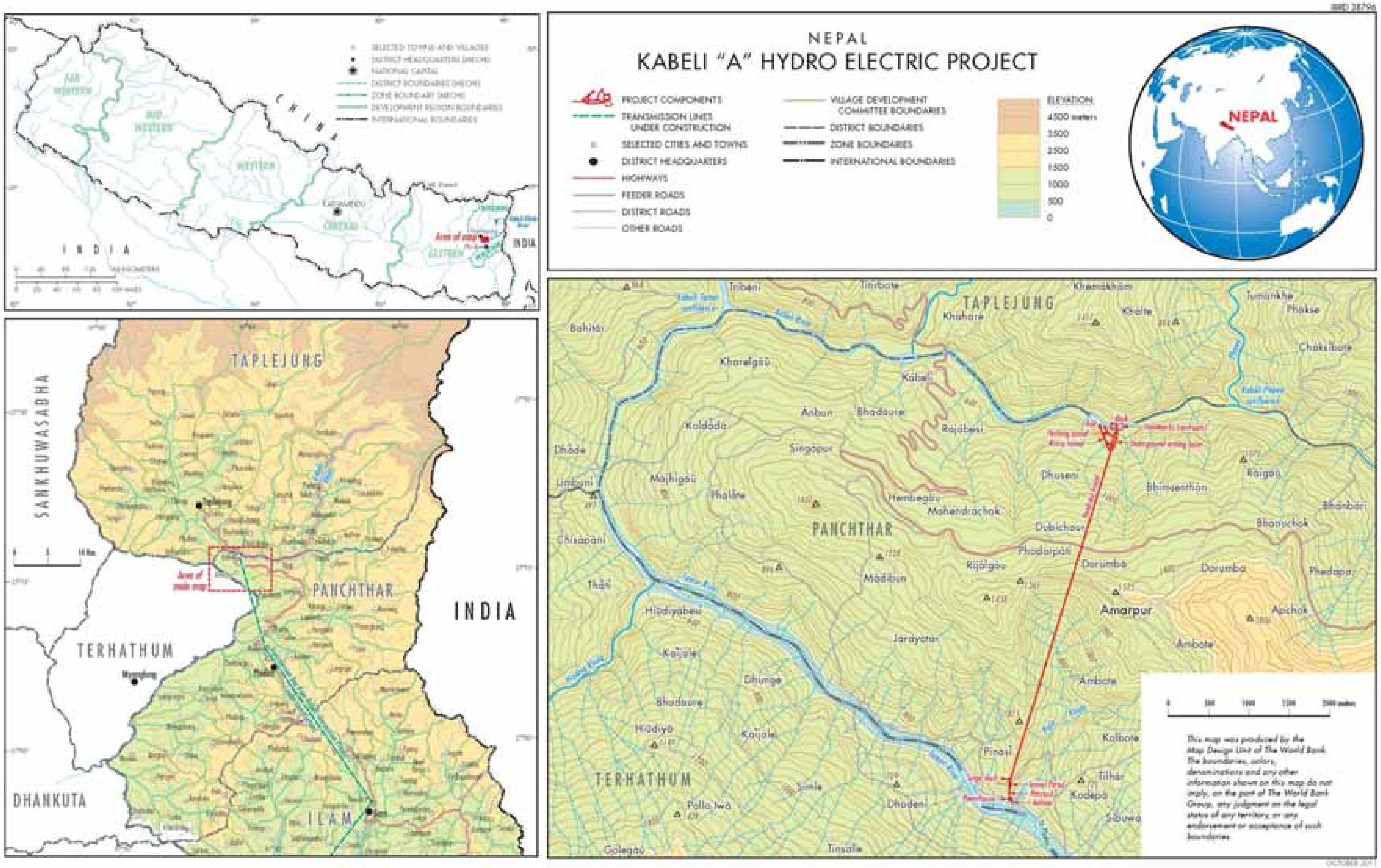
The main components of the project include: a dam (14.3 m high and 60 m long barrage) with live storage of 335 thousand m^3 on the river's natural flood plain; intake and settling basin; a tunnel (4.327 km long, 5.65 m diameter) and above-ground power-house with a design discharge of 37.73 m^3/sec and tailrace discharging directly into the Tamor River. The stretch of reduced water flow from the dam to the Tamor-Kabeli confluence is 5.60 km in length. The access road to the headworks is about 7.40 km and the access road to the powerhouse is about 15 km. A total of 47.71 ha of land will be required for the project, out of which 22.50 ha will be permanently required and 25.21 ha only temporarily required during construction.

Other project facility requirements are the camps for engineers, contractors, and laborers; quarry; construction powers, aggregate crushing, storage yards, batching plants and mechanical yards; spoil disposal sites, etc. All of these facilities will be located close to the headworks and powerhouse sites.

A total of about 600 to 800 workers will be needed for the construction whereas the operation phase is expected to require less than 50 permanent employees. Construction will take place over 4 years and the dam is expected to be operational by 2018.

Transmission Lines. Electricity evacuation capacity will be provided by a separate IDA-funded Kabeli Transmission Project (P112893), which is under implementation. That project involves an approximately 84 km T-Line at 132 kV, under construction by the Government, which will be used to interconnect the KAHEP and multiple other generation projects in Eastern Nepal to the national grid, and will include distribution lines and associated infrastructure to provide access to electricity to communities in its area of influence. The Right of the Way of the transmission line is 18 meters. There are four associated sub-stations for the transmission line located at Damak, Illam, Phidim and Kabeli. The Transmission Line EIA was prepared and disclosed on the NEA website on August 29, 2011.

Figure E.1. Project Location and Layout



Chapter III – Legislative and Regulatory Considerations

This chapter summarizes the applicable environmental legislative and regulatory context in Nepal, and notes the WBG requirements including applicable World Bank Environmental and Social Safeguard Policies and IFC Performance Standards on Environmental and Social Sustainability.

The project complies with Nepal environmental laws and regulations. The EPR 1997 Schedule 1 classified the KAHEP as an IEE category project. In addition to the requirements of national legislation, the KAHEP must also comply with applicable WBG requirements. The project triggered the following World Bank policies: Environmental Assessment; Natural Habitats; Indigenous Peoples; Involuntary Resettlement; Physical Cultural Resources; Safety of Dams; and International Waterways. It also triggered all eight IFC Performance Standards. Full EIA and SA were carried out following terms of reference (TOR) that were agreed with the IDA and IFC and discussed in public meetings.

Compliance with the WBG requirements is summarized in Table E.2.

Table E.2. Compliance with World Bank Safeguard Policies and IFC Performance Standards

Safeguard Policies	Actions
Environmental Assessment (OP/BP 4.01), and PS1: Assessment and Management of Environmental and Social Risks and Impacts.	• Category A project. Full EIA and EMP have been prepared for the project. • Full, stand-alone SA and SAP. • A rapid Cumulative Impact Assessment has been prepared as part of the EIA process, and management strategies will be complemented as part of the implementation process by Technical Assistance to the GoN, which is an integral component of the IDA operation. • A POE with environmental and one social international expertise was recruited. During implementation the POE will work with a TOR agreed with the Bank and will focus on ensuring that the SAP and EMP are implemented as per the agreed schedule. • Intensive, culturally sensitive consultations were designed and carried out in all communities in the project area of influence during the EIA, SA and SAP preparation, particularly to ensure that free, prior and informed consultation (or ICP) with project affected people, including Indigenous Peoples and vulnerable groups, had taken place. Governmental organizations and NGOs were also consulted in public meetings. • The EIA and SAP incorporated local concerns and recommendations. The SA also confirmed Broad Community Support for the project from affected communities, including vulnerable groups.
PS2: Labor and Working Conditions.	• Preliminary Occupational Health and Safety and Human Resources management plans and procedures have been developed, and an implementation plan has been agreed.
PS3: Resource Efficiency and Pollution Prevention.	• Adequate Pollution Prevention and Control measures are included in the EMP, and will be further detailed during implementation.
Safety of Dams OP 4.37, and PS4: Community Health, Safety, and Security.	• POE includes an international dam safety expert who has advised on all salient aspects of the project design and visited the site on two occasions during project preparation. • KEL prepared a Dam Safety Plan including an Operation and Maintenance Manual, Emergency Preparedness Plan and an Instrumentation Plan. • Further measures to assure safety and address public health concerns for

Safeguard Policies	Actions
	potentially impacted communities have been agreed for implementation (e.g., traffic management plan during construction).
Involuntary Resettlement (OP/BP 4.12), and PS5: Land Acquisition and Involuntary. Resettlement. Indigenous Peoples (OP/BP 4.10 and PS7).	• SA has been conducted. No physical resettlement required and limited economic impact envisioned. No significant ethnicity-differentiated economic impacts on Indigenous Peoples and/or other vulnerable groups. • SAP includes RCLAP and IVCDP, which also contains specific measures for Indigenous Peoples in addition to general assistance package.
Natural Habitats (OP/BP 4.04), and PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.	• The project does not have direct impacts on critical habitats. • Main impacts are on aquatic ecosystems (e.g., restriction of movement and potential entrapment of resident and migratory fish). • Environmental downstream flows were estimated to meet human consumptive and non-consumptive water uses and ecological needs. An Aquatic Ecology Management Plan (AEMP) is being designed, and will include mitigation measures aligned with good international practices and an adaptive management approach to correct any issues raising during construction and operation. • Additional Tamor-Kabeli basin-wide fish and invertebrate studies will be conducted during project implementation, to assist the GoN to better design mitigation measures for the potential basin-wide cumulative effect on the natural aquatic habitats.
Physical Cultural Resources (OP/BP 4.11), and PS8: Cultural Heritage.	• Based on field surveys, no archeological or historical sites were found in the project area. • Several religious ritual sites (e.g., cremation and resting sites, religious temples) were identified downstream of the dam. Appropriate mitigation measures have been designed (e.g., environmental downstream flows, extraordinary downstream release during high water demand for ceremonial purposes, additional water storage infrastructure to guarantee continuation of religious practices, etc.) • Chance find procedures for archaeological sites and materials located during construction have been prepared and will be included in bidding documents and contracts.
International Waterways OP7.50	• World Bank Management served riparian notifications to China, India and Bangladesh on June 27, 2002 and re-issued them in August 2013. • No comments in connection with the proposed project were received from the notified countries by the indicated deadline to date.

Chapter IV – Baseline Environment

This chapter describes existing environmental and social conditions of the project's area of influence and highlights the ecological and socio-cultural characteristics of the greater project area, including migratory fish species, heavy sediment loads typical of Himalayan rivers, and the presence of vulnerable communities in the direct area of influence.

The Kabeli River Watershed: The Kabeli River is one of the tributaries of the Tamor River and has a total length of about 52.4 km at the intake site. The catchment area of the Kabeli River is 862.3 km^2 at the barrage site. The Tawa Khola, Phawa Khola and Inwa Khola are the three major tributaries of the Kabeli River upstream intake. The river at intake has an average annual flow of 61.4 m^3/s, minimum during the month of February of 8.63 m^3/s and maximum during the month of August of 181.71 m^3/s.

An important characteristic of the Kabeli, similar to many of the rivers in Nepal, is the presence of about 40 to 50 old landslides within its catchment above the headworks. No recent active landslide features have been reported or noted close to the project development sites. The maximum recorded suspended sediment concentration is an outstanding 13,616 ppm. The monsoon – June to September – is a period of high sediment load in the river.

Terrestrial Ecology: The project area lies outside any official biodiversity conservation site declared by the GoN. The Kanchenjunga Conservation Area (KCA) and Tinjure Milke Jaljale (TMJ) forest are the two important biodiversity areas in the region, neither of which is likely to be affected by the KAHEP. Both KCA (25 km aerial distance from KAHEP) and TMJ (10 km aerial distance from KAHEP) are in remote mountainous region and are accessible only by trekking over steep mountainous terrain from the KAHEP site – at least two days to KCA and one and a half days to TMJ.

There are no IUCN critically endangered species found in the affected area, although *Dioscorea deltoid* (Ban tarul, Deltier yam) and *Orchids* (Sungava, Orchids) found in the region are IUCN threatened and endangered species, respectively. Further, *Shorea robusta* (Sakhuwa, sal tree), *Bombax ceiba* (Simal, Silk cotton tree), and different *lichen* (Jhyau) species are nationally protected for their economic value. All of the listed species are commonly available in the project region.

Farming practices in the project's area are characterized by traditional integrated crop-livestock production, and sub-systems for household subsistence. Farmers cultivate mostly in rain-fed terraced upland and grow a number of cereals like maize, millet, wheat, various pulses, mustard, and vegetables, as well as some perennial crops like fruits, fodder, and timber.

The lands of the project affected villages are predominantly agricultural, with some forest. Settlements are scattered and are located at various distances from the project development sites. Part of the headworks and head pond area lies in the Kabeli Garjite and Thulo Dhuseni Community Forests of Amarpur village. Of the 22.50 ha of land that will be permanently required, 59 percent (13.28 ha) is river bed, river banks and flooding zone, 34 percent (7.65 ha) agricultural land, and the remaining 7 percent (1.57 ha) community and leasehold forests. Community and leasehold forest lands are affected at nine different places (the biggest single forest plot that is likely to be occupied is 0.70 ha).

Most of the forested areas are degraded, open, or are under the heavy influence of human and domestic animal grazing activities. The forest areas in and around the project sites are not a suitable habitat for medium and large animals. There are no migratory routes of animals with conservation or economic value; although there is a possibility of occasional visits by some solitary animals such as ghoral and barking deer.

Aquatic Ecology: A total of 31 species of fish has been reported for the Kabeli River. Out of the total, only 12 species were actually collected during the 2011 and 2013 field surveys.There are no IUCN critically endangered fish species found in the affected area, although there are five species reported for the Kabeli River which are on the IUCN Red List: three reported long distance migrants, namely *Bagarius yarrelli*, *Tor putitora* and *Tor tor*, and two mid-distance migrants, *Schizothorax richardsoni* and *Neolissochilus hexagonolepis*. Only the *Tor putitora* is listed as an endangered species, the *Schizothorax richardsoni* is listed as vulnerable, and the rest are reported near threatened species.

The Kabre fish (*Glyptothorax sp*), which is a resident fish, is the most valued fish species to the riparian communities of the Kabeli River. The *Schizothorax sp*, also commonly known as snow trout, are the only commercially important mid-range migrants found in the Kabeli River. Other high value and long distance migratory species reported for the Kabeli River are found only in the wet season (June–October) and they mostly migrate for spawning and return to the Tamor River.

Upstream fish migration occurs normally from late spring and through the monsoon, while the downstream migration normally takes place for most species during monsoon and late monsoon. Spawning season for most of the fish species present in Kabeli occurs in the wet season, although some spawn before the monsoon, with juveniles of these species staying in the Kabeli River for few months. There are five spawning areas and two rearing sites found in the reduced water flow section of the river.

All these fish species have also been reported in the Tamor River and its other tributaries, and are reportedly still very common throughout Nepal.

Socio-cultural Setting: About 336,654 people live in the two project districts, Panchthar and Taplejung. Both districts have limited transportation and electricity facilities. The project affected VDCs are Amarpur and Panchami in Panchthar and Thechambu and Nangkholyang in Taplejung. Major project structures including the headworks, surge shaft, waterways and powerhouse are located in Amarpur VDC. The population of these VDCs is 21,098 (48.1 percent male and 51.88 percent female) having a gender ratio of 1:1.07. Average household size is 5.54. These four VDCs comprise an ethnically heterogeneous mix of people, including various indigenous groups.There are three major groups in the project area of influence that have been defined as vulnerable: women, *Dalits* and Indigenous Peoples (*Adivasi Janajati in Nepali)*.

In Nepal the *Adivasi Janajati* are recognized Indigenous Peoples having their own territory, language, traditional rites and customs, distinct cultural identity, social structure, and history. The SA identified the presence of *Adivasi Janajati* living in mixed communities within the project's area of influence, where they constitute 53 percent of the total local population, with ethnic Limbu, Rai, and Tamang making up major *Adivasi Janajati* groups. Limbu constitute the highest percentage of population in both districts. Kirat and Hindu are the two major religions of the project districts.

As indicated in the SA, the overall economic structure of the project districts is characterized by a mixture of farm and non-farm activities. Non-farm income is the major source of household income, including foreign employment/remittances, services, pension, trade, wage labor and cottage industries. Agriculture and livestock contributed less than 10 percent of household income while services/jobs/pensions provide about 20 percent and remittances 50 percent. The SA also indicates that the different indigenous groups share a common approach in terms of livelihood patterns, resource use and economic activities and that one common package of economic assistance will be applicable to all, but particular attention needs to be given to indigenous and disadvantaged groups to ensure their participation and maximum benefits from the project.

The Kabeli River is not used for irrigation, drinking, water-mills or any other human consumptive uses in the project's area of impact. It must be noted, however, that local community members practice occasional fishing on different sections of the Kabeli River impacted by the project, but none of them is fully dependent on fishing for their livelihood. The majority of them fish for recreational purposes in their leisure time. Only a few households have adopted fishing as a profession but only during the non-agricultural periods do they sell fish at the local markets. According to the local fishermen and communities, the fish population of the area has rapidly declined in recent years due to an increased opportunistic illegal fishing practices that include poisoning and electric shock.

Archaeological, Cultural and Historical Resources: There are no known archaeological sites located within the project area; however, there are several religious sites that require consideration in design and operation of the project.

Adherents to Hindu ritual practice require water for bathing and funeral rites. The Panchayan Shivalaya (Kabeli) Temple is located about 2.5 km downstream from the barrage at Kabeli Bazar and it is an important religious temple that lies within the 5.6 km section of the river that will be dewatered by the project. Large numbers of worshippers visit the temple, particularly during the festivals such as Shiva Ratri and Ekadashi when bathing is an important ritual of purification. Hindu pilgrims from the surrounding VDCs come to bathe in the Tamor and Kabeli Rivers on religious holidays like Aushi, Kuse Aushi, and Matatirtha. Hindus in the project area also perform cremations at three sites (Kholakharka cremation site, Kabeli cremation site and Sirupa cremation site) located also in the 5.6 km section of the Kabeli River that will be subjected to modified flows by the project.

The Majhi community of Pinasi village performs rituals like Udyouli and Ubhauli, Dhuli Puja, Sansari Puja, and Tamor Puja in the Tamor River. Near the project construction site there is also a rest house (patti) at Pinase Ghat for funeral processions.

It is reported that Trout (*Schizothorax sps.*) and Stone carp (*Psilorhynchus pseudochenius*) are ritually required for Adivasi Janajati (Limbu, Rai and Majhi) to worship and propitiate their clan deities and for other ritual performance.

Chapter V – Alternative Analysis

This chapter describes the alternative analysis performed for KAHEP's siting and project design, the reasoning for its selection over other hydropower projects, over the "no-project" option, and over the overall power generation alternatives in Nepal, including power import (Table E.3).

Additional power generation capacity is urgently needed in Nepal to address the ongoing power crises. Other sources, including solar, biomass, solid waste and wind are not technically feasible at the present time in Nepal for large scale power generation as a substitute for the proposed project. Given this constraint, in the "no project" scenario, technically feasible alternative sources to the KAHEP for grid-connected power generation are diesel and incremental electricity import from India.

Section 5.3 of the EIA specifically deals with the "no project" alternative and discusses implications of meeting equivalent power requirements from all the above, including diesel, other fossil fuel, biomass and solid wastes, solar and wind sources or by importing power from India. Selection of the Kabeli-A project from the list of potential hydropower projects in Nepal is also discussed.

In 1997, the Government of Nepal carried out a screening and ranking study of 138 hydropower projects (ranging from 10 to 300 MW) under the Medium Hydropower Study Project (MHSP) with the support of the World Bank. The ranking was done on the basis of technical, economic, social, and environmental criteria. The KAHEP is one of the top seven ranking hydropower projects.

Table E.3. Summary of Alternative Analysis Process

No.	Alternatives	Major Conclusions
1	No Project	The gap between current power demand and supply will widen resulting to additional hours of load shedding, with serious socio-economic consequences. Market response to the load shedding would be a continued installation of small captive diesel generation.
2	Fossil fuel based Power Plant	Cost of generation will be (at about 0.30 US$/kWh) nearly 5 times the current retail tariff, and not affordable by NEA/consumers. Greenhouse gas emissions are estimated at about 160,800 tons of CO_2 annually in order to generate an equivalent amount of energy (201 GWh), based on the CO_2 emission factor of 800 g CO_2/kWh. In addition, there would be local and regional level environmental impacts due to the emissions of particulate matter, sulfur and nitrous oxides emissions from the diesel plant.
3	Additional power import from India	Currently additional power import from India cannot be secured and the cost is high. In the long run, Nepal will need to import coal based power from India in dry seasons, and export surplus hydropower to India in wet seasons. Additional generation of 201 GWh in India will result in about 164,820 tons of additional CO_2 emission annually, based on the average emission factor of 820 g CO_2/kWh of the respective regional grids in India.
4	Solar	Cost of generation is much higher than the current retail tariff. Subsidies needed to make it financially viable are unlikely to be available.
5	Wind	Technically, the power system in Nepal is not able to accommodate intermittent wind power generation; Cost of generation is also much higher than the current retail tariff. Subsidies needed to make it financially viable are not available.
6	Other hydropower as alternatives	The proposed project is one of seven projects/sites selected for a full feasibility/EIA study through a screening of 138 sites, including a rigorous environmental and social screening. Various alternative locations and dam designs were reviewed and the proposed project was selected as a result of the maximum optimization of multiple criteria.

Chapter VI – Potential Environmental Impacts and Mitigation Measures

This chapter describes environmental impacts expected from construction and operation of the KAHEP, and briefly outlines the measures proposed to manage such impacts

(Table E.4). These measures follow the mitigation hierarchy, and therefore, are designed to avoid, minimize, and mitigate potential impacts, and are aligned with good international practices for the sector.

Temporary Construction Impacts

As with any large civil works, the project construction phase will generate environmental and social impacts, including but not limited to: (i) increase in air emission, dust and noise from construction works, construction traffic and operation of heavy machinery; (ii) generation of waste water and process waters and potential contamination of ground and surface waters, (iii) generation of solid and hazardous wastes, (iv) increased erosion and surface runoff, (v) increased risk from occupational accidents to construction workers, and (vi) a risk of traffic and pedestrian accidents from the increased construction traffic. In addition, during construction, the project area will likely witness an increase in population due to an influx of workers and service providers (e.g., transport, food, lodging). Peak labor force is expected to be around 600-800 workers who will be housed in construction workers camps within the project sites. Indirect impacts, stemming from the construction and enhanced access, may include increased pressures on natural resources and community forests from hunting and timber extraction, among others. The expected increase in population will also strain local services such as water supply, health care, and sanitation facilities. Lack of proper sanitary measures and increases in water pollution and in solid waste could potentially lead to public health issues. Furthermore, the influx of a large number of people with different social and cultural backgrounds and a sudden inflow of additional cash at the same time, if unmanaged, can result in social conflicts, excessive use of alcohol, and increases in solicitation and prostitution with the subsequent spread of the sexually transmitted diseases, including HIV, etc.

Mitigation.KEL has developed construction Environmental Management Plans (EMPs) that include measures to address these impacts, such as: (i) collecting and re-using top soil; stockpiling and storing construction materials in the designated sites only; protecting excavated surfaces against water erosion (providing vertical and horizontal drainages, and discharging collected water to a safe area); (ii) protecting cut slopes (benching, breast walls, vertical and horizontal drainage and grass plantation); (iii) provisioning drainage in the construction areas and along the access roads; applying noise controlling measures (blasting and noisy activities only during the day time, no horns close to village, etc); (iv) collecting wastewater in settling tanks/ponds (aggregate wash water, tunnel seepage water); (v) collecting and safely disposing of used lubricants/grease/toxic chemicals; (vi) separating collection of wastewater from mechanical yard; (vii) providing toilets in the camps and active construction sites and a system for collection and storage of solid wastes from camps and construction sites; (viii) compensating for houses/structures damaged by vibration/blasting; (ix) measures to avoid soil compaction; measures to mitigate atmospheric pollution due to dust, based mainly on periodic water spraying of unpaved roads and work areas and systematic maintenance of construction vehicles and equipment; (x) measures to minimize water quality impacts, consisting of erosion and sediment runoff control and prohibition of discharges of solid or liquid wastes directly into the water bodies; (xi) establishing a waste management program and clear procedures for handling, classification, transportation and final disposal of all solid wastes generated by the construction process; (xii) re-vegetation program, establishing requirements for reinstatement and bio-restoration of all areas to be directly affected by construction support infrastructure, such as construction camps, borrow pits, and others; (xiii) creating decommissioning procedures, establishing a comprehensive approach to ensure that all applicable construction close-out procedures are adequately implemented as part of the decommissioning process and that no environmental liabilities are left behind; and (xiv) housekeeping and pollution prevention measures, as pertinent to minimize the risk of spills and other impacts resulting from the use and handling of hazardous products.

In addition, to address the impacts related to workers' influx, KEL has developed a comprehensive strategy that includes: workers code of conduct, rigid camp management restrictions (e.g., no hunting, illegal trade, no alcohol), provision of cooking fuel to workers, and a camp followers management plan.

Other plans and procedures to manage temporary construction impacts and risks include:

- Communication and Social Awareness Program will inform local communities on the project's progress and ensure community safety; this Program will include feedback, grievance and conflict resolution mechanisms;
- Public Health Action Plan to manage health risks to local communities, to the workforce and to the camp followers; and
- Construction Traffic Management Plan.

Furthermore, environmental specifications will be incorporated in all bidding documents and contracts. Environmental supervision of all construction activities will be part of the construction EMP compliance framework.

Long Term Environmental Impacts

The most significant long term environmental impacts are related to the permanent conversion of both terrestrial and aquatic habitats.

Terrestrial Ecology: Direct impacts on terrestrial biodiversity are expected to be minimal. The area to be flooded, the construction and camp sites, quarry site, and other infrastructure will affect mostly modified habitat, composed of pastures, agricultural lands, grasslands, and degraded forests. Only 1.57 ha is forest area (0.33 ha of Community Forest, 0.97 ha of Leasehold Forest and 0.27 ha of communal national forest) land with a total of 200 trees and 153 pole sizes. However, indirect impacts on terrestrial biodiversity could potentially occur as a result of an increased population (workers and camp followers) and increased access to the area, for instance, the increased demand for fuel for cooking and food could increase illegal timbering, poaching and hunting.

Table E.4. Summary of Potential Project Environmental and Social Impacts and Risks and Mitigation Measures

<table>
<tr><th>Project Impacts/Risks</th><th>Mitigation Measures</th></tr>
<tr><td colspan="2">Temporary Construction Impacts</td></tr>
<tr><td>Increase in air emission, dust and noise from construction works, construction traffic and operation of heavy machinery</td><td rowspan="6">KEL developed a dedicated construction EMP to include related measures to address all these impacts (e.g., storing construction materials in the designated sites only, protecting cut slopes, applying noise controlling measures, providing toilets in the camps, measures to minimize water quality impacts, re-vegetation program, workers code of conduct, rigid camp management restrictions, etc.)
Communication and Social Awareness Program (include feedback, grievance and conflict resolution mechanisms)
Public Health Action Plan
Construction Traffic Management Plan
Environmental specifications to be incorporated in all bidding documents</td></tr>
<tr><td>Generation of waste water and process waters and potential contamination of ground and surface waters</td></tr>
<tr><td>Generation of solid and hazardous wastes</td></tr>
<tr><td>Increased erosion and surface runoff</td></tr>
<tr><td>Increased risk from occupational accidents to construction workers</td></tr>
<tr><td>Potential risk of the increased population due to an influx leading to increased pressures on natural resources, water and worsened public health</td></tr>
<tr><td colspan="2">Long Term Environmental Impacts</td></tr>
<tr><td>Direct impacts on terrestrial biodiversity are expected to be minimal. Indirect impacts on terrestrial biodiversity could potentially occur as a result of an increased population and increased access to the area</td><td>Compensatory afforestation as per the Nepali Forest Guideline (2006)
Lease compensation for forest land area
Reforestation and re-vegetation of cleared areas
Technical and financial assistance to the affected Community Forests and Leasehold Forest users
Preference given to local communities for project employment
Provision of kerosene to the workforce for cooking and prohibition of sale and purchase of local non-timber forest products and fish in the camps
Prohibition of roaming in the local forest area by the outside workforce</td></tr>
<tr><td>Permanent modifications of Kabeli River natural flow regime (and geomorphologic and ecologic modifications as a result) by:
i. creating a barrier to migratory fish and entrapment of resident and migratory species
ii. reducing available spawning, foraging, hiding, and resting fish and invertebrate habitat in the dewatered reaches of the river
iii. modifying a lotic to a lentic environment by creating a small reservoir upstream from the dam
iv. producing daily flow fluctuations at the Tamor downstream</td><td>EIA confirms that (iii) and (iv) are expected to be negligible
As part of the EMP, an AEMP is being developed where all relevant mitigation measures will be incorporated, including a robust quarterly aquatic monitoring system
The project will release at least 10 percent of the minimum monthly flow, or 0.86 m^3/s at all times (legal requirement), sufficient to maintain minimum thriving conditions for selected aquatic species
The migratory pathways will be kept open by the construction of a fish ladder, assuring that the minimum release is passed through this proposed fish ladder during dry months
Based on the monitoring results, the measures will be adjusted accordingly</td></tr>
</table>

Project Impacts/Risks	Mitigation Measures
from the tailrace during peak generation	
Long Term Social Impacts	
Permanent acquisition of 22.50 ha of land and temporary lease of 25.21 ha during construction affecting 13 households: 2 will lose >50 percent of their total land, 8 < 25 percent, 3 between 25 and 50%. No physical displacement is required, only limited economic displacement ~ 22.4 km of existing community tracks will be upgraded and used as access roads to headworks and powerhouse	• To mitigate the economic displacement, the RCLAP was developed, meeting WBG land acquisition, involuntary resettlement and livelihood restoration and requirements • 25 trees will be replanted for every tree lost • Affected CFUGs will be compensated through: (i) compensation for an equivalent of 5 years' production potential; (ii) technical assistance through forestry enhancement programs
Adverse impacts on the Panchayan Shivalaya Temple, 3 funerary cremation sites, and a rest house located close to the construction site	• Extensive consultation held with the affected communities • Although the proposed ecological flow is deemed sufficient for general river sanitation, the river water will be canalized every November to assure that there is sufficient depth and flow of water for funeral rituals at the river cremation sites during the dry season. • Suitable ponds of chest-height will be established in the dry seasons at the Kabeli Temple site for religious baths • Structures will be built as check dams as needed near cremation sites to create water reservoirs. Regular flushing of the river bed will be carried out • During religious festival days, the project will release additional water flow from the intake structure to maintain adequate water supply
Potential adverse impacts on 4 VDCs comprising an ethnically heterogeneous mix of people with several degrees of vulnerability and families / individuals belonging to Indigenous groups. Project will <u>not</u> result in: (i) impacts on lands or natural resources subjected to traditional ownership or under customary use; (ii) relocation of Indigenous Peoples from lands/natural resources subjected to traditional ownership or under customary use; (iii) significant impacts on critical cultural heritage that is essential to the identity and/or cultural, ceremonial, or spiritual aspects of Indigenous Peoples' lives; or (iv) use of cultural heritage.	• Related mitigation measures included in the SAP and RCLAP • Community consultations • IVCDP developed specifically to manage impacts on 3 groups of vulnerable people: women, Dalits and Indigenous Peoples. It includes actions related to: (i) agriculture support program; (ii) small loan programs; (iii) skills training; (iv) preferential employment; (v) drinking water; (vi) health and sanitation programs; (vii) capacity building programs; and (viii) programs focused on women and Indigenous Peoples • Small loans and other assistance programs for women • Indigenous Peoples' focused programs to unleash their potential through various training, assistance measures and project employment • KEL committed to support measures for development and welfare opportunities for local and regional affected communities • Two categories of local development funds: (i) for the affected VDCs over 3.5 years during construction; (ii) 50 percent of the royalty received by GoN during 30 years must be allocated to regional development; 12 percent of which is allocated to the project's districts

Mitigation: To minimize these impacts, the following measures will apply: (i) compensatory afforestation as per the Forest Guideline of Nepal (2006); (ii) lease compensation for the forest land area; (iii) reforestation of clearings of vegetation required for the project structures and facilities; (iv) technical and financial assistance to the affected Community Forests and Leasehold Forest users; (v) preference to the local communities for project employment; (vi) provision of kerosene to the workforce for cooking and prohibition of sale and purchase of local non-timber forest products (NTFPs) and fish in the camps; and (vii) prohibition of roaming in the local forest area by the outside workforce. In addition, the forest enhancement programs and compensation for 5 years of production potential from lost forest area will be provided to the affected forest users.

Aquatic Ecology: The most significant long term environmental impacts of the KAHEP are expected to result from the permanent modifications of the Kabeli River natural flow regime and the resulting geomorphologic and ecologic modifications. Construction and operation of the project has the potential to significantly degrade the Kabeli River aquatic natural habitat by: (i) creating a barrier to migratory fish and entrapment of resident and migratory species with the construction of the dam and headworks; (ii) reducing available spawning, foraging, hiding and resting fish and invertebrate habitat in the dewatered reaches of the river; (iii) modifying a lotic (e.g., river, free flowing) to a lentic (e.g., lake or pond) environment by creating a small reservoir upstream from the dam; and (iv) producing daily flow fluctuations at the Tamor downstream from the tailrace during peak generation.

The EIA process has determined that impacts (iii) and (iv) above are expected to be negligible, as the dam will form a fairly small daily regulation reservoir, with a retention time of only a few hours. During monsoon season the river will flow like a natural river, and the powerhouse will discharge in the tumid or torrential Tamor River. The worst case flow fluctuation downstream of the tailrace has been estimated to be about 42 centimeters difference in the river water level during peak generation, and thus is not expected to have any noticeable impacts on the aquatic habitat of the Tamor River.

The most significant impact related to the KAHEP project will be the disruption of the natural upstream-downstream connectivity by the dam and headworks, especially during the dry months of November to May. This barrier effect will likely impair fish migration from the downstream to the upstream reaches for spawning and feeding, and cause entrapment of juveniles and resident fish upstream from the dam. Closing of the natural in-stream connectivity may mean the reduction in species diversity, change of species dominance/natural assemblies and impairment of migratory species' ability to fulfill their life cycle. In addition, the reduced flows expected in the dewatered section during the dry season are also likely to impair lateral movement of fish and invertebrates in and out of the river banks and significantly reduce wetted usable habitat availability. This will affect both resident and migratory fish, by potentially reducing spawning, foraging, feeding, resting, and cover habitat.

During the wet season, the flow regime will suffice for migration and spawning to occur as under natural flow conditions. In the wet season (June through October) nearly 64 percent of the existing average wet season flow will pass through the dewatered section.

Mitigation: Consistent with the Hydropower Development Policy 2001 of GoN, the KAHEP will release at least 10 percent of the minimum monthly flow, or 0.86 m^3/s at all times, aimed at maintaining dry season conditions for selected aquatic species. Downstream of the dam, Kabeli River has three small tributaries which provide an estimate of at least 0.18 m^3/s in the dry months, in addition to the above mentioned 0.86 m^3/s legally required for the minimum ecological flow release.

Based on the field and desk studies performed in 2011 and 2013, independent international expert advice, and the experience from similar projects in Nepal, the KAHEP determined that the proposed 0.86 m^3/s minimum ecological flow, together with the additional input from the tributaries release will: (i) provide depth and velocity in the dewatered stretch to maintain the shallow water ecological requirements for the fish species of Kabeli, thus maintaining shallow water ecological conditions for feeding and rearing of adult and juvenile fish species; and (ii) maintain the migration of fish upstream and downstream along the dewatered section. In addition, the migratory pathways will be kept open by the construction of a fish ladder and assuring that the minimum release is passed through this proposed fish ladder during the dry months.

Literature review and consultation with local fishermen revealed a normal downstream fish migration starting towards the end of September and continuing through December, with peak downstream migration in October. The available flow in October is larger than the KAHEP design discharge, whereas in November and December the available discharge is less. Therefore, the risk of fish entrapment in the turbine is considered higher for the migratory species in November and December than in October. In these months, the only available discharge through the diversion structure is the downstream flow that will be released through the fish ladder structure. The KAHEP will incorporate a surface spill in its barrage design to release the ecological flow through the fish ladder. During the high flow periods or periods when the design flow of the KAHEP is less than the available Kabeli River flow (June through October), the opening of the radial gate of the barrage in addition to the fish ladder structure will provide pathways for migration.

KEL is evaluating different options to avoid fish entrapment in the desanding basin and subsequently in the headrace tunnel and turbine of the KAHEP. One option being considered is to build the fish ladder on the right bank of the dam where KAHEP is also considering construction of a fish friendly spillway. Constructing the fish ladder on the right bank is expected to reduce the risk for up migrating fish to be trapped in the tunnel inlet as soon as they enter the reservoir. Alternatively, these structures may be built on the left bank but in addition to fish friendly spillways and physical barriers, the water velocity at the intake will be kept at less than 1 m^3/s to avoid entrapment of upstream migrating fish when they enter the reservoir.

As part of the implementation management plan and process, KAHEP is developing an AEMP, where all the proposed mitigation measures will be incorporated. This plan is expected to help strengthen the existing hydro-biological baseline by proposing a robust aquatic monitoring protocol to better understand the significance of the potential degradation caused by the reduced flows, and propose – via an adaptive management approach – potential mitigation, compensation and offset measures, if and as needed. The AEMP will include provisions for: (i) the minimum ecological downstream release, and (ii) the construction of physical structures at the dam and headworks to assure upstream fish migration (e.g., fish ladder) and avoid downstream migration and resident fish entrapment (e.g., fish friendly spillway, location and intake designs).

In addition, the AEMP will also include provisions for other relevant mitigation measures such as: (iii) catch and release program paired with cold-water native fish hatcheries with open water stocking of mid-range and long distance migrant species annually in the upper catchment of the Kabeli; (iv) habitat management program (e.g., minimize removal of boulders from the river bed, construction of pools at specified locations or other physical modification in the river channel); (v) promotion of protection/conservation of pristine tributaries elsewhere in the Kabeli watershed; (vi) plantation and bioengineering works to the extent possible in the areas upstream of the reservoir, in the stretch of reduced water flow and catchment of tributaries joining in the stretch of the reduced water flow; (vii) prohibition of fishing in the stretch of the reduced water flow in the seven dry months and patrolling to enforce prohibition; (viii) aquatic habitat/fish conservation awareness program; and (ix) assistance to local communities for improvement of onsite sanitation management and in the use of agrochemicals.

The AEMP will include a robust quarterly monitoring program of water quality and quantity (e.g., temperature, dissolved oxygen, flow, depth and velocity), along with fish and invertebrate diversity, population health and species composition, to allow adaptive management and minor adjustments as required. It is expected that if, as a monitoring consequence, it is determined that there is a need to adjust the minimum flow release, these are likely to be only minor adjustments, such as increasing flow for a few days or a week to meet specific ecological (e.g., specific fish migration during dry months) and/or social needs (e.g. specific ceremonial needs).

Long Term Social Impacts

The most significant long term potential social impacts relate to land acquisition, socio-cultural impacts caused by modification of the Kabeli River natural flow regime, and any impact on Indigenous Peoples and other vulnerable groups. The project direct impacts include permanent land acquisition required for the reservoir, headworks, powerhouse and other infrastructure. No physical relocation is expected under the proposed project. There will be some social impacts associated with reduced river flows, particularly during the dry season, in the 5.6 km stretch of the Kabeli River downstream of the diversion dam before the confluence with the Tamor River. These include impacts on fishing, cultural and religious practices (bathing and cremation) for which the river is used.

The project will require the permanent acquisition of 22.50 ha of land and temporary lease of 25.21 ha during construction (e.g., camp and storage sites). Out of the permanently required land, 7.6 ha (34 percent) is private agricultural land, affecting 13 households of 122 people. As shown in the SA, agriculture contributes less than 16 percent to their total annual household income and the impact of the land loss on their household income is expected to be small. Community and leasehold forests comprise 1.57 ha of lands being permanently acquired. They are small areas scattered in nine different places, which are used for the collection of timber and NTFPs.

Approximately 22.4 km of existing community tracks will be upgraded to be used as access roads to headworks (15 km) and powerhouse (7.4 km). This option/alignment was chosen after extensive consultations with and upon eager requests of local communities who expect to improve and upgrade their village access roads under the project. No relocation or land acquisition is required for these access roads.

The project activities will affect the Panchayan Shivalaya (Kabeli) Temple and three funerary cremation sites along the 5.60 km section of the reduced water flow. Under the reduced flow condition during dry months, the Kabeli River may not be able to maintain the basic sanitation conditions needed for ash dispersion and spiritual purification during cremation and religious ceremonies. This issue may be aggravated when large numbers of people gather during religious holidays and festivals.

Following the principle of free, prior and informed consultation (or ICP) as outlined in the government policy framework and WBG policies and performance standards, KEL designed its consultations in a tiered fashion. Apart from general community level consultations where all members could attend, the SA team organized separate focused group consultations with Indigenous Peoples, Dalits, women and community organizations, such as Community Forestry Organizations. The consultations were held in different impact zones to understand specific concerns and requests from the respective community groups. These consultations managed to reach all different cultural and ethnic groups, enabled a free and transparent environment for meaningful consultations and brought forward rich feedback from various groups of local communities, particularly the indigenous and other disadvantaged groups. The SA documents the consultation process, its feedback as well as the broad support of the project by local communities, including the indigenous groups.

As stated above the KAHEP may have potential adverse impacts on four VDCs comprising an ethnically heterogeneous mix of people with several degrees of vulnerability as well as families and individuals belonging to the different indigenous groups.

The SA shows that, in spite of the ethnic differences, local population shares a common pattern in terms of their livelihoods and economic activities. It is expected that the economic impacts due to land loss would be the same for all ethnic and cultural groups and therefore one common compensation and livelihood assistance package would be applicable to all community groups.. 13 households will lose land as a result of the project. Of these 13 households, only one is a *Limbu* household – who are considered the original settlers of the project area. In addition, the project land-take from that household represents only 1.8 percent of its total land holding. As such, the KAHEP will not result in: (i) impacts on lands or natural resources subjected to traditional ownership or under customary use; (ii) relocation of Indigenous Peoples from lands and natural resources subjected to traditional ownership or under customary use; (iii) significant impacts on critical cultural heritage that is essential to the identity and/or cultural, ceremonial, or spiritual aspects of Indigenous Peoples' lives; or (iv) use of cultural heritage, including knowledge, innovations or practices of Indigenous Peoples for commercial purposes. The SA also analyzed the vulnerable status of the identified vulnerable groups, namely the indigenous groups, dalites and women, and recommended that particular attention should be given to them in the program design and implementation to ensure their meaningful participation and maximum benefits from the project.

Mitigation and Social Development Interventions: Development interventions have been designed in line with relevant GoN and WBG policies and performance standards on consultation, land acquisition and involuntary resettlement, and Indigenous Peoples. These interventions and action plans were developed on the basis of the findings and recommendations of the SA. They respond to different policy requirements and are packaged into one project SAP for ease of implementation. The SAP includes: (i) an overall social safeguard policy framework; (ii) the RCLAP; (iii) the IVCDP; (iv) public health measures; (v) benefit sharing measures; (vi) a public consultation and communications strategy; and (vii) implementation arrangements including grievance redress and monitoring mechanisms.

- ***Resettlement Compensation and Livelihood Assistance Plan (RCLAP):*** The RCLAP was designed to mitigate the direct project impacts and to support local development through a comprehensive package of interventions. This package includes: (i) cash compensation payment at replacement cost for land acquired and leased; (ii) an agricultural extension program; (iii) vocational training; (iv) preferential employment of local people by contractors; (v) health awareness programs for construction workers and the local population; (vi) establishment of clinics for construction workers and the local population; (vii) assistance to local communities in building new and repairing existing drinking water and sanitation schemes; and (viii) measures to mitigate the impacts of reduced river flows downstream of the diversion dam, including higher releases of water as required for cremations and ritual bathing on religious holidays.
- ***Indigenous and Vulnerable Community Development Plan (IVCDP):*** Three groups have been identified and covered under this program. They are Indigenous Peoples, Dalits and women-headed households. The IVCDP was developed in keeping with the relevant policies of the GoN, including ILO Convention 169 and UNDRIP as well as with the requirements of the World Bank's Indigenous Peoples operational policy and IFC's Performance Standards. While these groups are entitled to benefit from the generic measures in the SAP, the IVCDP includes specifically designed measures such as: (i) specific interventions that target *Adivasi Janajati* households, such as employment, and livelihood empowerment activities; (ii) awareness training in health, sanitation, gender and other life-skills improvement activities; (iii) supplementary infrastructure facilities in the Majhi settlements; and (iv) and women-focused programs. This last contain a series of measures for women's empowerment, including micro-credit, village banking and savings, small income generating business, social mobilization and capacity-building for women's empowerment.
- ***Benefit Sharing Schemes:*** In consultation with local communities in the project area and guided by the principle of promoting social cohesion and inclusion, KEL has agreed to benefit sharing mechanisms to be supported under the proposed project. During the construction period, the project will fund local infrastructure works, including new and improved health facilities; drinking water schemes; health services such as clinics; occupation skill training; upgrading of education facilities, and agricultural extension services in the project areas. The IDA-funded Kabeli Transmission Project includes funds for extending access to electricity in the Kabeli corridor, including the project affected village communities. In addition, the hydropower royalty that KEL will

pay once the project is operational will also serve as a source of funding to support rural electrification, in keeping with the established procedures for the use of these funds.

Regular monitoring of SAP implementation will be conducted by KEL as well as by an independent external monitor who will be designated to carry out semi-annual reviews of the SAP implementation. The specific monitoring activities and monitoring framework are detailed in the SAP. A third-party monitoring mechanism is also included in the Governance and Accountability Action Plan that has been agreed for the project. An ex-post third party audit of the implementation of the RCLAP and IVCDP will also be undertaken by KEL.

Chapter VII – Rapid Cumulative Impact Assessment and Management

There are in total 24 hydroelectric power projects (HPP) at different stages of development and licensing in the Tamor-Kabeli watershed. The KAHEP is not only the first hydropower project to be developed in the Kabeli River, but also the first one in the entire watershed. (Figure E.2)

This chapter describes KEL's efforts to identify cumulative impacts that the KAHEP may generate or initiate when placed in the context of existing, planned, and reasonably predictable developments in the future.

As part of the EIA process, KEL performed a Rapid Cumulative Impact Assessment (RCIA). In 2011, a preliminary RCIA only covering the Kabeli River watershed was performed, but as a result of this initial effort, the final RCIA geographical boundaries were expanded to cover the whole Tamor-Kabeli watershed.

Preparation of this RCIA involved consultation with local experts, government officials, and international CIA practitioners; advice from an independent international freshwater fish ecology expert who has worked in Nepal for several years; collection of additional fish and water quality data; and an extensive literature review.

KAHEP is committed to manage the significant potential cumulative impacts identified by the RCIA by:

- Including in its EMPs the mitigation measures to appropriately manage its contribution to any potentially significant cumulative impacts; and
- Work with the WBG, GoN and other stakeholders to design a governance mechanism that would allow for the appropriate development, implementation, enforcement, supervision and monitoring of a basin-wide approach to the environmental and social management of the cumulative impacts.

To implement the second part, the proposed project includes a separate US$2 million Technical Assistance component for the Ministry of Energy (MoE). This Technical Assistance is to increase GoN's capacity to manage the potential cumulative impacts and risks, and carry out any additional basin-wide studies that are necessary to design additional measures to manage potential cumulative impacts at the Tamor-Kabeli watershed level. The main components of this Technical Assistance are summarized in Table E-5.

Table E-5: Components of the IDA Technical Assistance to the DOED

Component	Budget (USD)
1. TA for supervision of KAHEP to ensure compliance with PDA.	300,000
2. Capacity Building of GoN agencies and financial institutions in hydropower development	200,000
3. Capacity Building on Social Aspects • Development of implementing guidelines for resettlement, community benefit-sharing mechanisms, monitoring and evaluation etc. • Strengthen capacity of regulators, project developers and consultants by offering short and medium term training	500,000
4. International Workshop on "Integrated River Basin Management For Sustainable Hydropower Development"	Trust Fund (TBD)
5. Additional Basin-wide Studies to Manage Cumulative Impacts in Kabeli-Tamor Watershed	600,000
6. Capacity Building on Environmental Aspects • Review of existing guidelines for hydropower sector • Develop supplementary guidelines on specific topics such as Minimum Ecological Flows; Watershed Management; Sediment Management etc. • Strengthen capacity of regulators, project developers and consultants by offering short and medium term training	400,000

The RCIA addresses the set of potential concerns posed in three different proposed development scenarios, and focuses on cumulative impacts on those elements considered to be key Valued Environmental and Social Components (VECs).

KEL undertook a rigorous and extensive consultation process to define, together with the relevant stakeholders, which VECs are most likely to be significantly affected or to be the most sensitive receptors to the potential cumulative impacts of the project. VECs were divided into three major categories, namely, physical, biological, and socio-economic/cultural.

Among the residents of the Tamor-Kabeli basin, the most valued VECs were fishing resources. Another important concern associated with the Kabeli River is its cultural and spritual value to local communities. Culturally and spritually the Kabeli River has its own significance to the local communities and is regarded as the most holy river by the people of the region. In that context, the water quantity and quality of Kabeli River are extremely important to local people, as it is a source of spiritual cleansing in religious rituals, including burial ceremonies.

As a result of the consultation process, and based on advice of international and local experts, KEL focused the RCIA on five selected VECs (Table E.6).

The VECs, considered by stakeholders to be the most likely significantly affected by the cumulative impacts from the multiple hydropower developments in the Tamor-Kabeli basin are:

- Physical environment:
    - Surface and water quality and quantity; and
    - Erosion/Landslide and sedimentation.
- Biological environment:
    - Resident and migratory fish populations.
- Socio-economic and cultural environment:
    - Spiritual and religious practices; and
    - Landscape integrity.

Figure E.2. Location of Potential Hydroelectric Power Project in the Tamor-Kabeli Basin

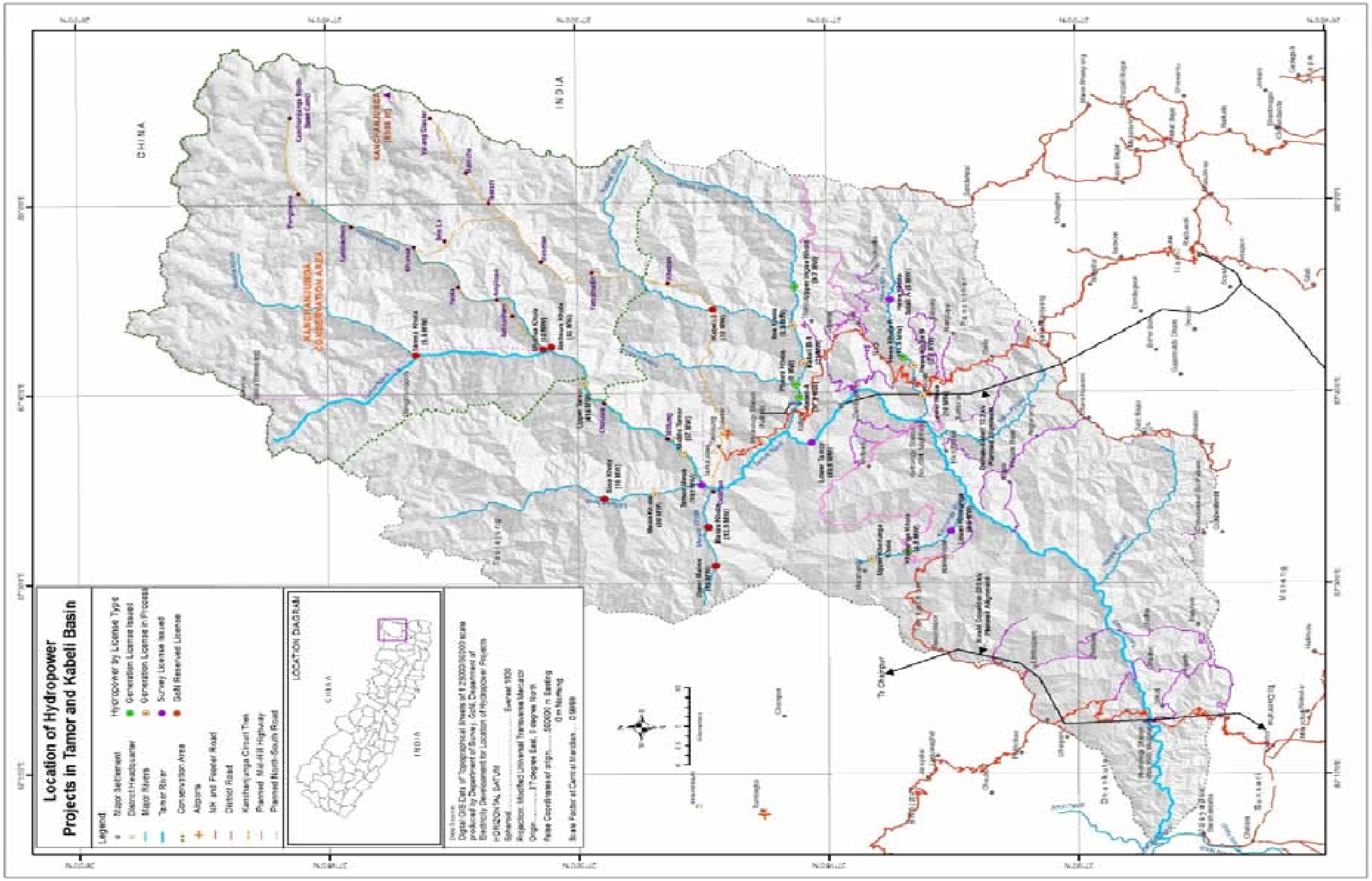


Table E.6. Selected Valued Environmental and Social Components

Feature	VEC	Valued Feature to Focus Management Strategies
Physical Environment	Surface Water Quality and Quantity	• Ecosystem and environmental services integrity: long-term temperature (T°C), Dissolved Oxygen (DO), Total Suspended Solids (TSS), microbiology, natural patterns should remain within acceptable limits; • Enough quantity/quality of water to satisfy present and future consumptive human uses (e.g., domestic, irrigation, others).
	Landslide/Erosion and Sedimentation	• Erosion control: watershed sediment load retention/ regulation capacity should not be degraded; and ideally, it should be improved.
Biological Environment	Resident and Migratory Fish Population	• Basin-wide aquatic connectivity: fish upstream and downstream migration should not be impaired; • Suitable habitat availability: foraging, spawning and cover habitat for indicator fish species should be maintained.
Socio-economic and Cultural Environment	Spiritual and Religious	• Riparian flow regime: adequate quantity, quality, depth and velocity of river flow should be maintained to avoid disruption of existing cultural, spiritual and/or religious practices by local people.
	Landscape	• Landscape/ habitat fragmentation due to multiple and overlapping access roads and transmission lines should be avoided.

The potential cumulative impacts on these five VECs are:

- ***Reduction of water quality and quantity:*** Under a multiple hydropower plant cascade scenario it can be reasonably predicted that the natural river flow regimes will be modified, as the river system will be converted from free-flowing rivers to a highly regulated ones. Water quality is likely to be affected. Reduced flows in the dewatered sections will likely be warmer, dissolved oxygen reduced, and any pollutants, microbiological contamination, as well as suspended solids may be present at higher concentrations. This will be aggravated if water is extracted for human consumptive uses from any of the dewatered segments, or if they are subjected to domestic wastewater discharges.

Even though these cascading hydropower projects are not net consumers of water, the timing as well as the allocation of the water flow will be modified. During dry-month periods, the dewatered sections will likely achieve a steady state at the new reduced flows, typically of about 10 percent of the natural flow for that time of the year. On the other hand, during peak generation, the river sections downstream from the tailraces will be subjected to daily water pulses, that could sometimes be significantly higher than the natural base flow of the receiving river. These daily water flow pulsating shocks will not allow for the downstream stretches to reach an ecological steady state and thereby are expected to introduce a stressing river environment during low flow season. The daily flow fluctuations might also be accompanied by a subsequent daily modification in the water quality. Furthermore, these downstream pulses of water could also compromise any traditional downstream water uses (e.g., irrigation, recreation), as even though technically the amount of water release will be the same, it will be coming all at once, thus not allowing for the timely use for the intended purpose.

- ***Landslide/erosion and sedimentation:*** Landslides and sediment transport in the Himalayas is a natural phenomenon, often aggravated by anthropogenic influences. Multiple hydropower developments, paired with the increased human activities from enhanced access (e.g., deforestation, slash and burn, haphazard dumping of spoil from road construction directly into the rivers, indiscriminate garbage disposal) will likely reduce forest cover and increase the rate of land-use change and overall erosion. A reduction of the forest cover's catchment will have a significant impact on the soil retention capacity, increasing surface sediment runoff and the vulnerability to landslides.

Flow modification resulting from multiple and cascading hydropower developments will likely have implications on the river morphology and hydraulics/ sediment loads and dispersion dynamics. Sand, gravel and boulder deposition dynamics will likely change. Debris flows are also likely to be modified.

If unmitigated, the potential cumulative impacts of poor watershed management, deforestation, and increased erosion could be significant, not only for the ecological and geomorphological integrity of the basin, but also for the technical and financial sustainability of the cascading hydropower projects.

  - ***Aquatic habitat degradation and fragmentation:*** As a result of cascading hydropower plants in the same river system, fragmentation of aquatic habitat is expected from the barrier effect of dams and weirs, and of the reduced flows in the dewatered reaches. This fragmentation will interfere with upstream and downstream fish migration as well as lateral in-stream movements in-and-out of the riverbanks.

Furthermore, natural flow disruption and the reduced flow in the dewatered segments will likely reduce the quantity and quality of suitable foraging, spawning, cover and habitat for both migratory and resident species.

The most important effect due to this habitat fragmentation is the closing of the ecological aquatic corridors. Closing of the ecological corridor means reduction in species diversity, change of species dominance/natural assemblies and impairment of migratory species' ability to fulfill their lifecycle. The river system's natural upstream-downstream connectivity will be significantly disrupted, especially during the dry season. The barrier effect will likely impair fish migration from the downstream reaches to the upstream reaches for spawning and feeding. Once breeding habitats and nursing areas are lost, a gradual decline in the fish population leading to the extinction of certain fish species in the watershed may be inevitable. One of the main reasons for this is that robust fish populations in the downstream reaches of the large river systems depend largely on the recruitment of fish fry and fingerlings from the upstream nursing areas.

- ***Adverse impacts on spiritual and religious sites/practices:*** Reduced flows in the dewatered sections as well as the overall cumulative flow regime modifications resulting from the development of cascading hydropower plants in the Tamor and Kabeli basins also have the potential to adversely affect water availability and quality needed for religious ceremonies. Cremation sites require clean water in enough quantity (chest-high depths) for people to perform their traditional ceremonies and rituals. Pure and clean flowing water is a prerequisite for performing these rituals. The minimum constant depth of water in the river is also required for these traditional cultural and religious activities.
- ***Landscape conversion:*** Multiple cascading hydropower plants, together with the construction of ancillary facilities such as roads and transmission lines, and all the induced development could significantly modify the existing landscape. This could be a very significant negative impact to Nepal's development of tourism based activities in the project area. The visual impacts and landscape fragmentation as a result of unplanned and multiple roads and electric transmission and distribution lines, though still uncertain, could potentially be very significant. Nepal is a country that markets its natural pristine beauty as one of its main touristic features, and this image could be significantly jeopardized if the landscape is encroached upon by multiple transmission lines, towers, cables and roads.

Mitigation of Potential Cumulative Impacts: Since the KAHEP is the first hydropower project to be constructed and operated in the Tamor-Kabeli basin, it has the opportunity to establish a good practice in the design and implementation of appropriate mitigation measures and to incorporate continuous management of the potential cumulative effects in the EMP.

KAHEP will include in its operational EMP the following measures to curb the cumulative impacts at the basin level:

- Design and construction of a fish ladder to assure that upstream-downstream fish migration is not impaired;
- Design and construction of structures / check dams along cremation sites to create chest-depth pools. In addition, downstream flow release will be increased during religious festivals to meet riparian communities' ritual requirements and maintain adequate sanitation;
- Design and construction of fish diversion structures to minimize fish entrapment in the headrace tunnel;
- Release of a downstream environmental flow regime that will: (i) maintain the ecological river corridor open; (ii) secure survival of substantial amounts of fry and fingerlings of target species in the dewatered segments; and (iii) ensure local populations can continue performing their traditional burial rituals and other religious ceremonies undisturbed;
- Development and implementation of a robust monitoring program during the construction and operation phases to allow for improved understanding of the potential effects of the proposed minimum downstream release on riparian connectivity and migration challenges of the key fish species; and

- Adaptive management to allow for adjustments of the downstream environmental flow regime releases as a response to the monitoring program results.

In addition, in the area of terrestrial influence KAHEP will apply:

- Soil conservation through biological and engineering solutions in the catchment areas to reduce the upland erosion and sediment load in Kabeli River; and close monitoring of the grain size distribution and sediment concentrations in the river in real time;
- Awareness programs at catchment level for ecosystem conservation through improvements in the water retaining properties of soil;
- Afforestation and bio-engineering works for degraded areas to enhance basin vegetative cover; and
- Promotion of rural electrification as per the hydropower policy (2001) in the project influenced VDCs to reduce reliance on fuel wood for energy.

It is expected that once KAHEP makes the investments required to develop and implement these mitigation measures, all other projects in the basin will follow the trend. However, if the future projects upstream and downstream from the KAHEP do not implement similar and coordinated measures, KAHEP's efforts alone will not be sufficient to maintain the ecological and socio-economic integrity of the Tamor-Kabeli watershed.

With the support of the WBG, KEL will use best efforts to leverage and engage the GoN and other developers in the application of good practices. Therefore:

- All hydropower developments should provide downstream flow regimes that will adequately meet ecological and social requirements, especially during the dry season. Establishing the required flow release is often a challenge and needs multi-stakeholder long term coordinated monitoring efforts;
- To assure ecological corridors are kept open, all projects should include fish ladders and entrapment prevention measures in their design;
- Native fish hatcheries should be supported by all developers in the basin, and open water fish-restocking should take place on an annual basis and in a coordinated fashion;
- It is envisaged that all developers with stakes in the Tamor-Kabeli basin shall work jointly for the overall development of the Tamor-Kabeli basin. For this purpose a joint Catchment Area Treatment (CAT) plan should be developed. The CAT will highlight erosion control techniques, and will involve understanding of the erosion characteristics of the terrain and suggest preventive, stabilization and remedial measures to reduce the erosion rate. These shall give attention to the proper construction of rural roads and rural electrification to avoid and minimize the potential adverse environmental impacts;
- Infrastructure should be shared to avoid unnecessary land acquisition and additional habitat and landscape fragmentation as a result of overlapping access roads and transmission lines; and

- Joint operation and maintenance activities should be developed (e.g., agreeing on common operation and maintenance manuals and guidelines). Coordinated downstream environmental flow and extraordinary flow release, flushing, and other operational, maintenance and emergency prevention and response activities are crucial for increased efficiency and reduction of maintenance costs.

As stated above in Table E. 5, the IDA has allocated a total of US$2 million to help the DoED to carry out the following capacity building activities during implementation.

- **International Workshop on "Integrated River Basin Management for Sustainable Hydropower Development in Nepal"**

  The WBG in collaboration with the DoED and other development partners active in Nepal, assist the GoN in organizing an international workshop on "Sustainable hydroelectric project development in Nepal". This proposed workshop will focus on sharing international experiences and case studies on sustainable hydropower development and bring together key stakeholders to discuss technical assistance needs to promote sustainable hydropower development in Nepal. Some of the specific topics that will be discussed include: cumulative impact assessment methodologies and their application to hydroelectric development at the watershed level; maintenance of minimum ecological flows and regimes; ecological compensation and offsets; design of Environmental Management Plans for construction and operation; community engagement and consultation with project affected people; resettlement and land acquisition aspects; consent from affected indigenous peoples; and good practices on benefit sharing.

  Target Groups: Policy makers, Regulators, Civil society, Project developers, Private sector, Government Departments connected to Hydropower development in Nepal, Academia, and Consultants

- **Additional Basin-wide Studies to Manage Cumulative Impacts in Kabeli-Tamor Watershed**

  This task will provide resources for the DoED to engage national and international consultants to consolidate good baseline data, develop thematic maps of the Tamor – Kabeli watershed, collect all relevant data needed to assist the GoN to manage Cumulative Impacts in Kabeli-Tamor Watershed.

- **Capacity Building**

  This task will focus on two aspects of environmental capacity building for regulators, consultants, private developers, construction engineers, academia etc: (a) preparation and issuance of guidelines on specific topics such as: Cumulative Impacts; Minimum Ecological Flows, Watershed Management, Sediment Management etc. and (b) offer specialized short and medium term training programs on Sustainable Hydropower Development in Nepal.

  The project will provide resources to DoED to hire national and international experts to prepare the above stated specific guidelines. DoED will also hire reputed national institutions such as: Institute of Engineering (IoE), Kathmandu University, New Era, Winrock International, Nepal, and Himalayan Resources etc. to offer regular training programs for various stakeholders (policy makers, regulators, civil society, project developers, private sector, relevant Government departments, Academia, and Consultants) connected to hydropower development in Nepal.

In addition to the above, DoED will receive support to implement the following two initiatives to manage social aspects: (a) development of implementing guidelines for resettlement, community benefit-sharing mechanisms, monitoring and evaluation etc. and (b) Strengthen capacity of regulators, project developers and consultants by offering short and medium term training.

Chapter VIII – Environmental Management Plan, Monitoring Plan and Audit

This chapter describes KEL's proposed measures to manage environmental and social impacts associated with the construction and operation of KAHEP. The mitigation measures are encompassed in a comprehensive EMP that identifies the principles, approaches, procedures and methods to be used to control and minimize environmental and social impacts of all construction and operational activities associated with the project development. It is intended to ensure that commitments made by KEL to minimize project related environmental and social impacts are upheld throughout all project phases. The EMP is also a companion document to the SAP.

Basic principles under which the EMP will be implemented are:

- Fulfill all environmental and social conditions associated with the project approvals;
- Develop, promote and foster a shared sense of responsibility for environmental and social performance of the project;
- Promote environmental awareness and understanding among employees and contractors through training, identification of roles and responsibilities regarding environmental and social management and linking project performance to the overall environmental performance;
- Encourage an understanding of social and cultural sensitivities in local communities and the importance of minimizing project impacts on local lifestyles and cultures;
- Monitor environmental and social performance throughout the project and implement an adaptive management approach to continuous improvement;
- Work with local communities and project affected stakeholders to ensure that they benefit as a result of the project development; and
- Maintain an ongoing commitment to informing, engaging and involving local stakeholders throughout all phases of the project.

KEL's environmental management activities reflect a synthesized plan incorporating the elements of environmental mitigation and enhanement measures. They can be described as activities to manage construction and operation impacts and adaptative management strategies to adress the selected environmental impacts the magnitude of which may still be uncertain.

Management of construction and operation impacts addresses all the issues that are associetd with the impacts from the project's activities, and include: (i) permits and approvals; (ii) environmental training; (iii) construction camps and traffic management plan; (iv) pollution abatement plan; (v) terrestrial ecology management plan; (vi) AEMP; (v) erosion abatement and muck/spoil management plan; (vi) public health and occupational safety management plan; (vi) emergency management plan; (vii) rehabilitation plan; (viii) chance find procedures; (ix) labor law compliance; (x) security personnel; and (xi) grievance redress mechanisms.

Contractor responsibilities during construction in all of these plans will be detailed in the Environmental Specifications for Contractors. which will be included in bidding documents and enforced by an external supervising consulting firm.

To effectively integrate various stakeholders in KAHEP environmental management, an institutional framework for the different phases of project development and implementation will be established. The objective of the institutional framework is to establish linkages of various stakeholders such that project activities are taken forward through a linear command and control, while inputs from various stakeholders are taken into account and internalized in the project implementation at various levels of the institutions.

As noted above, a POE has been established to provide independent review and guidance on the treatment of technical, environmental and social issues associated with the KAHEP. Among other duties, the POE will provide reports on the status and compliance with EMP and SAP requirements.

Adaptive Management: It is recognized that the proposed plans may need future adjustments. An adaptive management approach will therefore be adopted for environmental and social management components. Based on monitoring and evaluation of actual performance, proper adjustments will be made to the management plans. This iterative process needs to be repeated until all environmental and social systems are stabilized upon project completion. Adaptive management approaches will particularly apply to the management of fish populations, the management of water releases and environmental flows, and the management of cumulative impacts. The EIA report revealed key areas in which additional information is needed to identify or improve mitigation measures. The main baseline studies are: baseline information on the aquatic life and community water uses of the Kabeli and Tamor Rivers and baseline information on the status of houses and infrastructure along the tunnel alignment.

In addition to the monitoring efforts and the baseline studies, the adaptive management framework will be supported by two key studies that will be carried out during project construction:

- ***Migratory and resident fish study:*** The water diversion projects such as KAHEP may affect fish diversity and population through barrier and dewatering effects. In order to minimize the impacts the project has integrated a ladder provision in the dam body. The uncertainty of the effective use of the fish ladder for upstream and downstream migration of the fish is one of the concerns. Therefore, a fish hatchery, annexed with an open water fish stocking, is proposed for the KAHEP to minimize the uncertainty risks of the fish ladder with an objective to maintain the fish diversity and population in the upstream section of the Kabeli River. Target fish species for hatching in the fish hatchery are the Red List species, the migratory species, and those species that have an economic value to locals. The study TOR will include: (i) a review of the fish hatching experience of the target fish species in Nepal; (ii) identification of suitable fish hatching site close to the KAHEP; (iii) design of the fish hatching facility with the required accessories; (iv) operations management and (v) costs of construction and operation of the fish hatching facility.

- ***Catchment Area Treatment Plan*****:** Upland erosion and downstream sedimentation are issues of concern in Himalaya Rivers including the Kabeli basin. To minimize the effects of erosion and sedimentation, there is a need for basin wide identification of vulnerable areas and activities that result in erosion and subsequent sedimentation. To date, there are no such studies of the Kabeli basin. The KAHEP will conduct a basin wide study for identification of the key erosion prone areas and activities that are likely to exacerbate erosion and sedimentation in future. Based on such a study, a catchment area treatment plan will be drawn for the Kabeli basin. This study will form a basis for responsibility sharing between various development agencies including KAHEP developer for the minimization of erosion and sedimentation in the basin.

Environmental Monitoring: Environmental monitoring plans include environmental monitoring during pre-construction, construction and operational phases for the baseline, compliance and impact monitoring of the project activities. A set of measurable indicators have been selected for the monitoring and the plan includes methods of monitoring, monitoring frequency, monitoring location, and personnel responsible for monitoring along with the costs. Quarterly internal monitoring will be carried out by KEL regularly and four reports will be issued per year. During construction, independent external monitoring will be carried out semi-annually to review the implementation of environmental and social safeguard measures.

Chapter IX – Environmental Mitigation, Monitoring, Auditing and Management Costs

This chapter provides the expected costs associated with the implementation of the EMP, environmental mitigation and environmental monitoring costs. The total environmental costs of the project are NRs 238,279,187.00 (about US$2,307,833.00);[4] out of which 30,223,575.00 NRs are dedicated to environmental management during construction; NRs 13,502,500.00 to environmental monitoring during pre-construction, construction and operations; NRs 41,744,177 to overall environmental mitigation, NRs 750,000.00 to environmental audit and NRs 152,058,935.00 to environmental and social civil costs including camps, resettlement, rehabilitation and other.Additional NRs 29,579,173.05 are dedicated separately to SAP implementation.

Other Safeguard Issues

Safety of Dams (OP.4.37): An international POE advised the project on all salient aspects of its design and visited the site twice during project preparation. KEL prepared a Dam Safety Plan, including an Operation and Maintenance Manual, Emergency Preparedness Plan and an Instrumentation Plan satisfactory to the WBG.

International Waterways (OP 7.50): The initial feasibility study and the environmental impact assessment for KAHEP were completed in 1998. Riparian notification was made to

[4] Exchange rate 1 US$ = NRs 103.25.

China, India and Bangladesh on June 27, 2002. The riparian notification letter requested comments from the riparian countries by September 30, 2002. No comments in connection with the proposed project were received from China, India or Bangladesh by the indicated deadline or at any time since then. An updated riparian notification was submitted to the three riparian countries on August 15, 2013, with a deadline for submitting comments on September 27, 2013. No comments were received.

Chapter I: INTRODUCTION

1.1 BACKGROUND

The Kabeli A Hydroelectric Project (KAHEP) located in between the geographical coordinates, latitudes 27°17'32"N to 27°13'41"N and longitudes 87°45'50"E to 87°40'55"E in Pachthar and Taplejung district, Mechi zone of Eastern Development Region of Nepal, is based on the water resources of the Kabeli Khola, a natural border between the Panchthar and Taplejiung districts in the Middle Mountains of Eastern Nepal about 800km east of Kathmandu. This project utilizes a more than 15 km long loop of KabeliRiver formed with TamorRiver. The Kabeli River is diverted through a 4.327 km long tunnel and discharges into Tamor River for power generation.

Initial identification of the project was made during the Koshi River Basin Master Plan Study (1983-85). Successive studies (MHSP/NEA, 1998) formulated the 30 MW Kabeli-A Hydroelectric Project with an average annual estimated energy of 164 GWh. The project was later offered for a competitive bidding to private developers on build, own, operate and transfer (BOOT) model. Butwal Power Company Limited in Joint Venture (JV) with two Nepalese companies - Shangrila Energy Ltd and Khudi Hydropower Ltd - and two foreign companies SCP Hydro International Inc. (Canada) and Asia Pacific Power Tech. Ltd., China won the bid and established a Project company under the name- Kabeli Energy Ltd (KEL) and signed the Project Development Agreement (PDA) with the Department of Electricity Development (DoED), Government of Nepal (GoN) in 2010. Subsequently, DoED has assigned the survey license of the project to KEL (Annex 1.1).

The Project configuration was decided after concluding the project optimization studies during updated feasibility study Report (USFR) and supplementary studies to UFSR by KEL in 2010 and in 2011. Major project features of KAHEP are diversion weir, side intake, settling basin, headrace tunnel, surge shaft, surface penstock, powerhouse and tailrace. KEL is under taking a detailed design and environmental and social assessments and is set for the development of the Project as early as possible.

The updated feasibility study (UFSR, 2011) proposed a 37.6 MW installed capacity to the project. The gross head of the project is 116.8 m and the design discharge based on the 40 percentile flow in the river is 37.73 m^3/s. The proposed project is a Peaking Run-Of-River (PROR) type project with a peaking reservoir constructed by damming the Kabeli River at the headworks. The live storage capacity of the reservoir is 0.335 million m^3. The plant has been designed as a 6 hour peaking plant but at a reduced capacity of 26.5 MW during the month of the lowest mean monthly flow. The peaking will be done in two slots in a day: two hours in the morning and four hours in the evening peak. The annual average energy generation is estimated at201.0 GWh (excluding 6% outage). The firm and secondary energy of the project excluding outage has been estimated as 149.4 GWh and 51.6GWh respectively.

1.2 PROJECT PROPONENT

The KEL is the project proponent and has signed a PDA with the Department of Electricity Development (DoED) for the development of KAHEP on 31 January, 2010 (Annex 1.2). The detailed address of the project proponent is given below:

Kabeli Energy Limited
Ganga Devi Marga - 313,Buddha Nagar,P.O Box: 11728, Kathmandu, Nepal;
Tel: +977 – 1- 4781776 / 4784026; Fax: + 977 1-4780994
E- mail: kel@bpc.com.np
Website: www.kel.com.np

The KEL is a subsidiary company of the Butwal Power Company Ltd (BPC), established to develop, own and operate the Kabeli ‘A’ Hydroelectric Project. BPC, a leading hydropower developer of Nepal, holds 54% stake, while other JV partners SCP Hydro International Inc. (Canada), Shangri-La Energy Ltd. (Nepal), Khudi Hydropower Ltd. (Nepal), and Asia Pacific Power Tech. Ltd. (China) hold 30, 5, 6, and 5% respectively. The company's assets and key features of the major shareholder, BPC, are as follows:

- Around 300employees
- Owns and operates the 12MW **Jhimruk Hydropower Plant** and the 5.1MW **Andhi Khola Hydropower Plant**. Besides supplying power to the national electricity grid, the company has electrified more than 35,000 households through these power plants under its rural electrification program
- Owns 16.88% of the shares in Khimti I Hydropower Plant (60 MW), 51.3% in Nepal Hydro and Electric Ltd, 20% in Hydro Lab Pvt. Ltd and 24% in JIDCO. It also owns 60% of the shares in the 4 MW Khudi Hydropower plants which has been in commercial operation since 30December, 2006.
- In 1986 BPC established Hydroconsult as the company's consulting wing for engineering and consulting services in hydropower, water and irrigation sector. **BPC Hydroconsult** was restructured as a separate entity, Hydro-Consult Private Limited (HCPL) in 2009 that was again renamed Hydro-Consult Engineering Limited (HCE) in 2012. HCE is a subsidiary of BPC and is recognized as a leading consulting organization undertaking multi-disciplinary projects.

1.3 INSTITUTION RESPONSIBLE FOR PREPARING THE DOCUMENT

Nepal Environmental and Scientific Services [NESS] Private Limited, an environmental consulting firm has been assigned as a consultant by KEL to carry out the EIA study as per the requirement of the World Bank. The address of the consulting firm is:

GPO Box 7301, Jitjung Marga-26,
Thapathali, Kathmandu, Nepal
Tel.:977 1 4244989 / 4241001; Fax: 977 1 4226028
E-mail: ness@mos.com.np;
Website: www.ness.com.np

NESS is a company incorporated under the Ministry of Industry, Government of Nepal. Established in 1992, the company has its head office at Thapathali, Kathmandu Nepal.

1.4 PURPOSE OF THE PROJECT

The purpose of KAHEP is to harness the hydropower potential of the Kabeli River within the licensed geographical coordinates by optimizing the available water resources with a minimum possible environmental and social damage in the project development area. The project proponent has the objective to deliver the generated electricity to the central electricity grid under a power purchase agreement with the concerned electricity transmission and distribution agency of Nepal and assist the Government of Nepal to overcome the ongoing load shedding and contribute to the national development efforts.

1.5 STATUARY ENVIRONMENTAL REQUIREMENT

The statuary environmental legislation for the development of the proposal in Nepal is the Environment Protection Act (EPA), 1997 and Environment Protection Rules (EPR), 1997. The EPR Schedule 1 classifies KAHEP as Initial Environmental Examination (IEE) category project, since the project has an installed capacity of less than 50 MW and does not affect forestland area above 5 ha and lies outside the limits of the officially gazetted National Parks, Wildlife Reserves, Sanctuaries and Conservation Areas (refer EPR Schedule 1, Section UU, and sub-section 2).Hence, KAHEP has to undergo IEE level study and its approval as per the EPR procedures to satisfy the environmental requirements of the Government of Nepal prior to development.

Since the project is seeking financial support from the World Bank Group to meet parts of the project development cost, it has to comply with the environmental and social safeguard policies of the World Bank Group. The project has been classified by the World Bank as a 'Category A' project and therefore a project specific EIA report is prepared within the framework of the World Bank’s Policies to be eligible for financial support.

1.6 OBJECTIVES OF THE EIA STUDY

The objective of the EIA study is to assess whether the proposed project is acceptable or not from the environmental point of view and make the proposed project technically and environmentally sustainable. The objectives of the EIA study are to:

- Collect baseline data on environmental conditions of the project area
- Carry out alternative analyses for various power generation, layout and design from the environmental point of view
- Identify environmental impacts of the selected alternative in terms of magnitude, extent and duration that may be expected to occur during pre-construction, construction and operation
- Identify the critical environmental problems that require further studies and/or monitoring.
- Suggest mitigation measures for adverse impacts and enhancement measures for beneficial impacts
- Develop an Environmental Management and Monitoring Plan
- Assess the institutional arrangements and capacity for the implementation of the Environmental Management and Monitoring Plan
- Develop information dissemination and consultation strategy for the implementation of the project
- Consult and inform the project affected parties and other stakeholders, and ensure their active participation
- Advise decision makers on the environmental implementation of the project
- Conduct a rapid environmental assessment of cumulative impacts of planned hydropower development in the Kabeli and Tamor basin and identify measures that need to be incorporated in the KAHEP based on the basin environmental considerations.

An integral part of the EIA study is the Social Assessment (SA) Report[5] prepared for the project. The Social Assessment addresses social impacts and other social issues associated with the project such as: resettlement and land acquisition, health impacts, physical cultural resources, ethnic minority issues, among others. A Social Action Plan (SAP)[6]was prepared to address social impacts of the project and it complements the Environmental Management Plan included in the EIA. The SA and SAP reports are integral parts of the EIA report.

1.7 EIA STUDY METHODOLOGY

The following methodologies have been applied for the collection of the baseline information and impact prediction:

1.7.1 Literature Review and Consultation with the Stakeholders

The available published literature, documents and maps were reviewed (GoN's topographic map with scales 1: 25,000 and 1:50,000, land use maps, aerial photographs, cadastral survey maps, Google maps etc.) related to the project area. The existing policies, legislations, guidelines and manuals related to the hydropower development in Nepal and the World Bank's Environmental Assessment policies and guidelines were also reviewed. Apart from the above, the EIA Scoping Documents, approved Terms of Reference (ToR) and the Detailed Design Report including the EIA study carried out by Nepal Consult (P) Limited in 1998 were thoroughly reviewed to come up with the project study requirements both at the desk level and the field level. The data collected through literature review onthephysical environment include physiography, geomorphology, geology and soil, drainage and hydrology, meteorology, land use, erosion and land stability, water use and rights, glacial lake outburst flood(GLOF) potential and seismicity. On the biological environment, information related to the forest coverage and types, floral& faunal biodiversity, rare, endangered and protected faunal and floral species, habitats and ecological conditions of the project area was collected. Demographic characteristics of the project district and the affected village development committees(VDCs), quality of life, culture and traditions were the key information collected in the socio-economic and cultural aspects.

Furthermore, series of discussions and consultations were carried out with the project technical team involved in the updated feasibility study (UFSR, 2011) to get updates on project location, design aspects, project construction and operation modalities, concentration of activities in the different periods of project construction and operation, etc. Design merits and demerits of the various alternative options of project development and operation were also discussed.

In order to cross check the local concerns and local information available in the secondary literatures, officials of the local and district level, particularly VDCs, District Development Committees, District Forest Office, Community Forest User Groups, District Soil Conservation Offices and District Land Revenue Office were contacted to solicit site-specific information of the project area. Furthermore, the local, national and international institutions working in the project area were also consulted to verify the project specific information related to the environmental and social aspects.

[5]Social Assessment (SA) of Kabeli-A Hydroelectric Project, JULY 2013, Submitted to
the WORLD BANK by KABELI ENERGY LIMITED, Buddha Nagar, Kathmandu, Nepal; Prepared by HYDRO-CONSULT ENGINEERING LIMITED.

[6] Social Action Plan (SAP) of Kabeli-A Hydroelectric Project, July 2013 Submitted to
the WORLD BANK by KABELI ENERGY LIMITED, Buddha Nagar, Kathmandu, Nepal; Prepared by HYDRO-CONSULT ENGINEERING LIMITED.

1.7.2 Field Study

The field investigation was carried out by a multidisciplinary team, which comprised of a wildlife expert, physical environment expert, environmental engineer, hydropower engineer, taxonomist and fishery experts. The design and hydropower engineers of the proponent also assisted the team members during the field survey. A month long field visit was conducted in September, October 2010to collect the baseline information. The study team carried out a field visit in two VDCs of Pachthar district (Amarpur VDC and Panchami VDC) and two VDCs of Taplejung district (Thechambu VDC and Nangkholyang VDC).

The required baseline information on physical and biological environment of direct and indirect impact areas of the project were collected during the field visit. The information on different environmental components was collected by using the tools included in Annex 1. 3.

1.7.3 Impact Analysis

After the full documentation of the baseline environmental data of the project area, each of the environmental parameters was examined against the project activities at different stages of the project development using various methods and tools as required by the environmental parameter in question. By using the format of the National EIA Guideline (1993), the impacts were categorized as direct and indirect impacts. Each of the direct and indirect impacts was further evaluated in terms of its extent as site specific, local or regional. Each of these was further analyzed in terms of duration as short-term, medium-term and long-term. The magnitude of each of the impact was then evaluated as high, medium and low based on the conditions of the environmental parameter at present and estimated or projected changes with the project. While doing so, reversibility of the impacts was also examined to qualify their magnitude for the impact significance. The evaluation of magnitude of impacts on the value based system as presented in the National EIA Guideline, 1993 is not used as this system does not take into account the impact irreversibility and the impact rating for magnitude often misguides the impact significance.

1.7.4 Public Consultation and Public Hearing

Regular informal public consultation is a part of an EIA study. Local people were consulted in a number of occasions and forums during the EIA process.

A total of 14 focus group discussions (FGD) with the local people have been conducted in different locations of the project areas to identify various issues related to the hydropower project development and its socio-economic consequences and corresponding mitigation measures. A total of 251 individuals representing different impact areas and socio-economic groups such as dam site, dewatering zone, access road, powerhouse site, community forest user groups (CFUG), leasehold forest user groups(LFUG), Dalits, indigenous peoples (IPs) and women participated in the FGDs. Out of the 14 FGDs, 2 were with women, 1 with Dalits, 3 with IPs, 1 with Kabeli Concern Committee, 1 with CFUG, 1 with LFUG, 1 with local school teachers and the rest 4 FGDs were conducted with the mixed groups comprising of male, female, IPs, Dalit, Bahun, Chhetri, etc. Table 1.1 presents the locations of the FGD and the members who participated in each of the FGD.

Table 1.1: FGD Locations and Participant Details

SN	Location of FDG	Date	Participants								
			Sex		Caste/Ethnicity			Occupation			Total
			M	F	Br/Ch	IP	Dalit	Primarily farming +supplementary fishing	Job and business	Other (leaders, school teacher)	
1	Amarput-6 Women	14/7/2010	-	14	14	-		14			14
2	Thechambu-5, Downstream	15/7/2010	14	02	03	13	-	07	04	05	16

	Affected households										
3	Amarpur-6 CommunityForest	16/7/2010	25	01	12	13	01	24	-	02	26
4	Amarpur-8, Downstream Affected households	17/7/2010	11	07	07	08	03	18			18
5	Amarpur-6 Kabeli Concern Group	18/7/2010	22	-	13	09	-	18		04	22
6	Amarpur-9, Pinase affected communities of Panchami VDC	19/7/2010	21	03	08	15	01	23	-	-	23
7	Amarpur-9, Pinase affected Majhi indigenous community and Leasehold forest, Amarpur VDC	19/7/2010	11	06	01	16	-	17			17
8	Nangkholyang-5, affected communities	21/7/2010	27	11	10	28	-	25	05	08	38
9	Nangkholyang-5, School teachers	21/7/2010	06	-	03	03				06	06
10	Thechambu-5 Indigenous peoples and VDC representatives	22/7/2010	25	02	05	21	01	21	06	-	27
11	Thechambu-5 women group	22/7/2010		07	01	06		07			07
12	Amarpur-6, Indigenous peoples of four affected VDCs	23/7/2010	19	-	01	18		15	03	2	20
13	Dalit people of Amarpur VDC	23/7/2010	7	3			10	8	2		10
14	Amarpur-9Pinase, Consultation Meeting with Majhi Indigenous Community	19/7/2010	10	7		17		17			17
	Total		**188**	**63**	**78**	**167**	**16**	**214**	**20**	**27**	**251**

**M=Male, F=Female, Br=Brahmin, Ch=Chettri, IP=Indigenous People*

The FGD meeting was organized by the SA consulting team by giving a prior verbal notice through a runner to the entire project affected VDCs. The main objectives of FGD were to collect information on socio-cultural landscapes, human-environment interactions, and livelihood practices, the views of local people towards the project, their perceptions, aspirations and expectations. FGDs were organized to collect the information on local development and their felt needs, their roles on project implementation, possible mitigation measures and institutional arrangements. Separate FGDs were organized for IPs, women, Dalits and affected households and other marginalized groups as they may have different agendas, interests and aspirations than the dominant groups. The purpose of the focus group discussion meeting was:

- To provide factual information on the project location, particularly the main project structures such as dam, tunnel, adit portals, powerhouse, surge tank, tailrace and the project access roads besides tentative locations of the quarry sites, construction camps and operation camps of the project.
- To clarify the objective of the Project SA and its procedures.
- To provide information on the potential impacts of the project and technical considerations during project construction and operation in the project area's physical, biological, social, socio-economic and cultural domain.
- To collect information on the project area’s physical, biological and socio-economic and cultural environments from the local peoples’ perspective.
- To collect opinion of the people on the project.
- To get feedback on the potential impacts of the project in the eyes of the local people particularly on the local infrastructure, social norms and culture and on the physical and biological environments.
- To solicit opinion of the local people on the alternative mitigation measures to abate, or avoid the potential impacts

- To solicit opinion of the local people with regard to the development aspiration of the project.

The focus group discussion meetings were informal. The project layout, its different components, details of the type of construction and operation activities, project's physical location in the field were explained during the meetings. They were opened to the general public. Annex 1.4 briefly summarizes the findings of the FGD meetings. The major issues, discussed during the FGDs were: land acquisition and mode of compensation; livelihood related issues due to the loss of land; dewatering; prior information dissemination practices; ILO 169 and the rights of IPs; rural electrification; current uses of Kabeli river; perceptions towards the project; socio-cultural practices associated with Kabeli river; local development needs; likely impacts due to various project structures and corresponding mitigation measures.

Information pertaining to the optimum environmental mitigation option and environmental enhancement measures was also obtained from the discussions and consultation with the local people. The information solicited has been used extensively in the preparation of this EIA report, particularly for the environmental baseline, prediction of environmental impacts; design of mitigation and monitoring and in the preparation of environmental enhancement programs. The list of persons consulted in the Community Forest User Group Meetings is presented in Annex 1.5.

Public hearings were organized at local level (project area) as well as national level (Kathmandu)to present the findings of the EIA study as well as to collect the issues, concerns and views of the people of the project area and stakeholders. A summary of public consultations, deliberations, comments and suggestions of the public hearings is incorporated in Annex 1.6.

1.8 SUPPLEMENTARY STUDIES AND REPORT FINALIZATION

This EIA Report, apart from findings of 2010 field work and analysis, has been updated several times based on findings from additional field works, supplementary studies and revisions. These supplementary studies and revisions were done only for the critical issues where ambiguity was encountered. These studies have been listed below in chronological order.

- **Social Assessment (SA) and Social Action Plan (SAP) of Kabeli A Hydroelectric Project:** SA and SAP study were carried out separately by Hydro-Consult Engineering Limited (previously HCPL) in parallel with the EIA in 2010 and 2011 This complements the EIA in social impacts and mitigations. The latest version of the SA and Sap were prepared in July 2013.

- **Review by Panel of Experts (PoE)**: PoE of KAHEP comprised of five members including one environmental and one social expert. Environmental and Social PoE members visited the KAHEP site on December 2012and reviewed/ commented on the draft EIA Report. The EIA report was again reviewed by the environmental member of PoE in November 2011 and again in February 2013. All the comments and suggestions of the PoE are incorporated in this final EIA Report. In addition, the environmental and social PoE members also reviewed the bid documents for incorporating environmental and social aspects.

- **Dam Safety Plan Report (DSPR)**: Despite all the safety measures envisaged by the design and safeguard documents, a dam safety plan is vital so that an acceptable level of dam safety is ensured. A Dam Safety Plan Report based on the suggestions of experts and PoE to list out different plans and programs to be carried out at different times during the implementation and operation of the project was prepared in May 2011 by Hydro-Consult Engineering. DSPR has

Operation and Maintenance Plan (O&MP), Emergency Preparedness Plan (EPP) and Instrumentation Plan (IP)as integral parts for Kabeli-A project for ensuring the non structural safety of the barrage structure. The DSPR was also reviewed by the World Bank dam safety specialist.

- **Ecological Flow Assessment of Kabeli River**: The KEL commissioned an independent assessment of the ecological flow in Kabeli River by engaging two national fish experts in August-November 2011 for assessing minimum releases and ecological flow requirements considering fish habitat, migration, and thriving/ survival conditions. The experts gave recommendations for the minimum flow requirements and Ecological Flow Management Plan based on experiences in Nepal and other countries.

- **Review of EIA by National Environmental Expert:** A national environmental experts was engaged from November 2012-January 2013 to review and update the EIA report in light of the comments received from US ED in June 2012. The national expert also reviewed additional secondary information related to the Kabeli basin to improve the cumulative impacts of hydropower development in the basin.

- **Review of EIA by International Environmental Expert:** KEL engaged an international environmental expert to further improve the EIA in March 2013. The International expert also updated the EIA considering all the studies carried out till March 2013.The international expert considered the entire Tamor basin, not only Kabeli basin, for reviewing the impact on fish, minimum downstream flow and cumulative impacts.

- **Engagement of International Fish Expert**: An international fish expert with substantial experience in Nepalese rivers was engaged in June 2013 to further review and revise the EIA, particularly fish and downstream flow issues. The international expert, together with local fish expert from KEL, made a rapid site visit in June 2013 and contributed to the improved and revised relevant sections of the EIA. The expert also provided some input regarding cumulative implications on the fishes and ecology of the entire Tamor basin considering the development of other hydropower in the Tamor and Kabeli Rivers.

- **Rapid Cumulative Impact Assessment (RCIA)**: RCIA study was carried out as a supplementary study for the EIA in November 2011 by the EIA Consultant for assessing the impacts of KAHEP on Kabeli basin. The CIA study looks into the “As Is analysis” and “Possible Scenario Analysis” of hydropower development in the Kabeli basin and provides recommendations for KAHEP and other potential developers to offset possible cumulative impacts on the basin. The RCIA has been updated at different stages – the current version of Chapter 7 incorporates information available until July 2013.

The World Bank, IFC, KEL and HCE teams have worked together to improve and make the EIA Report more feasible. The current EIA (July 2013), therefore, is the updated and revised version that incorporates the findings from the above mentioned studies and subsequent revisions.

Chapter II: PROJECT DESCRIPTION

2.1 PROJECT LOCATION

KAHEP is located on the Kabeli River Basinin the eastern Nepal (Figure No. 2.1). The Kabeli River at the project site is designated as a natural border between the Panchthar and Taplejung districts. The project site is approximately 800 km east of Kathmandu, the capital city of Nepal.

Figure 2.1: Location Map of KAHEP

The weir of the project is located at the border of Amarpur VDC of Panchthar and Thechambu VDCs of Taplejung district. The approximate longitude and latitude of the proposed intake is $87^0$44'56"E and $27^0$16'40"N. The intake, desilting basin, tunnel alignment, surge shaft, penstock pipe, and powerhouse and tailrace canal of the project falls within the jurisdiction of Amarpur VDC in the Pachthar District (Figure 2.2).

The geographical grid assigned in the survey license for the project does not fall inside the boundary of any protected areas such as National Park, Wildlife Reserve, Hunting Reserve, Wildlife Sanctuary and conservation area.

2.2 PROJECT ACCESS

The access to the project area is through an all season 228 km long Mechi Highway connecting Charali at the East West national highway and Taplejung (Figure 2.3). The Mechi Highway starts from Charali, located 4 km east from Birtamod Bazaar in Jhapa District and reaches Kabeli Bazaar (202 km) north on the left bank of the Kabeli River after crossing Phikkal, Ilam, Ranke, Phidim and Gopetar. Apart from this road, seasonal air services are available from Biratnagar to Taplejung which is 26 km further north from the Kabeli Bazaar along the Mechi Highway.

The Headworks and powerhouse are the two major sites of KAHEP, which are to be connected by motorways for the transportation of construction materials. The existing community developed earthen track roads will be upgraded for access to headworks and powerhouse sites. The access road to the headworks starts at Chainage 50 km (Mechi Highway) whereas the road to the powerhouse starts at the Chainage 48+000 at Bhanuchowk bazar of Amarpur VDC at Mechi Highway.

Figure 2.2: Location of the Key Project Structures in relation to the Project Districts and VDCs

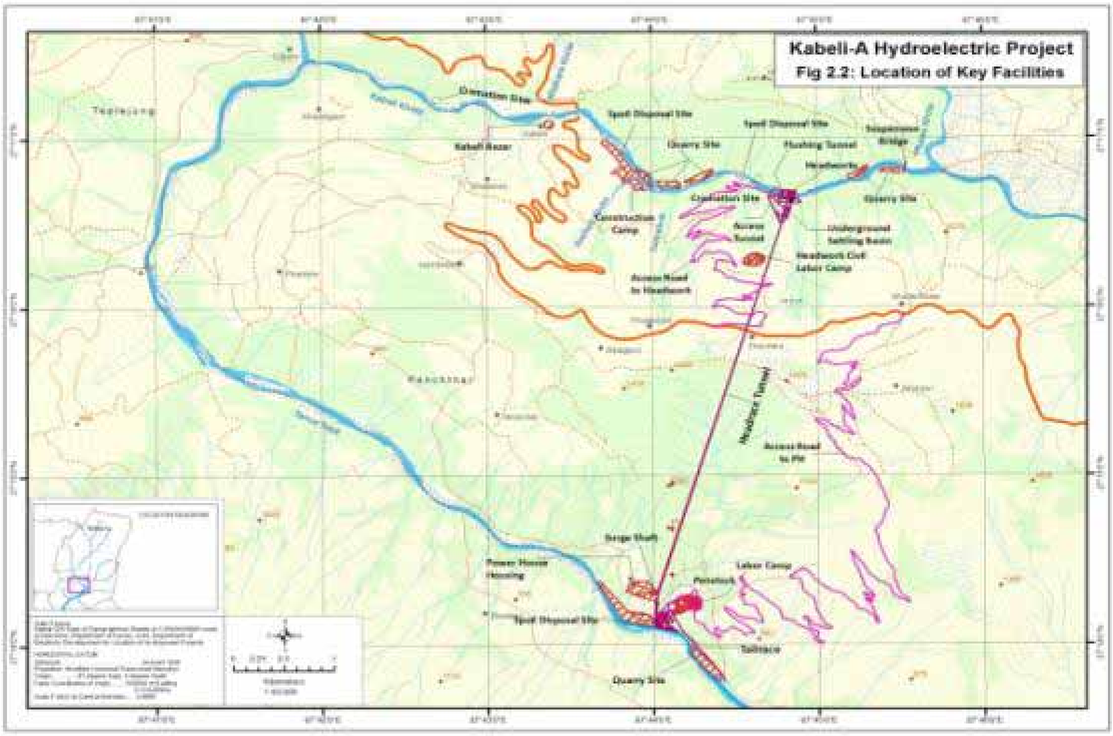
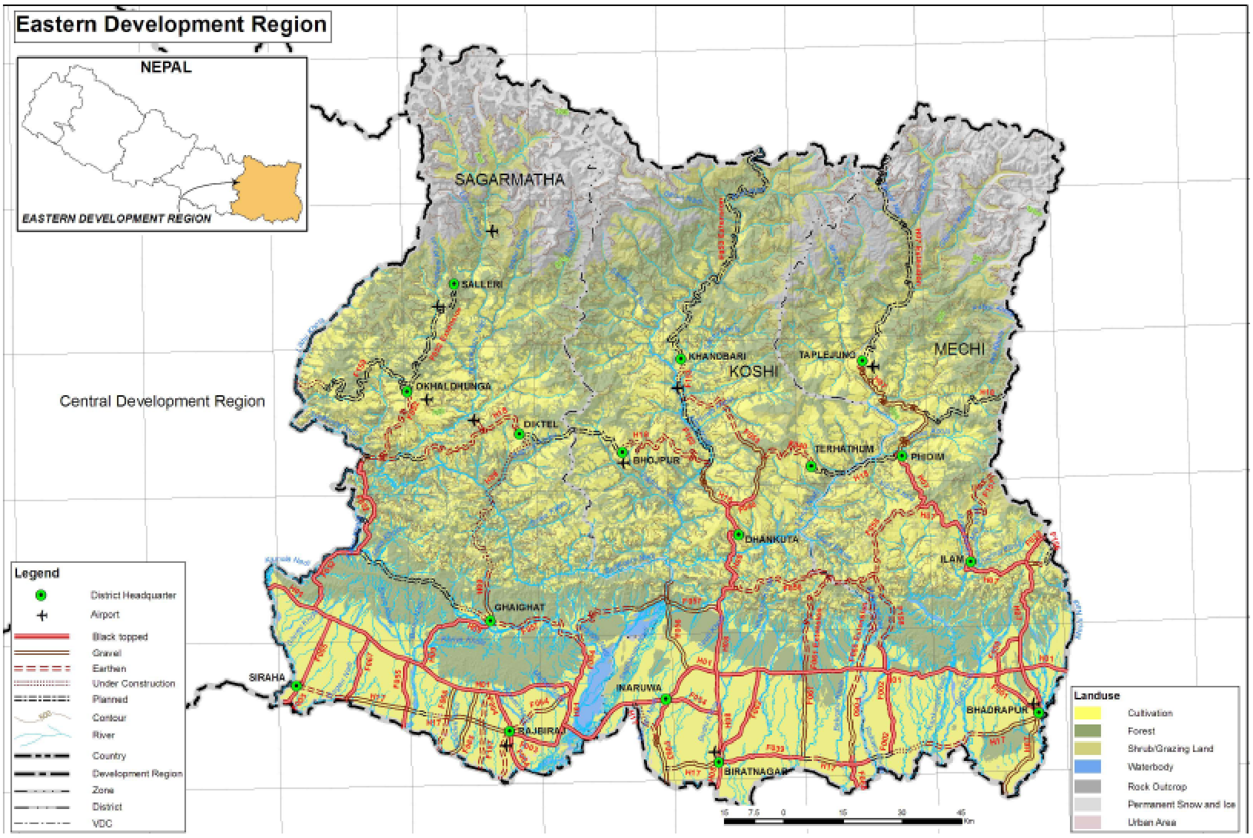


Figure 2.3: Road network linking the project area



2.3 SALIENT FEATURES OF THE PROJECT

The project is peaking run-of-river(PROR) type with a proposed installed capacity of 37.6 MW with a design discharge 37.73m^3/s. The diversion dam with provisions for ponding will be constructed at 2.5 km upstream of Kabeli Bazaar at Dhuseni village of Amarpur VDC on the left bank and Khudurke Ban of Thechambu VDC on the right bank. The intake on the left bank will feed the underground settling basin and is diverted to the Powerhouse located at Tamor River bank close to Pinase village through a 4.327 km long headrace tunnel. A semi-underground powerhouse will be constructed on the left bank of the Tamor River. The salient features of the project are presented in Table 2.1.

Table 2.1: Salient Features of KAHEP

SN	Items	Description
1.	**Project Name**	Kabeli-A Hydroelectric Project
2.	**Location**	Amarpur and Panchami VDCs of Panchthar District and Thechambu and Nangkholyang of Taplejung District
2.1	**Project Boundaries**	East 87° 45' 50" E West 87° 40' 55" E North 27° 17' 32" N South 27° 13' 41" N
3	**Type of Development**	Peaking Run-of-the-river (PROR)
4	**Hydrology at intake**	
	Catchment area	862.3 km^2
	100 year flood (Q_{100})	1860 m^3/s
	Probable maximum flood (Q_{1000})	2650m^3/s
	Mean monthly flow	61.4 m^3/s
	40 percentile flow	37.73 m^3/s
	Monsoon Design Discharge	40 m^3/s
5.	**Headworks**	
	Type/Length of weir/height	Barrage with 4 radial gates; 3 weir bays and one sluice bay
	Full supply level	575.3 m
	Peaking reservoir net live storage capacity	0.335 million m^3
	Crest elevation	561.5masl for barrage bays and 561.0 for sluice bay
	Gate Size	10 m Width * 9.0 m Height each
	Intake type	Tunnel intake on left bank
	Intake size at trash rack	2 nos. 5.4m Width * 5.8m Height
	Riparian/downstream Release	0.86 m^3/s (10% of average monthly minimum)
6.	**Diversion during construction**	
	Diversion flood (5 year dry season flow)	154 m^3/s
	Diversion tunnel	240m long; 4.8m diameter D-shaped tunnel
	Coffer Dams	80m at upstream side 90m long at downstream side
7.	**Approach Tunnel from Intake to Settling Basin**	
	Number	2 (1 each starting from either intake)
	Length	80.9 m
	Type	Inverted D shaped; Concrete lined
	Cross section	Internal Finished Diameter 3.2 m
8.	**Settling basin**	
	Type	Underground settling basin
	Number	2 basins with 2 hoppers in each
	Length of uniform section	76 m
	Total length including transition	113 m
	Width	15.8 m each
	Height	17 m
	Flushing system	S4 system
	Flushing tunnel length and size	150 m long; 2.25 m D-shaped tunnel with 1.75 m dia. MS pipe
9.	**Access tunnel**	
	Length	437 m
	Type	Inverted D shaped; shotcrete and rock bolt lined
	Cross section	Internal diameter 4 m
10.	**Waterways**	
10.1	**Covering Pair Tunnels from outlet of settling basin to start Headrace Tunnel**	
	Length	60.2 m

SN	Items	Description
	Type	Inverted D shaped; Concrete lined
	Cross section	Internal Finished Diameter 3.2 m
10.2	**Headrace Tunnel**	
	Length after pair tunnels	4327 m
	Type	Inverted D shaped; Shotcrete lined and Concrete lined
	Cross section	Internal Finished Diameter 5.65 m
10.3	**Surge Shaft**	
	Type	Underground and exposed to surface
	Internal diameter	10 m
	Height	51.7 m
10.4	**Penstock**	
	Material	Mild steel
	Length before bifurcation	223.3 m
	Length after bifurcation	27.2 m each
	Internal Diameter	3.55 m
	Shell Thickness	10-20 mm; partly ribbed
11	**Powerhouse**	
	Powerhouse type	Semi-underground
	Powerhouse size (L*B*H)	34.8 x 18.6 x 31.8 m
12	**Tailrace**	
	Design tailwater level	458.5 masl
	Length	93.1 m
	Cross-section	4.9 m wide * 4.65 m high Rectangular box culverts
	Longitudinal slope	1 in 1500
	100 year flood (Q100) in Tamor River	5800 m^3/s
	Probable maximum flood (Q1000) in Tamor River	8260 m^3/s
13.	**Turbine**	
	Turbine type	Vertical Axis Francis
	Number of units	2
	Rated speed	375 rpm
	Turbine Axis Level	457.64 masl
14.	**Power and energy output**	
	Gross head	116.8 m
	Rated net head	111.64 m
	Design discharge	37.73 m^3/s
	Installed capacity	37.6 MW
	Annual estimated energy per excluding 6% outage	201.0 GWh
	Firm energy excluding outage	149.4 GWh
	Secondary energy excluding outage	51.6 GWh
15.	**Transmission line (Not part of the project)-to be built by NEA**	
	Voltage	132 kV
	Length	83.74 km
16.	**Access road**	
	To headworks	7.4 km from Dhubichaur at Mechi highway
	To powerhouse	15 km from Bhanuchowk at Mechi Highway
17.	**Project Cost**	
	Total cost	70.84 Million US$
	Per kW cost	1884 US$
18.	**Financial analysis**	
	Net present value (NPV)	13.09 Million US$
	Simple payback period	6.9 years
	Return of interest (RoE)	15.38 %
	Internal rate of return (IRR)	12.71 %

Source: UFSR 2011 and Additional Report to UFSR 2011

2.4 PROJECT COMPONENTS

Figure 2.2 and Figure 2.4 present the general layout of the project and the location of the key project components. The section below briefly highlights the features of the different project components.

Figure 2.4: Project Layout in the Land Sat Imagery

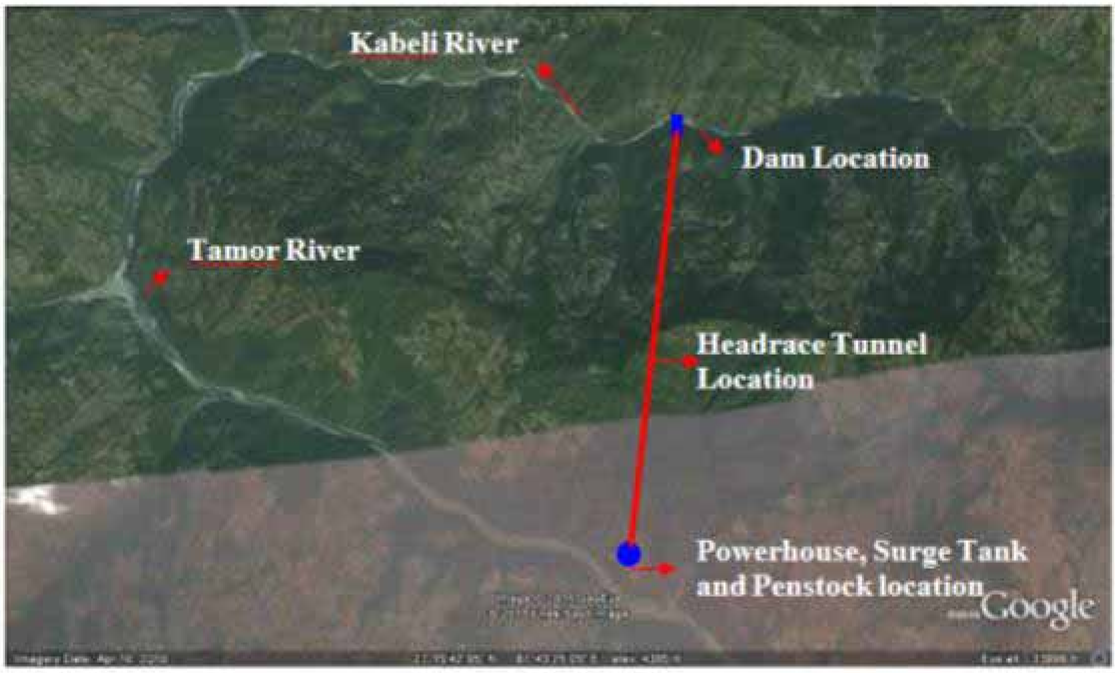
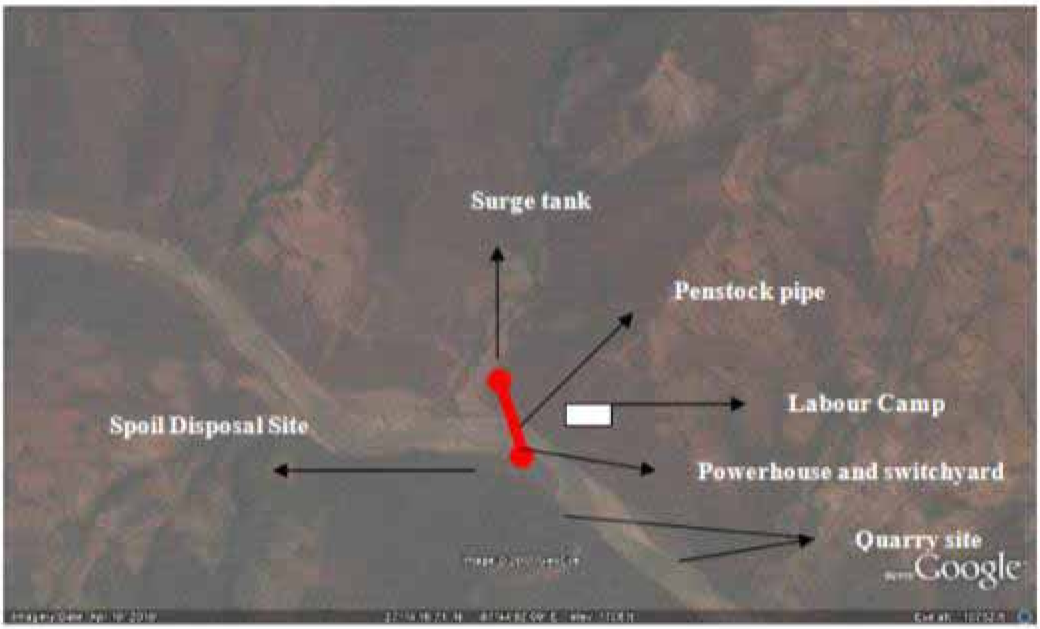


Figure 2.5 and Figure 2.6 present the location of the various project components and facilities in the land sat imagery maps.

Figure 2.5: Location of Key Facilities at Headworks

Figure 2.6: Locations of Key Facilities at Powerhouse



2.4.1 Headworks

(1) Barrage

The proposed barrage site is located at Amarpur VDC about 5.60 km upstream of its confluence with Tamor River. The dam will consist of a 14.30 m high and 60m long gated barrage with intake, settling basin and an underground settling basin on the left bank of Kabeli River near Dhuseni village, ward no.5, Amarpur VDC in Pachthar district while only the abutment of the barrage will be located on the right bank of the Kabeli River in ward no.6 of Thechambu VDC of Taplejung district.

(2) Head Pond

The barrage is so designed that it will not only divert the water of Kabeli but will also create a small pondage area for peaking power. At a full supply water level of 575.3 m the pondage area will cover a surface area of 10.60 ha. The length of the pond at the full supply level will be 1.385km with an average width of 78.44m. The height of the full supply level water will vary between 0 to 14.3m from the existing ground surface. At the minimum drawdown level at 570.5m, the pondage surface area will shrink to 6.92 ha and will extend about 1.37km upstream from the barrage with an average width of 62.89m 0 to 9.5m above from the existing ground level.

(3) Inlet Portal

Two side intakes will directly feed two approach tunnels. Two tunnel intakes have been designed to draw 120% of the design flow from the reservoir. The intakes are on the left bank of the river and will off take at a favorable orientation with respect to the barrage axis. The Intake sill has been kept well above the sluice floor to prevent the entry of bed loads even in extreme operating conditions. The trash rack opening is 5.4 m wide by 5.75 m high for each intake. The intake sill is at 564.7 masl and has a bell mouth opening to join a D-shaped approach tunnel of 3.2 m diameter. Each intake consists of one gate with one stop log. Two intakes can run independently and will feed two different settling basins through two approach canals. The approach canals following the intakes are 80.9 m long each up to the settling basin.

(4) Settling Basin

Two underground settling basins of length 76m, width 15.8m and height 17m are proposed. The approach canal from the Inlet portal will convey water to the settling basin. The minimum trapping efficiency of the settling basin is 90% and could remove sediment sizes of 0.2mm. The design parameters are: slope of the hopper floor 1 in 150; length of Inlet transition 20 m; slope of Inlet transition 1 in 20; angle of Inlet transition 20º and length of outlet transition 15 m.

An intermittent flushing system with 60 minutes time interval between two consecutive flushing cycles has been adopted to minimize water loss. As for the flushing system, the patented flushing system called S4 is proposed for use to enhance the efficiency of flushing. The proposed length of the flushing tunnel is 150 m and the diameter of the flushing conduit is 1.75m. For flushing system, two flushing hoppers in each basin of 1 m width and 1 in 150 bed slopes are proposed. The discharge of the flushing will be around 250 meters downstream from the dam.

2.4.2 Waterways

(1) Pair Tunnel

60.2 m long inverted D shaped pair tunnel with an internal finished diameter of 3.2m will convey water from the settling basin to the headrace tunnel.

(2) Headrace Tunnel

The length of the headrace tunnel after the pair tunnel is 4.327 km. The proposed headrace tunnel is an inverted D shaped concrete lined tunnel with an internal finished diameter of 5.65m.

(3) Access Tunnel for Settling Basin and Construction of Headrace Tunnel

The headrace tunnel excavation is proposed from the headworks and powerhouse side. From the powerhouse site the surge tank portal will be used for the construction of the headrace tunnel whereas at the headwork site, an access tunnel common to the settling basin during operation and headrace tunnel during construction will be used. The proposed access tunnels will be D-shaped and 4 m in diameter. The total length of the headwork side access tunnel is 437 m and the tunnel outlet adit portal is located on the downstream left bank of the barrage. The same tunnel also facilitates the construction of the headrace tunnel as it is required to construct the tunnel and the settling basin simultaneously. During the operation period, the access tunnel is used for access to the gate control chambers. Altogether there are three 5m by 5m gate control chambers above each gate.

2.4.3 Surge Shaft and Outlet Portal

The underground surge shaft is proposed at Pinase village of Amarpur VDC on the left bank of the Tamor River. The height and internal diameter of the proposed surge shaft will be 51.7 m and 10 m respectively. The topmost part of the surge shaft will be exposed to the ground. Outlet portal of the tunnel is proposed on a rock outcrop on the right bank slope of the Piple Khola. Some excavation is necessary to reach the level of the headrace tunnel. The outlet portal will house the initial portion of the penstock.

2.4.4 Penstock Pipe

A 223.3m long steel penstock pipe before bifurcation and 27.2 m after bifurcation is used to convey water from the surge tank to the powerhouse. A buried penstock will run along the ridge separating the

Tamor and the Piple Khola at Pinase. The internal diameter and the thickness of the penstock will be 3.55 m and 10-20 mm respectively.

2.4.5 Powerhouse

The semi-underground powerhouse will be constructed on the left bank of the Tamor River at Pinasi village of Amarpur VDC, just upstream of the confluence of Piple Khola with Tamor and on the bank of Piple Khola. It is a 34.8m long and 18.6m wide and 31.8 m high structure sufficient to house the turbine floor, generator floor, machine hall and service bay and control room and other utility spaces. The powerhouse contains two units of vertical axis Francis turbine and will be facilitated by the systems such as drainage and dewatering system, cooling water system, compressed air system, oil handling system, ventilation system, fire protection systems, elevator and land workshop equipment.

2.4.6 Draft Tube and Tailrace Canal

Draft tube with circular inlet and rectangular outlet has been proposed. Flap gates are provided at the end of the draft tubes to allow maintenance of the turbines and to protect the turbines and draft tube from grit entering from the tailrace side due to the backwater effect when the power plant is shutdown.

The tailrace channel is designed as a non-pressure ‘closed conduit channel’ flow. The tailrace channel would discharge water from the draft tubes into Piple Khola and later into Tamor River. The size of the proposed tailrace channel is 4.90 m wide, 4.65 m high and 93.10 m long. A bed slope of 1 in 1500 of the channel has been set to correspond to the normal depth line at full flow in the channel. The selection of invert level at the discharge point is based on the flood levels in the river.

2.4.7 Switchyard

The outdoor switchyard area is located close to the powerhouse. The switchyard covers 54.74 m x 34.43 m total area above the powerhouse at an elevation of 472.573 masl.

2.5 PROJECT SUPPORT FACILITIES

2.5.1 Access Roads

(1) Access Road to Headworks

The proposed access road alignment (Alternative II) to the headworks takes off from Dhubichaur (around 50 km from Phidim) of Mechi Highway passes along the hilly terrain with approximate length of 7.4 km including a numbers of bends. This is a community developed existing moterable earthen track along the edge of the forested area.This road will be upgraded before the initiation of works.

(2) Access Road to Powerhouse

The selected access road alternatives (Alternative II) to powerhouse is a community developed motorable earthen track that takes off from Bhanuchock (around 48 km from Phidim) of Mechi Highway with an estimated length of 15 km to the powerhouse at Pinasi. This road will be upgraded before the initiation of works.

2.5.2 Construction Power

For the construction power a 450 kVA, 425 kVA and 550 kVA disel generators will be stationed at powerhouse audit, tunnel intake audit and headwork area. The generator sets will be established and operated following best standard practices avoiding risks from electrical shocks, fuel leakages, and noise.

2.5.3 Employer's Camp, Contractor's Camp and Labor Camp

For the headworks area, one temporary contractor/labor camp site will be located at Rajabesi village near the headworks area of Amarpur VDC. Permanent security and operation housing will be established within the headwork occupied area towards the end of the construction phase.

The powerhouse area will have two camping facilities. One for the engineers which will be used during the construction and then become a permanent camping facility during the operation phase, while the other will be a temporary camping facility to be utilized by the contractors and labors during the construction phase only. The locations of the camp sites are presented in Photographs 2.1 and 2.2.

Camping facilities, both permanent and temporary, will be established prior to the start of actual construction works. The permanent and temporary camps for project engineers, contractor and laborers will have facilities such as adequate office and residential space with provisions of adequate ventilations, water supply, electricity, telecommunication, toilet/bathrooms, kitchens and space for recreations and grocery shops. The temporary camp facilities will be decommissioned at the end of the construction works. The areas occupied by camps will be rehabilitated to the original landscape and returned to the owners.

Photograph 2.1 : Location of Powerhouse, Switchyard and Labor Camp

Photograph 2.2 : Location of Labor Camp at Headworks

2.5.4 Quarry Site

The construction materials such as sand, aggregates and boulders required for the project will be sourced from the Tamor and Kabeli River's flood plains. For the headworks area, three locations (Photograph 2.3) have been identified along the Kabeli River. The total aggregate production capacity of the three sites is estimated to be 426,000 m3 with 164,700 m3 of boulders, 171,400m3 of cobbles and 25,000m^3 of sand sufficient to meet the headworks aggregate requirements.

For the powerhouse site, two sites have been identified at the Tamor River flood plain for construction aggregate. Of the two sites, the site located on the left bank of Tamor with a total aggregate production potential of 190,000 m^3 with 104,500m^3 of boulders, 57000 m^3 of cobbles and 28500m^3 of sand will be used. The site located on the right bank of the Tamor is an optional site proposed which will be used only if the tunnel spoil considered to be good for aggregate use does not meet the requirements of the aggregate as envisaged. Nearly 60% of the tunnel muck is considered to be good for the aggregate usage (KEL, 2011).

As the proposed quarry sites are river flood plain areas, trenching operation for material quarrying will be prohibited. These prohibitions will be included in bidding documents and contracts. Quarrying of aggregates will be carried out through striping operations such that the landscape after the quarry will be same as before, however, the land level will change. Besides, quarry operations will be conducted only up to the water level of river.

Photograph 2.3 : Location of Quarry Site at Powerhouse

2.5.5 Batching Plants, Aggregate Crushing Plants and Construction Material Storage

The facilities for aggregate crushing, storage of construction materials and batching plants will be located at the headwork and powerhouse site close to the active construction sites. These facilities will be operated with provisions of air pollution control, noise arrest facilities, and water and waste water management facilities. These will be temporary facilities to be demolished at the end of the construction period. The areas occupied by these facilities will be rehabilitated to the original land conditions and returned to the respective owners.

2.5.6 Spoil & Muck Disposal Area

The total amount of the excavation spoil from the barrage, settling basin, headrace tunnel, surge tank, powerhouse and tailrace tunnel is estimated to be 520,000m^3. Nearly 60% of the excavated material is envisaged to be used for aggregates. However, if all of the excavated material is found to be unsuitable, these have to be disposed safely. Disposal sites and contractor's disposal site plans will be approved by Supervising Engineers in recommendation of environmental specialist.

In the headwork site with a potential total muck of 270,000m^3, two sites have been identified on the flood plain area on the left bank of Kabeli. Similarly, for the powerhouse area, one site has been identified on the flood plain of the Tamor river little upstream of the proposed powerhouse site.

Spoil placement in these sites will be planned in such a way that, the fill surface and outward filling slopes will be protected from erosion by runoff and river flood by installing adequate drainage, toe protection against river erosion, and bioengineering measures as required. After the completion of spoil filling, upon the consent of the local communities these sites will be developed as sites for recreation or afforestation through proper landscaping.

2.6 CONSTRUCTION ASSOCIATED ACTIVITIES

2.6.1 River Diversion during Construction

Construction of the weir and side intake on the river will require keeping the working area dry during the construction period. As Kabeli River has high discharges (2000 to over 8000m^3/s) during the monsoon season, it will be uneconomical to construct a diversion structure during this season. The flow will be diverted during low flow season only and the construction job is to be completed in two shifts during the season. Initially a diversion tunnel was proposed for river diversion (UFSR 2011); however, later the concept has been changed and the river diversion will be a stage wise diversion and will be carried out in two stages. In the first stage of works, the construction will start from the right bank. The river will be allowed to flow in its natural path on the left bank. An upstream cofferdam will be built on the right bank to protect the construction area from flooding. In the second stage, upstream and downstream cofferdams will be built on the left bank of the river connecting with the stone masonry wall in the middle of the river, thus diverting the river flow through the right portion of the river. The Project has designed the diversion channel with a capacity of 300 m^3/s.

The Project has designed the cofferdams for 300 m^3/s flood which is near about 100 year dry season diversion flood (i.e. 311 m^3/s). The dry season has been taken from November to May constituting of seven months. The top of cofferdam will be 5 m wide with elevations of 566.5 masl for the upstream dam and 565.0 masl for the downstream dam.

The Contractor shall construct and maintain the diversion works in accordance with requirement stated in the drawing or as instructed by the Engineer. The Contractor will be made responsible for the design, construction, restoration, maintenance and repair of all the damages to diversion structures during the entire construction period.

The construction of barrage will be started after the construction of the diversion tunnel. Barrage construction is estimated to take two seasons. Similarly, the construction of the intake and settling basin can be continued in parallel with the barrage construction. Cofferdam and barrage foundation will be constructed during the dry season. Other construction activities will continue in monsoon also.

2.6.2 Civil Works

(1) Headworks Site Civil Work

a. Barrage, Intake and Sluice Bay

The barrage will have a low crest breast wall with 4 radial gates, 3 weir bays and 1 gate in the sluiceway structure. Each gate will be 10 m wide and 9 m high. Individual bays are separated by 2 m wide piers. The sluiceway bay is separated by a divide wall from the weir bays. The full reservoir level is at an elevation of 575.3 masl.

b. Settling Basin

The excavation of the settling basin will commence after the excavation of the approach tunnel, and will require 150 days to complete. The concrete works will be carried out in 2 phases. The erection and commissioning of all hydraulic structures will be completed in one and a half month. A flushing tunnel to the flush settling basin has been proposed. The 2.25 m diameter tunnel will be a D-shaped tunnel which is assumed to be excavated by using conventional drill and blast method.

c. Headrace Tunnel

Considering the size of the tunnel, the conventional drill and blast method will be employed. The design length of holes will be drilled over the face based on the design blasting pattern and charged with gelatin. Blasting will be done to break the solid rock into small pieces in the required tunnel area. Ventilation will be provided to remove gas and dust produced by blasting and to supply fresh air at the working face. The blasted material i.e. muck will be cleared by using trolleys or trailers. The excavated muck will be disposed in spoil tip area by trolleys. After mucking, the scaling process will be carried out in the newly blasted area. An engineering geologist will be involved to determine rock mass classification, support requirement to hold the rock in place and geological logging of the tunnel. During tunneling work, ventilation, lighting, compressors and dewatering pumps will be needed. The duration of tunneling is estimated assuming an average advance rate of 2.5 m per day per face. Accordingly, it will take about 30 months from each face to complete the tunnel excavation. After excavation, temporary support such as shotcrete and rock bolts will be provided immediately. Afterwards, permanent support will be provided depending on the rock mass quality. Spalling, umbrella grouting, reduction of pull length, water draining, etc. techniques will be applied in extremely poor to exceptionally poor rock class to avoid over breaks. Adit plug and bulkhead door will be placed upon completion of the permanent lining of the tunnel.

d. Surge Shaft

The surge shaft is 51.7 m high with 10 m diameter. It will be located near the outlet portal of the headrace tunnel and placed at a few meters offset from headrace tunnel. The excavation of the surge shaft will be carried out from both the top and bottom as the upper portion is exposed to the surface. It is envisaged that a pilot tunnel will be constructed first and then the shaft will be expanded to the required diameter. Shotcrete and grouted rock bolts in pattern will be provided after excavation.

e. Penstock Alignment and Supports

A steel penstock pipe of 3.55 m internal diameter and 223.3 m length will be laid inside the anchor block and thrust blocks and about 27.2 m length of bifurcation. Altogether 3 anchor blocks and 3 thrust blocks will be constructed for the buried penstock support. The steel penstock pipe will be welded in sections and cast into the anchor block.

(2) Powerhouse Civil Work

a. Powerhouse

The construction of the semi-surface powerhouse comprises of civil and electromechanical works. This section will briefly discuss the construction activities on the civil parts only. Electromechanical part will be briefed in section 2.6.2 (3).The main civil works in the powerhouse consists of excavation and concreting works. Excavators, loaders and dump trucks will be used for excavation of the surface powerhouse. The substructure or the first stage concrete will be placed before the erection of the Francis turbine units. The erection of the units will follow one after the other for efficient use of human resources and to save erection time. The size and position of columns, beams and roofs are designed such that there will be enough space for the installation and movement of the powerhouse crane. The remaining part of the structure can then be completed with the use of the main crane. As soon as the finishing works are completed, the erection of the auxiliary equipment will be started and then, the second stage structural concrete will be cast. Concreting work will be completed in 8 months.

b. Tailrace

The major work in the tailrace includes excavation and concreting. The total length of the tailrace canal is 93.1 m. The excavation quantity of the tailrace is about 1800 m^3. The excavation and the concreting are estimated to take 4 months.

c. Switchyard

The outdoor switchyard is located close to the powerhouse. The switchyard covers an area of 55 m x 35 m above the powerhouse at an elevation of 472.6 masl. The civil works for the switchyard will be completed in 5 months.

(3) Electromechanical Equipment

The construction activities of the electromechanical works will involve design and manufacturing of the auxiliaries by the supplier at the factory. The supplier will be responsible for the erection, installation and commissioning at the project site. The successful bidder/s will take 12 months for design, fabrication and delivery of the equipment. After completion of the necessary foundation works, the erection of the electromechanical equipment like turbines, generators, transformers and auxiliaries will commence. The erection of electromechanical equipment will take about 6 weeks.

(4) Transmission line

Transmission system for evacuation of the power from the Kabeli A Project is to be built under a separated project – the Kabeli Corridor 132 kV Transmission Line, which is a separate project under implementation with financing from IDA, along with the power expected to be generated by other small generation projects that are being developed by IPPs in the Kabeli Corridor. The 132 kV transmission line will extend from north of Panchthar District, to Damak in the south, in Jhapa District. Substations will be built in the vicinity of Kabeli Bazaar (a village on the Kabeli River) and at the towns Phidim, Ilam and Damak. At present, a few small generating plants with an aggregate capacity of about 10 MW distribute their output locally through a low voltage network. Contract for supply and installation was signed and the contractor is conducting detailed check survey – checking the route / Right-of-Way of the transmission line. Nepal electricity Authority (NEA) is responsible for project implementation, including the implementation of the EMP prepared in line with the World Bank Safeguard Policies.

2.6.3 Construction Traffic

Two types of vehicular traffic are expected in the area: one that brings construction materials from the south via the Mechi Highway (*Rajmarga*) while the other facilitates day to day construction works confined to the construction site vicinity. The former traffic comprising heavy vehicles with high pay loads are mostly slow moving ones. It is expected that the traffic flow of the first category will not exceed 30 to 35 vehicles in a day during the construction period in the Mechi Highway corridor. The latter traffic confined to the active construction sites which comprises of both light and heavy vehicles is expected to exceed 100 units. This traffic is also expected to frequently pass through the Mechi Highway and might cause problems to the traffic conditions of the Highway.

For the transportation of the fuels (diesel and other petroleum products) required for the project, the contractor will make special arrangements with the Nepal Oil Corporation, only authorized institution of the government of Nepal, to deal on the fuel handling and trade in Nepal. The proponent will assist the contractor for such arrangements. The Nepal Oil Corporation fuel transport and delivery vehicles will deliver the fuel up to the storage yards of the project site.

Explosives transport, delivery, and handling is totally regulated and controlled by the Government of Nepal under the Explosive Act, 1961. The security during transport and even in the storage yard and in the active construction site is provided by the government of Nepal, however, arrangements for transport vehicle, permanent storage yard and temporary storage yard is the responsibility of the developer and the contractor.

2.7 PROJECT REQUIREMENTS

2.7.1 Construction Materials

The main construction materials required are blasting materials and detonators, cement, brick or concrete blocks, steel pipe and angles, stone/boulders, gabion, geo-textiles, reinforcement bars and timber, fuels, coarse and fine aggregate, cohesive materials and admixtures, backfill and rock fill materials, rock bolts, mechanical and electrical items such as conductor wires.

Cement, reinforcement and steel use in the project are estimated to be about 40,000, 4,000 and 500 MT, respectively (UFSR, 2011). The purchase of these materials should be done on a bulk basis. Fine aggregates will be obtained from the nearby quarries at the headworks and powerhouse whereas coarse aggregates will be processed from the nearby respective sites at the headworks and powerhouse. The materials for backfill and rock fill will also be processed from the excavated materials and tunnel muck. The protection at Piple Khola and powerhouse will utilize the muck from the excavated material of the tunnel. The boulder will be directly selected from the river/river side (bagar).

2.7.2 Land Requirement

A total of 47.72ha of land will be required for the project. Of the total, 22.51ha is permanent land while 25.21 ha will be used temporarily (Table 2.2). In terms of land use, 61.10% is the riverine area including river beds, river flood plains and elevated banks. Other land requirement include agricultural land estimated to be 35.60% followed by 3.30% of the forest land including community forests, private forests and leasehold forests of the total project land area. Of the land use types, only 7.678 ha of agricultural land and 1.57 ha of forest land will be required permanently. The rest of the permanent land (13.26 ha) required is the riverine area.

Table 2.2: Land Requirements for Various Project Structures and Facilities

SN	Name of Project Structure and Facilities	Land Required (Hectare)						
		Permanent	Temporary	Total	Land Use			
					Agriculture	Forest	River	Total
A.	**Project Structures**							
A.1	Reservoir	9.973		9.973	0.293	0.57	9.11	9.973
A.2	Barrage, Operating Platform, Intake	3.654		3.654	0.954	0.03	2.67	3.654
A.3	Sensor Building	0.01		0.01			0.01	0.01
A.4	Powerhouse and Switchyard	3.922		3.922	2.182	0.27	1.47	3.922
A.5 A.6	Penstock Pipe and Surge Shaft	0.70		0.70		0.70		0.70
Sub- total (A)		***18.259***	***0***	***18.259***	***3.429***	***1.57***	***13.26***	***18.259***
B	**Project Facilities**							
B.1	Access Road to Headwork and Powerhouse	0		0	0	0		0

SN	Name of Project Structure and Facilities	Land Required (Hectare)						
		Permanent	Temporary	Total	Land Use			
					Agriculture	Forest	River	Total
B.2	Quarry Site (Headworks)		3.50	3.50			3.50	3.50
B.3	Quarry Site (Powerhouse)		4.31	4.31	1.01		3.30	4.31
B.4	Spoil/Muck Disposal (Headworks)		4.60	4.60			4.60	4.60
B.5	Spoil/muck Disposal (Powerhouse)		4.50	4.50			4.50	4.50
B.6	Construction Camp (Headworks)	0.709	2.20	2.909	2.909			2.909
B.7	Construction Camp (Powerhouse)		3.70	3.70	3.70			3.70
B.8	Engineer's Camp (Powerhouse)	3.54		3.54	3.54			3.54
B.9	Aggregate Crushing, Storage and Batching Plant etc (Headworks)		1.00	1.00	1.00			1.00
B.10	Aggregate Crushing, Storage and Batching Plant etc.(Powerhouse)		1.40	1.40	1.40			1.40
Sub-total (B)		***4.249***	***25.21***	***29.459***	***13.559***	***0***	***15.90***	***29.459***
Grand Total (A+B)		**22.508**	**25.21**	**47.718**	**16.988**	**1.57**	**29.16**	**47.718**
Percentage		47.17	52.83	100	35.60	3.30	61.10	100

Source: Field Survey 2010

2.7.3 Human Resources Requirement

Following assumptions were made in the estimates of human resource requirement:

- Project construction period of about four years and
- Wok operation by eight separate workforce team in different locations

A reasonable estimate based on the consultant's experience in Middle Marsyangdi Hydroelectric Project for skilled, semi skilled and unskilled human resources for a project of this size is about 600 to 800 person per day during the peak construction period.

2.8 IMPLEMENTATION SCHEDULE

An estimated total of four years is envisaged for the construction of the KAHEP. A tentative construction schedule is presented in Table 2.3.

Table 2.3: Implementation Schedule of KAHEP

SN	Construction Activities	Years															
		1				2				3				4			
		1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr
1.	Pre-construction works (access roads improvement and contractual																

SN	Construction Activities	Years															
		1				2				3				4			
		1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr
	works																
2.	Construction mobilization																
3.	Diversion facilities																
4.	Weir and barrage																
5.	Intake structure and settling basin																
6.	River Training works at headworks																
7.	Tunnel and surge shaft																
8.	Powerhouse and tailrace																
9.	Hydro mechanical parts																
10.	E & M equipment																
11.	Switchyard																
12.	Testing and commissioning																

Source: UFSR 2011

2.9 Project Operation Modality

The proposed project is a PROR Project. A typical ROR project generates energy at a reduced capacity during the whole day, whereas a PROR project can be designed to operate at full (installed) capacity for a specified number of hours. Considering the available river flow and the riperian water release, this project is designed for two slot peaking mode of two hours in the morning and four hours in the evening peaking hours with a reduced capacity. A detailed calculation showing the results for a two slot operation is shown in Annex 2.1, 2.2 and 2.3and presents the calculations for two hour peaking and four hour peaking separately i.e 6 AM- 8 AM in the morning and 6 PM -10 PM in the evening. Table 2.4presents the available mean monthly flow, flow that will be diverted for electricity generation and flow released in the Kabeli River downstream barrage for the different months.

Table 2.4: Flow Regulation of the Kabeli River during Operation of the Project

Months	Mean monthly flow available m^3/s	Flow diverted for energy generation m^3/s	Flow released from Barrage m^3/s (at least 10% of annual monthly minimum)[7]	Flow released from tailrace m^3/s
January	10.31	9.45	0.86	37.73 for 5.8 hours a day
February	8.63	7.76	0.87	37.73 for 4.7 hours a day
March	8.88	8.01	0.87	37.73 for 4.6 hours a day
April	13.30	12.44	0.86	37.73 for 7 hours a day
May	31.63	30.77	0.86	37.73 for 16 hours a day
June	86.28	40.00	46.28	40.00 for 24 hours a day
July	168.95	40.00	128.95	40.00 for 24 hours a day
August	181.71	40.00	141.71	40.00 for 24 hours a day
September	127.42	40.00	87.42	40.00 for 24 hours a day
October	58.11	37.73	20.38	37.73 for 24 hours a day
November	25.25	24.39	0.86	37.73 for 13.4 hours a day
December	16.18	15.32	0.86	37.73 for 8.1 hours a day

Source: UFSR 2011

2.10 Project Costs

Estimated construction cost of the project is about 70.84Million US$ (UFSR, 2011)

[7]Including environmental flow. See Chapter VI.

Chapter III: LEGISLATIVE AND REGULATORY CONSIDERATIONS

This Chapter reviews the Policies, Procedures, Guidelines and Legislative provisions of the Government of Nepal, the World Bank and the IFC that have a direct relevance with the proposed project development and operations.

3.1 PLANS, POLICIES AND STRATEGY OF GOVERNMENT OF NEPAL

3.1.1 Interim Constitution of Nepal, 2007

The Interim Constitution of Nepal, 2006 (2063 B.S.) has given high priority to the protection and conservation of natural resources and the environment as one of its principles. While recognizing the importance of the natural resources, it has emphasized the utilization of the resources in a sustainable manner for the national development through judicious management and protection of the natural resources. In other words, the Interim Constitution envisages the sustainalble utilization of natural resources for the national development by the judicious management of the available resources. The proposed project, thus does not contradict the tenets of the Interim Constituion of Nepal.

3.1.2 Thirteenth Three Year Plan, 2013-2016

The Approach/perspective paper of thirteenth three year plan document has been built on the basis of previous achievements in the six decade of Nepal's efforts on planned development. Some of the past plans had been implemented with poverty alleviation as the principal objective. The past experiences show that the objective of poverty alleviation might not be achieved even if the overall economic indicators remain positive. Based on this reality, past achievements and commitment towards Millennium Development Goals (MGD); the approach/perspective paper of thirteenth Plan has given emphasis on the sustainable economic growth and social and environmental justice to achieve its long term goal of transforming Nepal from the list of world's least developed country to developing country within 2022.

The approach/perspective paper has mentioned the promotion and development of hydroelectricity and alternative energy as the important priority sector to achieve the objectives, mission and goal of this plan. The plan emphasizes to encourage domestic and foreign investment for the development of hydroelectricity by adopting clear, simple and transparent procedures to increase the participation of the private sector, the community and the local bodies in production, consumption and export of hydroelectricity. The KAHEP Project complies with the policy principles of this approach/ perspective paper of the thirteenth three years plan.

3.1.3 Hydropower Development Policy, 2001

The main objective of the policy includes inter alia producing clean energy through the development of hydroelectric projects, and to help conserve the environment. One of the policy objectives stipulates to extend the use of electricity for the utility minimization of fuel wood and to render necessary assistance in the conservation of forests and the environment. Overall, the policy goal is to develop environmental friendly hydropower to meet the country's energy needs and to encourage the private sector to investment in the hydropower.

The policy has a provision to make public the programs and measures identified by the EIA study for implementation to the local people. The policy further states that all developers to release at least ten percent of minimum monthly average discharges below the water diversion structure for all types of water resource projects. The private parties developing hydropower projects are encouraged to acquire the private land and property required for the project at their own costs. If the lands and houses are not available, the government ensures to acquire such property to the private developers according to the prevailing laws. However, private developers will have to bear all the expenditures incurred towards such acquisitions, and resettlement and rehabilitation of the affected people. The government lands shall be made available to the private developers on lease basis or according to the prevailing laws.

For the development of the directly affected VDCs, the policy has made a provision to allocate one percent of the royalty obtained from the hydropower projects.

Environmental provision of the policy requires “to release such quantum of water which is higher of either at least ten per cent of the minimum monthly average discharge of the river/stream or the minimum required quantum as identified in the environmental impact assessment study report”.

3.1.4 National Forest Policy, 1998 (Revised 2000)

The revised National Forest Policy (2000) emphasizes the protection of soil, water, flora and fauna constituting the main element of forestry to sustain biodiversity. It recognizes that sustainable forests management is only possible when it gives adequate attention towards meeting the basic needs of the people, sustainable utilization of forest resources, participation in decision making and sharing of benefits and above all on socio-economic growth.

The Forest Policy does not specifically mention environmental policy strategies with regard to other development programs which might intervene in the forested areas, however, the other policy strategies related to forest management and forestry program implementation emphasize the need of land use planning, prioritisation for the conservation of biodiversity, ecosystem, and genetic resources, effective production and utilization of forest resources and blending forestry management, biodiversity conservation and community development activities in a holistic sense.

3.1.5 Nepal Biodiversity Strategy, 2002

The Nepal biodiversity strategy, adopted by GoN in August 2002, specifies the implementation of EIA process in accordance with the provisions of EPA 1997 and EPR 1997 to assess the impacts of development activities on biodiversity. The strategy has given emphasis on ensuring effective implementation of the existing laws regarding EIA.

The National Biodiversity Strategy plan describes the protection and wise use of the biologically diverse resources of the country, the protection of ecological processes and systems, and the equitable sharing of all ensuing benefits on a sustainable basis for the benefit of the people and to honour obligations under the Convention on Biological Diversity. Biological diversity in Nepal is closely linked to the livelihoods and economic development of most of her people, and relates to agricultural productivity and sustainability, human health and nutrition, indigenous knowledge, gender equality, building materials, water resources, and the aesthetic and cultural well being of the society.

3.1.6 National Water Strategy (2002) and National Water Plan (2005)

Integrated Water Resource Management has been adopted as one of the principle themes of the National Water Strategy. It professes that water must be viewed from a holistic perspective, both in its natural state and in balancing the competing demands on it, e.g. domestic, agriculture, hydropower, industrial, cultural and environmental. The National Water Strategy has set forth 10 strategic outputs for short, mid and long term for the overall development of water resources. The Nepal Water Plan is built around these strategic outputs of the National Water Resources Strategy.

The strategic output under the Environmental Action Plans on Management of Watershed and Aquatic Ecosystem has set short term, medium term and long term targets. The major action programs on this sub-sector are:

- Improve environmental database system;
- Map important, critical and priority watersheds and aquatic ecosystem;
- Develop and implement water and watershed quality and standards and regulations
- Implement water conservation education programs;
- Implement nationally important watershed and aquatic ecosystem protection, rehabilitation and management programs;
- Develop strategic environmental assessment in water resource management;
- Ensure compliance of EIA;
- Promote community participation in the management of watersheds and aquatic ecosystems;
- Enhance institutional capacity and coordination and
- Develop a watershed management policy

Under the strategic output of hydropower, the plan emphasises on programs on planning and implementation of new hydropower projects and calls for strengthening and capacity building of local level institutions in planning and project implementation.

3.2 ACTS AND RULES/REGULATIONS

3.2.1 Environment Protection Act 1997, Environment Protection Rules, 1997 & as amended (1999, 2007, 2009 and 2010)

Nepal has enacted a comprehensive and overarching environmental act, the Environment Protection Act (EPA) 1997, followed by Environmental Protection Rules 1997 and as amended (1999, 2007, 2009 & 2010) which are now enforced through appropriate regulatory measures.

Section 3 of the Act requires the proponent to conduct an IEE and EIA in relation to the prescribed proposals. The word "proposal" means any development work in relation to IEE/EIA. "Proponent" includes any person or government, quasi-governmental or non-governmental agency or organisation submitting an application for the approval of a proposal and possessing the responsibility to work according to such a proposal or implementing the proposal. Section 4 of the Act prohibits implementation of development proposals without prior approval of the concerned agencies or Ministry of Science, Technology and Environment (MoSTE) as specified by the Act. Section 5 of the Act provides that all IEE/EIA of the development proposals should be presented to the concerned agencies for approval. Under Sections 6 of the Act, the relevant agency is empowered to grant approval for the IEE/EIA report as per the provisions of the Act. MoSTE or the concerned ministry is empowered to set up a committee to provide opinions on IEEs/EIAs received by it. When granting approval to any proposal, MoSTE or concerned ministry is required to take into account public comments received on the IEE/EIA report and the opinion of the committee set up, if any.

Under section 7 of the Act, industries or any other development project owners 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 a manner which is likely to have significant adverse impacts on the environment or to harm human life or public health. Further, the section stipulates that causing pollution or allowing such pollution to be deemed a punishable act.

Section 10 of the Act prohibits any activity without the approval in the environmentally protected areas declared by GoN. 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 organisation that suffers any loss or damage, may, if she/he desires, have compensation recovered from the person, institution or proponent doing such an act. An application must be made to the prescribed authority, Chief District Officer (CDO) stating the details therein. 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.

The proposals requiring IEE/EIA studies are broadly listed in Schedule 1 and Schedule 2 under Rule 3 of the EPR enforced under the provisions of EPA. As per the Rule 4, proposals requiring EIA will have to prepare a scoping document incorporating the public concerns and apply to MoSTE through concerned agencies. In this process a 15 days public notice in the national newspaper requesting suggestions and comments on environmental issues arising due to the proposal implementation has to be published. The MoSTE is empowered to review the document and give approval with or without needed amendments.

As per Rule 5, the proponent of both IEE and EIA proposals has to prepare Terms of Reference (ToR) of the proposal for approval. In the case of IEE, ToR is approved by the concerned agency whereas MoSTE will give ToR approvals for proposals requiring EIA. Rule 6 stipulates that if the review of the IEE proposals identifies the proposal to require an EIA, it will have to comply with all the provisions of EIA.

Rule 7 of EPR requires the IEE proposal proponents to publish a 15 days public notifications in the national daily and present the notification to the public institutions of the affected area for comments and suggestion on IEE proposals during the study phase while the proponents of the EIA proposal have to organise a public hearing in the project affected area to collect public concerns and suggestions.

Rule 10 of EPR stipulates that all the proposals submitted for approval will have to take letter of recommendations from the concerned and affected VDCs and municipalities on the proposals. However, the rule is silent on the status of the IEE/EIA if it is approved contrary to the public and the affected VDCs and municipality opinions. However, the Ministry can only grant its approval to implement the proposal if it does not cause significant adverse effects on the environment under Rule 11.

Rule 12 of EPR stipulates that the proponent is obliged to follow the terms of conditions set by concerned agencies or the MoSTE in the approval letter during project implementation and operation. Rule 13 provides that the concerned agency to be responsible for the project monitoring.

Rule 14 provides that the MoSTE to be responsible for environmental audit after two years of project implementation.

3.2.2 Electricity Act, 1992 and Electricity Regulation, 1993

Under section 4, sub-section 1 of the Act requires any person or corporate body who wants to conduct survey, generate, transmit or distribute 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 as per EPA and EPR. The proponent will have to show in the EIA report that the proposed development project is not likely to cause soil erosion, flood, landslide and air pollution or any other forms of environmental degradation. Electricity Regulation, 1993, under rule 12(f) and 13(g) related to EIA, emphasizes that the EIA report should include measures to be taken to minimize the adverse effects of the project on social, biological and physical environments, and should also elaborate utilisation of local labour, source of materials, benefits to the local people after the completion of the project, training to the local people in relation to construction, maintenance and operation, facilities required for construction site, and safety arrangements.

3.2.3 Water Resource Act, 1992 and Water Resource Regulations, 1993

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 keeping water resources free from pollution. 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 an EIA report before a license can be granted. 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.

Under the Water Resource Regulation, it is mandatory under Rule 17(e) of the regulation that any person or corporate body, who desires to obtain a license for utilisation of water resources must state in the 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 labour should be utilised and the local people should get benefits after the completion of the project. The regulation also emphasises on providing training on construction, maintenance and operation of the project to the local people. 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 detailed information about the project to the people. If any person finds that the construction and operation of the concerned project is likely to cause adverse effects, he or she may furnish his/her reaction stating the reasons within thirty-five days from the date of publication of the notice. If the committee is satisfied with the reasons and justification given by the people, the proponent will be asked to revise the plan.

3.2.4 Soil and Watershed Conservation Act, 1982

The mismanagement of watersheds leads to the degradation of valuable land by flooding, water-logging, and accelerated silt 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 (formerly HMG) to declare any area a protected watershed area. Section 4 mentions 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 programmes, and
- Regulate agricultural practices pertinent to soil and watershed conservation.

Under Section 10 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, boulders and soil, discharge solid waste, and establish industry or residential areas within any protected watershed area. SWCA outlines the essential parameters necessary for proper watershed management (including both rivers and lakes). The Act is applicable only to protected watersheds and Kabeli watershed is not protected under this act

3.2.5 Aquatic Animal Protection Act, 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 materials 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 a surveillance system for conserving aquatic life. Under Section 4, the government is empowered to prohibit catching, killing and harming certain kinds of aquatic animals by notification in the Nepal Gazette. However, the government has never published any notice under this Section.

Aquatic Animal Protection Act, 1961 and First Amendment, 1998 (AAPA) promulgated for protecting aquatic animals in natural water bodies like rivers, reservoirs and lakes has remained virtually defunct due to lack of related bylaws/regulations. Its first amendment in 1998 Section 5a states the use of safe pesticides use for catching aquatic life. Section 4a, 4b and 5 empower the government to prohibit catching, killing and harming certain kinds of aquatic animals in different scenarios. Section 5b requires building fish ladder so that the movement of aquatic animals is not affected. Where fish ladder is not possible, the act suggest hatchery and nursery in such place or in an area in vicinity thereof for the purpose of having artificial breeding of aquatic animals.The Act stipulates a provision of minimum 5% of yearly minimum flow as environmental flow for water diversion points

3.2.6 Forest Act, 1993 and Forest Regulation, 1995

Forest Act, 1993 and Forest Regulation (1995), recognizes the importance of forests in maintaining a healthy environment. The Forest Act requires decision makers to take account of all forest values, including environment services and biodiversity, not just the production of timber and other commodities. The basis of the Act’s approach to forest and forest products is “resource oriented” rather than “use oriented”. Section 49 of the Act prohibits reclaiming lands, setting fires, grazing, removing or damaging forest products, felling trees or plants, wildlife hunting and extracting boulders, sand and soil from the National forest without 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 (Section 65).

3.2.7 Land Acquisition Act, 1977

Land Acquisition Act 2034 (1977) & Amendment, 2049, is the main legislation to guide the involuntary acquisition of land in the country. The Government can acquire land at any place in any quantity by giving the compensation pursuant to the Act for the land required for any public purpose or for the operation of any development project initiated by the government or government authorized institution (Sections 3 and 4). The provisions of this Act are not complementary to the best practice of resettlment and rehabilitation policies currently in practice of the funding agencies. The affected population of the development projects have a limited role in the decision making of land compensation. The Act does not have provisions of rehabilitation measures to the affected parties and all decision powers rest on the Compensation Fixation Committee, a body comprising mostly of government officials under the Act provisions.

3.2.8 Land Reform Act, 1964

The Land Reform Act has set a ceiling on the landholding for individual or households. Land holding above the prescribed ceiling could be confiscated as per the provisions of the Act. However, with the permission of the authorised government officials, landholding ceiling could be increased for the organisations as per the requirement of the organisational works.

3.2.9 Local Self-Governance Act (1998) and Regulations, 1999

The Local Self Governance Act (1998) and Regulation (1999) provides more autonomy to District Development Committees, Municipalities and VDCs. Section 25 of the Act outlines the functions, rights and duties of the Ward Committee. Section 25(e) of the Act requires the ward to help for protection of the environment through plantation over bare land, cliff and mountains. Section 28 has mentioned the functions, rights, and duties of VDCs. The VDCs are required to protect the environment, nature and natural resources. Section 55 empowers VDCs to levy taxes on utilization of natural resources. Section 68 lists the property of the VDC, which includes natural resources. Apparently, natural resources include mineral, land, forest and water resources and thus, VDCs have an absolute authority over the natural resources by the regulation provisions. However, due to conflicting provisions of the other sectoral acts and regulations, the provisions enshrined in the Local Self Governance Act and Regulations are apparently null and void.

3.2.10 National Parks and Wildlife Conservation Act, 1973

The conservation of ecologically valuable areas and indigenous wildlife is provided by the National Parks and Wildlife Conservation Act (NPWCA). In Nepal, all wildlife species within National Parks are protected from exploitation through the National Parks and Wildlife Protection Act, 1973. In Section 9, 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 even outside the national park boundaries.Since the project area lies outside the National Parks, Wildlife Reserves and Conservation Areas, the Act provisions are not applicable to the project.

Rule 30 of the Mountain National Parks Regulations (1979) stipulates that permission from the Government of Nepal, Ministry of Forests and Soil Conservation must be obtained in case of any plan to be implemented within a mountain national park.

3.2.11 Labour Act, 991

The Labour Act mandates the employer to give priority to the Nepalese citizen while employing personnel and workers in a company. After a year of service, the company or employer has to employ the workers permanently with broadly defined position, roles and responsibilities and the pay scale. But an employee under contract for short duration of time will not entitled for permanent employment. The employer could terminate the employee with prior approval of the Department of Labour and prior notice to the employee as defined by the law. The Labour Act prohibits the employment of children or under-aged persons. The employer could not force the workers to work for long hours other than defined by the law. The employer has the responsibility to ensure healthy environmental conditions of the workplace as defined by the law.

3.2.12 Explosive Act, 1961 as amended 1974 and 1991

The Act defines the explosive matters and reserves the right to the government to define the explosive as per the requirement by publication of a notice. Without holding the license from the government authorised person, individuals/institutions are prohibited to manufacture, use, sell, transport or import/export explosives defined by the government. The licensee has the obligation to report in case of accidents while manufacturing, using, selling, storing, and transporting of the explosive. Those not complying with the provisions are treated as offenders of the law and are punishable as per the law provisions.

3.3 GUIDELINES

3.3.1 National Environmental Impact Assessment Guidelines, 1993

To address environmental impact assessment as envisaged by the National Conservation Strategy (NCS) 1987, National Environmental Impact Assessment (EIA) Guidelines were endorsed by the Government of Nepal on 27 September 1992 and gazetted on 19 July in 1993, Volume 43, Number 5. The guideline provides criteria for project screening and initial environmental examination (IEE). This includes scoping, preparation of ToR 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.

Many of the guideline provisions are now included in the EPA, 1997, and EPR, 1997. EIA in Nepal has now become legally mandatory. However, as the National Environmental Guidelines, 1993 have not been issued under the Environmental Protection Act (1997); they do not have any legal force. It is a policy guideline issued by the Government that is still followed in matters which are not covered by the EPA (1997) and EPR (1997).

3.3.2 EIA Guidelines for Forestry Sector, 1995

The EIA guidelines for the forestry sector aim to facilitate the sustainable use of forest resources for socio-economic development and to meet the basic needs of the communities for forest products. 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.

3.3.3 Department of Electricity Development Manuals

The Department of Electricity Development (DoED), Government of Nepal, in collaboration with the United States Agency for International Development and International Resource Group has developed a series of manuals for the conduction and preparation of EIA and IEE documents in the power and transmission line development sector. Important manuals developed are:

- Manual for Preparing Terms of References (ToR) for Environmental Impact Assessment (EIA) of Hydropower Projects, with Notes on EIA Report Preparation, (2001)
- Manual for Preparing Environmental Management Plan (EMP) for Hydropower Projects, (2002)
- Manual for Developing and Reviewing Water Quality Monitoring Plans and Results for Hydropower Projects, (2002)
- Manual for Conducting Public Hearings in the Environmental Impact Assessment Process for Hydropower Projects, (2004)

- Manual for Addressing Gender Issues in Environmental Impact Assessment/Initial Environmental examination for Hydropower Projects, (2005)

The manuals set forth by DoED provide systematic details of methods and tools for the conduction of IEE/EIA public hearing, IEE/EIA level assessment of gender related issues, preparation of IEE/EIA level environmental management plans, review of IEE/EIA level water quality assessment, and preparation of IEE/EIA ToR.

3.3.4 Department of Forest Guidelines

The Department of Forest has made public various guidelines with relevance to environmental assessment of the development projects which are as follows:

- Forest Products Collection, Sale and Distribution Guidelines, (1998);
- Community Forest Guidelines, (2009);
- Community Forest Inventory Guidelines, (2005);
- Guidelines for use of forest area for development works (2006)

The forest produces collection; sale and distribution guideline details (clauses 3 to 10) various procedures and formats for getting approval for vegetation clearance, delineation of lands for vegetation clearance, evaluation of wood volume among others, and government offices and officials responsible for the approval, delineation and evaluation. These provisions have direct relevance to the development of the project and need compliance to these provisions.

The objective of the community forestry guideline is to develop the community forest through the active participation of the poor, disadvantaged, indigenous, Janajati, Madhesi, women, communities lagging behind due to various reasons and the traditional community forest users. The guideline sets process and procedures to identify and capacitate the community groups, establish and register the community forest user groups, preparation of the forest management plan and registration, regulations and implementation of the forest management plan, amendments of regulation and management plan, and roles and responsibilities of the forest stakeholders. The community forest guideline was endorsed by GoN in 2009. The guideline provides clear direction and demarcation for development works and projects. It was developed to maximize people participation and protect the sovereignty and rights of the local people on natural resources: community forests and associated natural resources as per the ILO 169 convention. Moreover, it helps to support the Tenth Five Year Plan and Three Year Interim Plan on internal planning, development and utilization of forest resources for addressing the millennium development goal through upliftment of the poverty level of the local people. Apart from it, the guideline covers various aspects of forest management mainly on sustainable forest management, good governance and livelihood of local people.

Community Forest Inventory Guidelines details the processes and procedures for evaluating the forest stock and it’s harvesting potentials while preparing the operational plans with an objective to ensure sustainable harvesting by limiting the extraction with the annual increment.

Guideline for the use of the forest area for development projects reiterates the use of the forest area only if other options are not available. The projects requiring the forest land area have to make alternative studies to minimise the forest land use areas. Development projectsof national priority will be allocated with such lands on the decision of the Ministry of Forests. To compensate the forest area and resource lost the project proponent has to comply with the following provisions:

- The propnent has to afforest the area equal to the forest area lost at the minimum, if the forest area occupied by the project is a barren land. The land area for afforestation will have to be decided based on the discussion with the district forest office. Or the proponent could deposit the required amount as per the forest norms to the district forest office.

- The proponent should plant 25 trees for every lost tree of above 30cm DBH in areas designated by the district forest office and look after the plantation for 5 years to ensure their protection and growth of every planted tree. Or the proponent should deposit the required amount for plantation and protection for five years to the district forest office.

- The proponent will have to compensate the lost forest land for 30 years. The compensation amount for the forest land per ha will be as per the provisions of leasehold forest.

3.3.5 MOE Guide to Environmental Management Plan of Hydropower Projects, 2006

The guide sets out the guideline for the formulation of the environmental management plan of hydropower development projects relating to project management structure, roles and responsibilities of the stakeholders and the project proponent. It provides the framework for monitoring and auditing principles and planning.

3.4 STANDARDS

3.4.1 National Ambient Air Quality Standards, 2003

The National Ambient Air Quality Standards, 2003 enforced by GoN has set quality standards for seven parameters: total suspended particles (TSP), particulate matter (PM10), sulphur dioxide, nitrogen oxide, carbon mono-oxide, lead and benzene for the maintenance of the ambient air quality. The project during its construction and operation will have to comply with the set standards for the ambient air quality.

3.4.2 Nepal Vehicular Emission Standards, 2000

Nepal Vehicular Emission Standard, 2000 enforced for the vehicles operating on petrol, gas, and diesel. The emission standards are very specific for two, three and four wheeler vehicles. The vehicles used by the project should comply with the vehicular emission standards during the construction and operation phase.

3.4.3 Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, 2003

The MoSTE (then Ministry of Environment) has set tolerance limits for the industrial effluents to be discharged into the inland surface water. Since the project is considered as an industry, it will have to comply with the tolerance limits set in the standard prior to the discharge of the effluents into the inland surface water during the construction and operation period.

3.5 INTERNATIONAL CONVENTIONS

3.5.1 Convention on Biological Diversity, 1992

Power projects that may be planned for lands that are designated as UN Biosphere Reserves, national parks, nature reserves or conservation areas will fall under UN Charter. Besides, the convention also emphasises the conservation of biodiversity in any other sites while implementing and operating a project in compliace with the national IEE/EIA procedures.

3.5.2 Convention on International Trade in Endangered Wild Fauna and Flora (CITES), 1973

The convention classifies species according to the 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 (CITES 1983). The project will have to minimise impacts to the CITES species as far as possible

3.5.3 International Labor Organization (169), 1989

Article 7 of the convention provides the right to the indigenous and tribal people to decide their own priorities for the process of development. However, for the national development plans and programs, it mandates consultation with them in the formulation of the plans and programs. Articles 12, 13, 14 and 15 safeguard rights of the indigenous people in the land and natural resources in territories traditionally occupied by them. In the event that the state retains the right of the natural resources in their territories, it mandates formulation of special provisions under the state legislation for their participation in the decision making process and resettlement process with full compensation of the resulting loss or injury (Article 16). As Nepal is signatory to the convention, it is obliged to comply with the provisions stipulated in the conventions, if the project is to impact the safeguard rights of the indigenous people.

3.6 WORLD BANK GROUP'S REQUIREMENTS

3.6.1 Relevant Policies and Guidelines of the World Bank

The project also complies with the following World Bank safeguard policies and all eight IFC performance Standards:

- Environmental Assessment EA (0P 4.01)
- Natural Habitats (OP 4.04)
- Safety of Dams (OP 4.37)
- Involuntary Resettlement (OP 4.12)
- Physical and Cultural Resources (0P 4.11)
- Indigenous People (0P 4.20)

IFC's Performance Standards (PS)

- PS1: Assessment and Management of Environmental and Social Risks and Impacts.
- PS2: Labor and Working Condition.
- PS3: Resource Efficiency and Pollution Prevention.
- PS4: Community Health, Safety, and Security.
- PS5: Land Acquisition and Involuntary. Resettlement.
- PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.
- PS7: Indigenous Peoples and.
- PS8: Cultural Heritage.

Compliance with these policies and standards is summarized in Table 3.1.

Table 3.1 - Compliance World Bank Safeguards Policies and IFC Performance Standards

Safeguard Policies	Actions
Environmental Assessment (OP/BP 4.01), and PS1: Assessment and Management of Environmental and Social Risks and Impacts.	• Category A project. Full EIA and EMP have been prepared for the project • Full, stand-alone Social Impact Assessment and Social Action Plan. • A rapid Cumulative Impact Assessment has been prepared as part of the EIA process. • A Panel of Experts team on Environmental and Social issues was recruited. • Intensive, culturally sensitive consultation efforts were carried out in all communities in the area of influence of the project during the EIA, SA and SAP preparation. Governmental and Non-Governmental organizations were also consulted in public meetings
PS2: Labor and Working Condition.	• Preliminary Occupational Health and Safety and HHRR management plans and procedures have been developed, and are included in the agreed Environmental and Social Action Plan for implementation
PS3: Resource Efficiency and Pollution Prevention.	• Adequate Pollution Prevention and Control measures are included in the EMP, and will be further detailed as required per the Environmental and Social Action Plan during implementation.
Safety of Dams OP 4.37, and PS4: Community Health, Safety, and Security.	• An International Panel of Experts advised on all salient aspects of the project design and visited the site twice during preparation. • KEL prepared a Dam Safety Plan including an Operation and Maintenance Manual, Emergency Preparedness Plan and an Instrumentation Plan. • Further measures to assure safety for potentially impacted communities have been included in the agreed Environmental and Social Action Plan for implementation (e.g. traffic management plan during construction)
Involuntary Resettlement (OP/BP 4.12), and PS5: Land Acquisition and Involuntary. Resettlement. Indigenous Peoples (OP/BP 4.10 and PS7).	• Social Assessment has been conducted. No physical resettlement required and very limited economic displacement envisioned. No significant or differentiated impacts on IP and/or other vulnerable groups. • Social Action Plan includes: Resettlement Compensation and Livelihood Assistance Plan (RCLAP) and Indigenous and Vulnerable Community Development Plan (IVCDP) which also includes specific measure to manage any differentiate impact on Indigenous Peoples.
Natural Habitats (OP/BP 4.04), and PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.	• The project does not have direct impacts on critical habitats. • Main impacts are on aquatic ecosystems (e.g. restricting of movement and potential entrapment of resident and migratory fish). • Environmental flows were estimated to meet human consumptive and non-consumptive water uses and ecological needs. An Aquatic Ecology Management Plan (AEMP) is being designed, and will include mitigation measures aligned with good international practices and an adaptive management approach to correct any issues raising during construction and operation. • Additional Tamor-Kabeli basin-wide fish and invertebrate studies will be conducted during project implementation, to assist the GoN better design mitigations measure for the potential basin-wide cumulative effect on natural aquatic habitats.

Safeguard Policies	Actions
Physical Cultural Resources (OP/BP 4.11), and PS8: Cultural Heritage.	• No archaeological or historical sites were found in project area. • Several religious ritual sites (e.g. cremation and resting sites, religious temples) were identified downstream of the dam. Appropriate mitigation measures have been designed (e.g. environmental flows, extraordinary downstream release during high water demand for ceremonial purposes, additional water storage infrastructure to guarantee continuation of religious practices, etc.) • Chance finding procedures during construction have been prepared and will be included in bidding documents and contracts.
International Waterways OP7.50	• Riparian notification was served to China, India and Bangladesh on June 27, 2002 and re-issued in August 2013. • No comments in connection with the proposed project were received from Notified countries by the indicated deadline or at any time since then.

3.6.10 Environmental, Health and Safety Guidelines

International Finance Corporation (IFC) of the World Bank Group has designed a guideline for environmental, health and safety (EHS) of the projects. The objective of the guideline is to identify the project EHS hazards early in the project cycle and develop strategies and plans to avoid, minimise and/or respond to the potential hazards and accordingly implement the EHS plan and monitor the EHS performance in the project cycle.

Chapter IV: BASELINE ENVIRONMENT

This section describes the existing baseline environmental situation of the project site areas. The information provided is based on the detailed on-site environmental studies for the project area during the EIA study phase. The regional information on the catchments is based on the review of the secondary literatures supported by the field studies and interpretation of the available topographic and Landsat imageries.

The objective of the environmental baseline assessment in this section is to assess the present state of the environmental conditions in the project area (Site Specific, Project VDCs and Project Districts) in order to evaluate environmental impacts and issues of the project development and operations.

4.1 PROJECT IMPACT AREA

The project impact area is defined as the Project Districts, Project VDCs and Project area.The Project Districts are the districts where the project structures, facilities and river dewatering are located. For KAHEP, Project Districts are the districts of Panchthar and Taplejung. The Project VDCs of KAHEP comprise four VDCs namely Amarpur and Panchami of the Panchthar district and Thechambu and Nankholang of the Taplejung district where the project structures, facilities and river dewatering are located. The term “Project area” includes both Project Districts and VDCs.

Based on the potential environmental impacts of the project, the Project VDCs are further classified as direct impact areas and indirect impact areas:

a) Direct Impact Area

This includes all the areas where construction and operation activities of the project and their implications are confined. In this area, environmental components will be directly affected by the project activities. These areas include project structural and facility sites and the river stretches, where the dewatering occurs such as headworks, settling basin, waterway, quarry site, muck disposal site, construction and operation camps, access and construction roads, dewatered zone along the river in between the barrage and Tamor River, the stretch of Tamor river that receives the final discharge of the power plant, and reservoir areas created by the barrage. The direct impact zone extends 250m surrounding the deginated areas of the project structures and facilities.

b) Indirect Impact Area

The surrounding areas of the direct impactareas, not affected directly by the construction and operation activities but affected indirectly by the induced and allied activities of the construction and operations,are defined as the Indirect Impact Areas. They consist of forest areas and settlements within the Project VDCsand access roads.

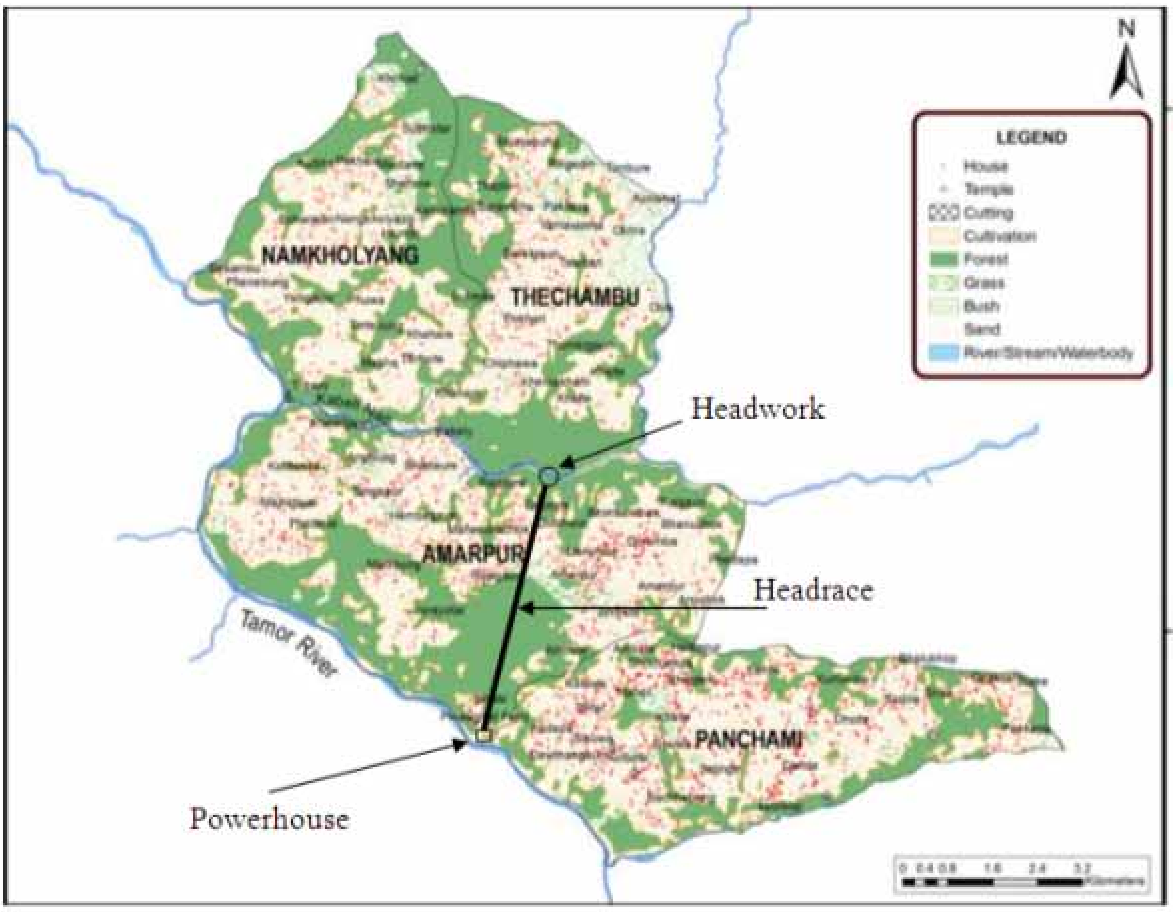
The key settlement within thedirect and indirect impact areas is presented in the Table4.1 and Figure 4.1.

Table 4.1: Settlements in the Impact Areas

Project Districts (PD)	Project VDCs (PVDCs)	Settlements in the Direct Impact area	Distance in Meter	Settlements in the Indirect Impact Area
Panchthar	Amarpur	Dhuseni (HW, TA, AR),	250	Bhanuchowk
		Rajabesi (HW,DS, AR),	1000	Bhadaure
		Kabeli Bazaar (DS, AR),	2.5 km from HW	Kurledanda
		Dubichaur (TA)	400	Simle
		Phodarpati (TA)	600	Jarayotar
		Pinasi (PH, AR)	500	Madibung
Panchthar	Panchami	Kodekpa (PH,)	1000	Tilhar
Taplejung	Thechambu	Kharelgaun (DS)	2.5 km from HW	Khalte
				Chipnewa
Taplejung	Nangkholyang	Khaharegaun (DS)	3 km from HW	Myakha

Note: HW = Headworks, TA = Tunnel alignment, AR = Access road, PH = Powerhouse, DS =Dewatered stretch

Figure 4.1: Key Settlement within theDirect and Indirect Impact Area



4.2 PHYSICAL ENVIRONMENT

4.2.1 Topography and Geomorphology

The major part of the project area is located in the Mid-Mountain Physiographic Zone (LRMP, 1986). Characteristic of the Mid-Mountain Physiographic Zone is a ramification of the elevated mountaineous topgraphy (>1.500m) with intervening deeply entreched "V"shaped valleys (<700m). The higher mountain ranges and the principal valley generally extend northsouth whereas the minor mountains and tributary valleys extend in the eastwest direction. The physiographic distribution of the project area is presented in Table 4.2.

Table 4.2: Physiographic Division of the Project Area

Project District	Physiographic Zone	Area in Hectare (Ha)	Percentage (%)
Panchthar	High Himalaya	715	0.57
	High mountain	17,264	13.86
	Mid-Mountain	1,06,611	85.57
	Subtotal	*1,24,590*	*100.00*
Taplejung	High Himalaya	16,588	20.93
	High Mountain	15,072	19.01
	Mid-Mountain	47,609	60.06
	Subtotal	*79,269*	*100.00*
Total Panchhar and Taplejung	High Himalaya	17,303	8.49
	High Mountain	32,336	15.86
	Mid-Mountain	1,54,220	75.65
	Total	**2,03,859**	**100.00**

Source: ISRSC, 2004

Geomorphologically, the area is still in the formative process. The steep mountain slopes, particularly the valley slopes and the upper middle hillslopes reflect the geomorphic dynamism of the area related to the mountain building tectonic activities (refer Figure 2.2, 2.4, 2.5 and 2.6). The general topographic forms reveal periods of active tectonism and tectonic quisence. The terraces at 2 to 3 levels at the Tamor valley and one or two levels towards the mouth of the tributary valleys reveal periods of tectonic quiscense and high degree of sediment deposition, whereas the steep valley mountain slopes, particularly the vertical topographic breaks between the alluvial terraces (Tars) are the product of high degrees of active tectonism related to the Himalayan uplift and active riverine erosion. The gentler lower middle, and upper middle mountain slopes reflect stabilisation of the landforms and mostly represent stabillised pre-historic landslide areas.

The general landuse in the project area is dictated by the geomorphic forms of the area. The alluvial tars of the valley, and the lower and middle mountain slopes are extensively used for agriculture and human settlement. The steep valley slopes and upper mountain slopes are either under the forest cover or are very steep represented by the bare rocks with the thin soil development.

Most of the project structures and facilities are located at the valley section represented by active alluvial flood plains or on alluvial tars. The headworks, reservoir and the intake structuresare located on the active alluvial plain of the Kabeli river with altitude less than 600masl. The diversion canals, settling basin and the headrace tunnel are underground structures (Refer Figure 2.5).The diversion tunnel and the settling basin lies beneth the relatively steep northwest facingvalley foot slope of the Kabeli on the left bank. The headrace tunnel passes along the eastwest direction extending mountainous ridge and connects to the underground surge tank located on the south facing valley at the foot slope of the

Tamor River on the left bank. The penstock pipe, a surface structure, linking the surge tank to the powerhouse, lies over a rather steep and rocky valley foot slope. The powerhouse sructure is located in the alluvial tar of the Tamor and Piple Khola on the left bank of Tamor River. This alluvial tar is a fan deposit of the Piple Khola (refer Figure 2.6) and is being constantly changing its morphology owing to the erosional and depositional activities of Piple Khola even at the recent times and is likely to change in the future. The tailrace covered canal passes through the active fan of the Piple Khola and opens up on the left bank of the Tamor River a little downstream of Piple – Tamor confluence.

The quarry sites for the aggregate materials are located on the flood plains and sandbars of Kabeli and Tamor River (refer Figure 2.5 and 2.6). The muck/spoil disposal sites are also located along the flood plains along the left bank of Kabeli and Tamor Rivers. The construction camps, labor camps, aggregate storage, batching plants, etc. are located on the alluvial tars and gentler valley foot slopes of Kabeli and Tamor Rivers on the dominantly agricultural land use, high above the potential flood limits of Kabeli, Tamor, and adjoining tributary streams.

The active alluvial plain of the Kabeli River is reported to be changing its geomorphic forms depending upon the river floods and sediment deposition. The location of the river channel changes its course within the confines of the active flood plain. With the change in the river channel, the shape and size of the flood plain and the sand/boulder island bars also change. The high standing alluvial terraces (above 5m from the river bed) and the geomorphic forms of the sloping valley flanks are, however, stable (powerhouse camp areas) and are not reported to have changed their forms since the establishment of settlements in these areas. The Piple Khola alluvial fan at the powerhouse site is also reported to have changed its geomorphic forms frequently due to floods and debris slides in the catchment area.

4.2.2 Geology and Soils

Geologically the area lies in the Lesser Himalayan Crystalline to Meta-sedimentary rock sequences representing Taplejung Window. The headworks area is comprisedof dominantly granites. The settling basin, and headrace tunnel is made up of granite, gneisses, schists, phyllites and quartzites whereas the surge shaft and powerhouse areas consist of phyllite, schist, and quartzite. In general, the orientation of the foliation is 30-40ºtowards the north direction.

The dam will be abutted into rocks at both banks. The rock type is thick blocky granites with three prominent joint sets. The uniaxial compressive strength of granite is of 150 to 230kg/cm^2. The dam is likely to be founded into the river channel deposits of over 20 m thickness. The quality of rock mass at the intake is assessed as of Rock Mass Rating (RMR) good category and Q value as fair. The left and right bank slopes at the dam site are relatively stable at the present conditions. The geological parameters measured, however, indicate a potential instability in the event of haphazard excavation with inadequate support.

The approach tunnel and the settling basins are located in the thickly jointed, medium strong coarse granite zone. The engineering properties of rock mass are classed as fair to good RMR and poor to fair Q value.

It is highly likely that the headrace tunnel will pass through a major portion from granite rocks beginning from the settling basin. The downstream stretch of the alignment is then expected to pass through gneiss, schist, quartzite and phyllite. Table 4.3 depicts the tentative percentage of rock encountered through the tunnel alignment.

Table 4.3: Expected Rock Types along the Headrace Tunnel

SN	Rock Types	Percentage of Alignment
1.	Granite	73
2.	Feldspathic schist and gneiss	14
3.	Quartzite and schist	3
4.	Phyllite	10
	Total	**100**

Source: UFSR, 2011.

The Headrace tunnel is passing oblique to the major discontinuity and is likely to pass bisecting the discontinuities along its way. Such a relation of the tunnel axis to the discontinuities is favorable for the tunneling works. The rock mass quality of the headrace tunnel assessed based on RMR and Q – System is presented in Table.4.4.

Table 4.4:Rock Mass Quality of the Headrace Tunnel

SN	Rock Mass Class	Percentage of Alignment
1.	Fair to good	28
2.	Fair	45
3.	Poor	17
4.	Very poor	8
5.	Extremely poor	2
	Total	**100**

Source: UFSR, 2011.

The surge shaft portal and surge shaft location comprise phyllite with intercalation of thin quartzite rocks, which are exposed few meters downhill slope at a rock cliff. Bedrock was reported as strong to moderately strong, hard light green to white schist with micro fold and quartz veins. On RMR and Q value system of rock mass classification, the rocks of the surge shaft are assessed to be poor and very poor respectively.

The powerhouse is locatedin almost flat alluvial deposit on the right bank of Piple Khola. The powerhouse area up to the depth of 20 meters consists of alluvium materials comprising pebbles of gneiss, phyllite, schist, quartzite and granite and boulders of granite and quartzite with grey silty sand to light brown clayey silt sand.

The tailrace canal passes through the active channel of Piple Khola. The channel deposit consists of moderately compact alluvial materials mostly derived from TamorRiver. The alluvium contains boulders and cobbles of granite, gneiss, schist, phyllite and quartzite with a matrix of pebbly sand.

The construction camps and other support facilities are mostly located in the alluvial deposits of tar land comprising of boulders, pebbles and cobbles of granite, gneisses, schists, phyllite and quartzites within the matrix of clay and silt /sand. The land use is predominantly agricultural.

4.2.3 Climate and Meteorology

As is typical for most of the watershed of Nepal, the Kabeli Basin covers a wide range of climates due to high topographic variations from valley bottoms to mountain ridges. Within the project development site, the altitude varies between 500masl to above 2000masl. This difference in the altitudegreatly influences the climatic region within short distances. Further, the aspects of mountain slopes also influence the climatic conditions. Two distinct climatic zones at the immediate project location sites are observed. The valley sections less than 1000masl experience a sub-tropical climate while the uplands at 1000masl and above experience warm to cool temperate climate.The project vicinity area exhibitsfour seasons annually: Winter(December-February), Pre-monsoon (March-May), Monsoon (June-September), and Post-monsoon(October-November).

There is no meteorlogical station at the project development site. The nearest meteorological station at Taplejung reveals the temperature to range between a maximum of 28ºC to a minimum of -10ºC. In general, the mean daily temperature at Taplejung varies from 16.9°C in January to 26.4°C in August. The average daily relative humidity varies from 71 % in April to 90% in July and August. The vapor pressure varies from 15.2 mb in January to 32.1 mb in August. Since Taplejung is located at a higher altitude, the temperature variation may not appropriately characterize the project development sites. The temperatures at the dam and powerhouse site are expected to be about 5 to 10°C higher than Taplejung for both summer and winter seasons. The powerhouse site is expected to be hotter and more humid in the summer than the dam site because of the difference in altitude.

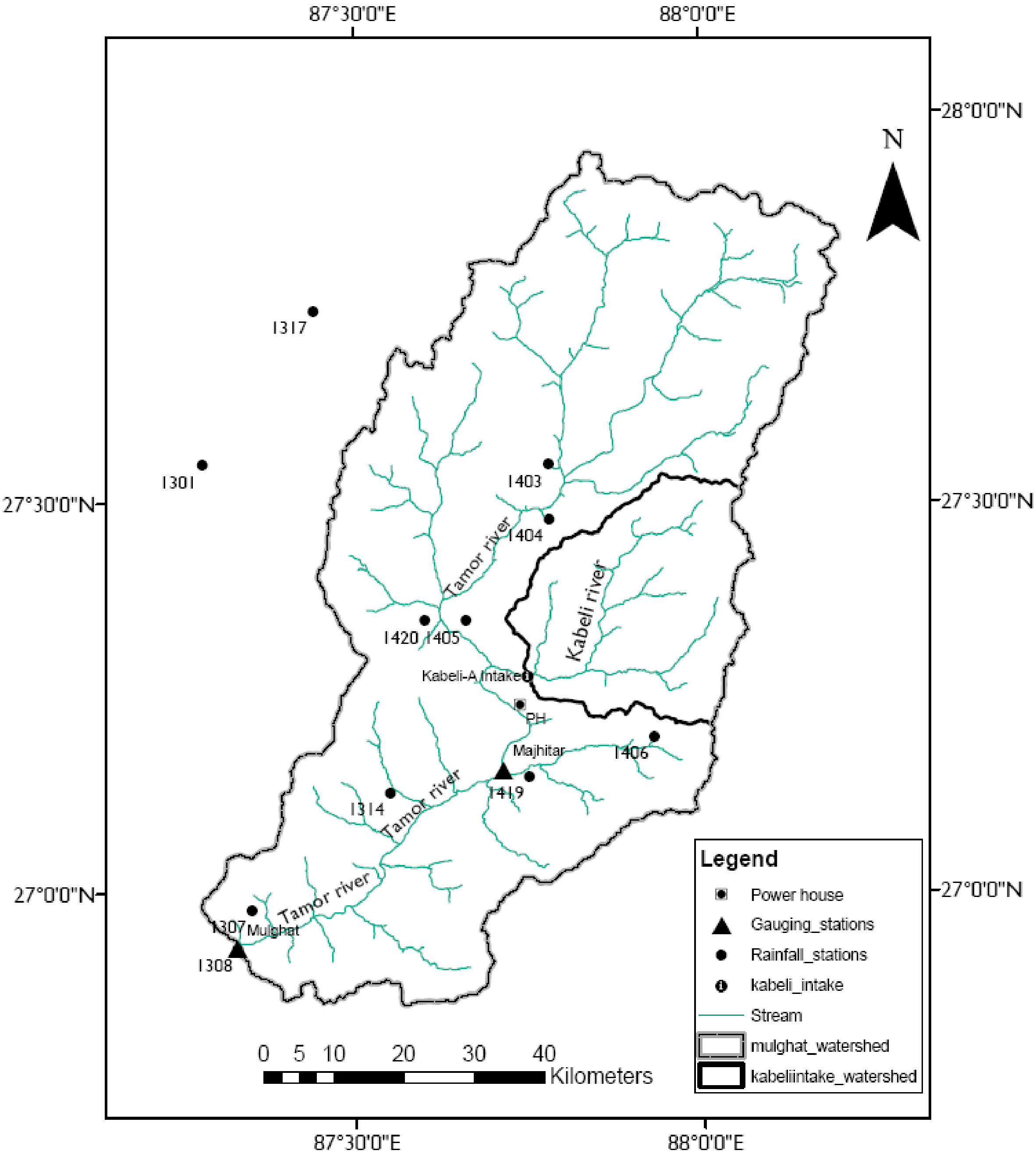
The monsoon has agreater influence on the precipitation of the area and also controls summer season temperatures and wind pattern. The monsoon commences from June and remains until September. Nearly 80 % of the rainfall occurs during the monsoon season. The intensity of the monsoon rain varies in Kabeli River catchment with elevation. In general, the amount of precipitation is highest in the south at the lower elevation and gradually decreases towards the north with the increase in elevation. The nearest precipitation stations are located at Lungthung, Taplethok, Taplejung, Memang, Jagat and Phidim. The mean annual precipitationin the project area is estimated to beat is 2.135 mm. The topographic locations of the dam and powerhouse site show that the powerhouse site might receive more rainfall than the dam site, because of the likely torographic effect of the mountain barrier in-between.

4.2.4 Drainage and Hydrology

Kabeli River Basin

Kabeli River is one of the tributaries of Tamor River. Tamor River is one of the major rivers of the Sapta Koshi Basin. The total length of Kabeli River is about 57 km, which up to the intake site is 52.4 km. The Kabeli basin is located in-between latitudes 27° 16' and 27° 17' N and longitudes 87° 42' and 87° 43' E .The Sapta Koshi Basin drains the Eastern Development Region of Nepal to the Ganges Indian territory. The map of the catchment area of Kabeli River above the proposed intake site and its location with respect to the Tamor basin ispresented in Figure 4.2.

Figure 4.2: Catchment Area of Kabeli upstream the KAHEP Barrage



Source: UFSR, 2011

The catchment area of Kabeli River is 862.3km^{2}at the barrage site. The catchment area above the permanent snowline (El. 5000masl) is about 1.1km^2(Table 4.5).The catchment elevation ranges from 560maslto 5.600masl. The oval shaped basin extends from the northeast to the southwest. The mountain ranges separting the basin from other sub-basins of Tamor on the east and west elevates from 2.000 to 4.000masl, whereas on the north the elevation exceeds 5.000masl. Kabeli River flows with an average river slope of about 1 in 100 in the vicinity of the headworks area. Tawa Khola, Phawa Khola and Inwa Khola are the major tributaries of Kabeli River. According to the hydrological regions of Nepal the catchment area belongs to the Hydrological Region 1 with a monsoon Wetness Index (WMI) of 1.500mm (UFSR 2011).

Table 4.5: Catchment Area Altitudinal Characteristics

Elevation, masl	Intake area		Powerhouse area	
	Area in km^2	% of total area	Area in km2	**%** of total area
Above 5000 masl	1.1	0.1%	717.0	18.2%
Between 5000 masl and 3000 masl	227.2	26.3%	1325.0	33.7%
Below 3000 masl	634.0	73.5%	1888.0	48.1%
Total catchment area	862.3	100.0%	3930.0	100.0

Source: UFSR, 2011

Drainage Characteristics

The general drainage pattern of the catchment basin is dendritic. The main tributaries have a drainage slope of gentler nature varying between 1:100 and 1:200, while that of the minor tributaries and upland area the slope exceeds 1:200. The river is characterised bya number of rapids and falls.

Kabeli River Hydrology

Kabeli River was an ungauged river till 2010 when the update of the feasibility study was initiated by KEL. The hydrological study team has established a gauging site near the headworks area in March 2010. It is required to develop the rating curve at the proposed intake site. In order to record daily flow data, a local person was assigned as a gauge reader after the orientation. Water level has been recorded twice a day since March 5, 2010 (UFSR 2011).

However, gauging data of one year is inadequate to determine the design discharge for the power generation Therefore, various methodologies (Correlation with Tamor at Mulghat, HYDEST and MSHP[8]), common for ungauged catchments, were used to determine the river hydrology in UFSR 2011 that are discussed in this section. The gauging data is recorded to derive the rating curves and to compare a long term average flow with an observed flow. Gauging data is also required to check the validity of the adopted method and the considered long term daily data (refer Figure 4.5***)***.The mean monthly flow derived from three methods (Correlation with Tamor at Mulghat, HYDEST, and MSHP)is presented in Table 4.6.

Table 4.6.: Mean Monthly Flows from various Methods, m^3/s

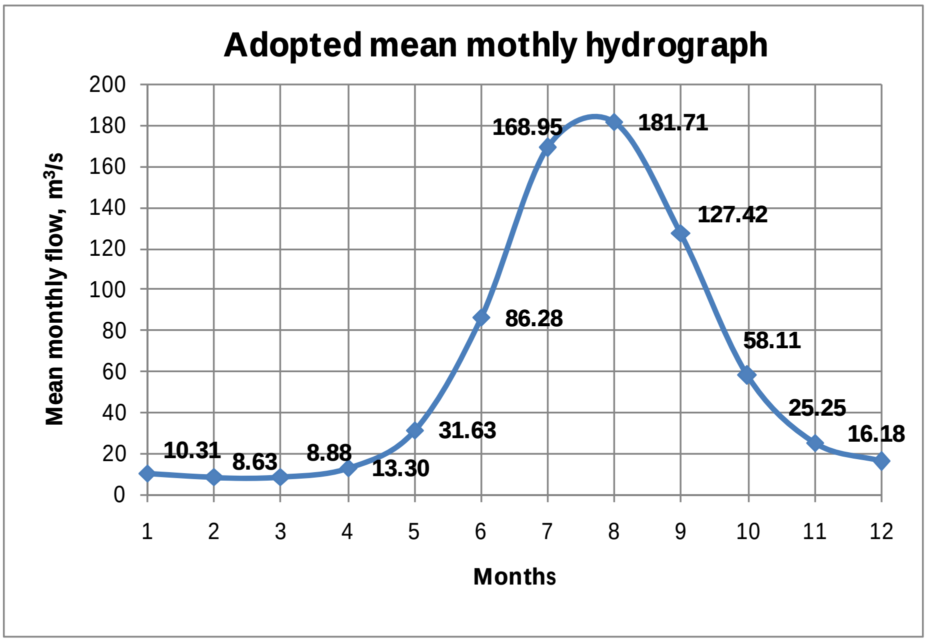
Months	Adopted Hydrograph	HYDEST	MSHP
January	10.31	10.58	10.77
February	8.63	9	8.98
March	8.88	8.34	8.44
April	13.30	9.25	11.43
May	31.63	13.38	13.22
June	86.28	39.6	40.70
July	168.95	123.70	115.21
August	181.71	145.96	134.98
September	127.42	110.73	103.14
October	58.11	48.52	46.98
November	25.25	20.32	22.77
December	16.18	13.11	14.92
Annual Average	**61.4**	**46.04**	**44.29**

Source: UFSR, 2011

[8]HYDEST: Method to estimate flows developed by the Government Agency WECS/DHM.
MSHP: Medium Scale Hydroelectric Project

Since Station 690 at Mulghat being the mother catchment of Kabeli and having a long term data of 41 years, the mean monthly flow based on the catchment correlation and precipitation ratio has been adopted for the design of KAHEP. The adopted hydrograph is shown in Figure4.3.

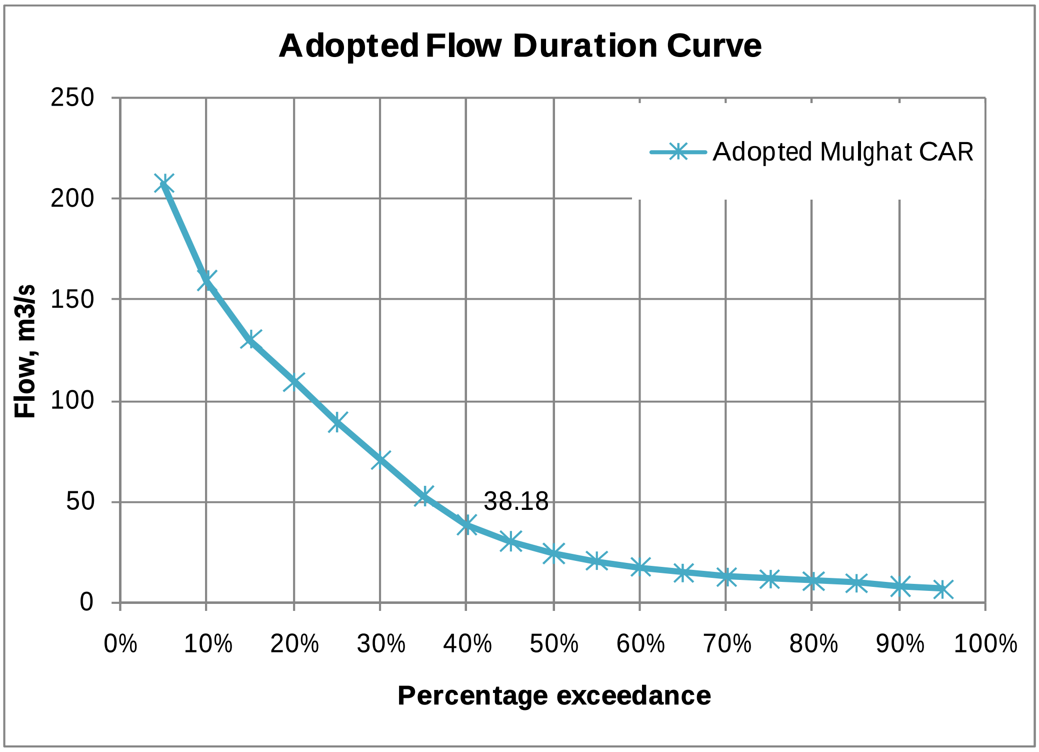
Figure 4.3: The Adopted Hydrograph of Kabeli at Intake Site



Source: UFSR, 2011

The derived flow duration curve for the Kabeli based on the daily flow data is presented in Figure 4.4.

Figure 4.4: Flow Duration Curve for Kabeli River



Source: UFSR, 2011

The analysis of the long-term hydrological data from1965 to 2006 showsthe highest mean monthly flow in the year 1998, followed by 2000 and 2002. The maximum yearly runoff was recorded in the year 1998 and remainedsimilar for the successive 6 years. The maximum flood was observed in 1987 with a derived flood discharge of 703m^3/s for the Kabeli headworks. On the other hand, the lowest flow of 1.7

m^3/s in Kabeli River was recorded in 1970 (derived from the available data of 1965 to 2006). Similarly, the lowest mean monthly and annual average flows in Kabeli were in 1992 as derived from the available data.

A low flow analysis by analyzing the derived daily inflow series (1965-2008) at theintake site of Kabeli is presented in Table 4.7.

Table 4.7: Low flows at the Intake Site, m^3/s

Return period (T-year)	Minimum Daily flows, m^3/s			
	1-day	7-day	15-day	30-day
2	7.23	7.43	7.66	8.03
5	5.48	5.67	5.84	6.10
10	4.56	4.74	4.89	5.09
20	3.83	3.99	4.12	4.28
50	3.05	3.20	3.30	3.42
100	2.57	2.71	2.79	2.89

Source: UFSR, 2011

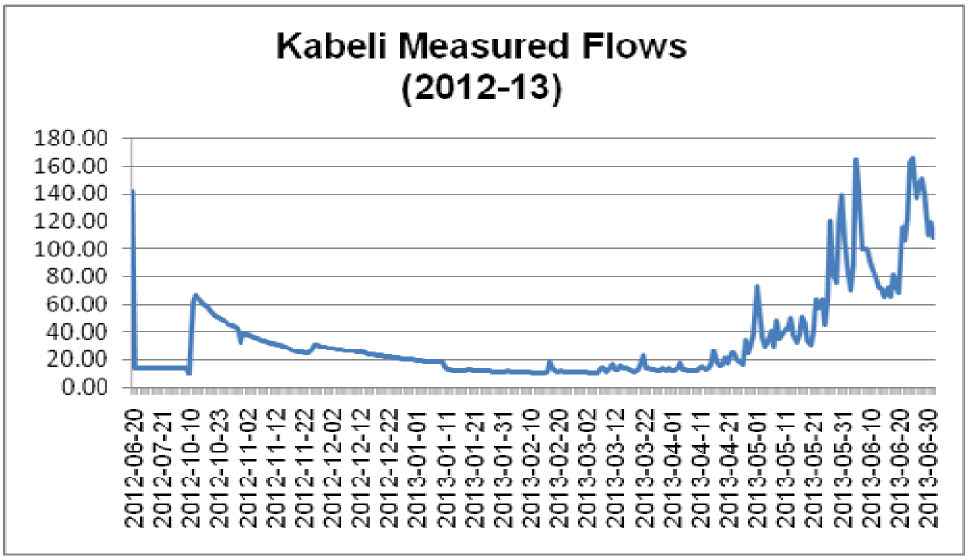
The flood flow for different return periods at the intake and powerhouse sites using Catchment Area Ratio (CAR), Regression analysis andRegional flood frequency methods are presented in Table 4.8 and Table 4.9 respectively. The CAR method is more reliable as explained below.

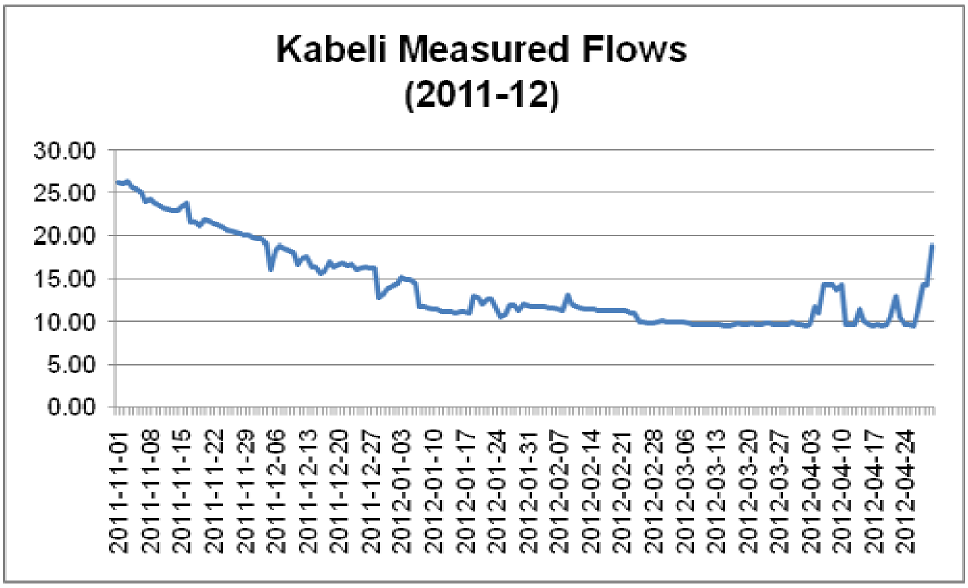
Table4.8: Flood Flow at Intake Site (m^3/s)

Return period	Flood flow, m^3/s		
	CAR Tamor at Mulghat	Regression analysis	Regional flood frequency
1	**268**		
2	**687**	1215	488
5	**971**	1712	676
10	**1171**	2045	801
20	**1371**	2362	920
50	**1644**	2773	1075
100	**1859**	3081	1191
200	**2083**	3387	1306
500	**2397**	3791	1458
1000	**2648**	4097	1573

Source: UFSR, 2011

Figure 4.5 Measured flows from Kabeli Gauging Station from November 2011 to June 2013.





These two figures (Figure 4.5) from the actual flow data of Kabeli river show that the adopted mean monthly flow derived from CAR method is on the safer side and is consistent with the adopted flow during the dry months. However, to derive a conclusion for the adopted flow, a regular data for 6-8 years is required. Therefore, the adopted hydrology from CAR method is the basis for hydrological considerations for KAHEP.

Table 4.9: Flood Flow at Powerhouse Site (m^3/s) – Tamor and Kabeli Combined

Return period	Flood flow, m^3/s		
	CAR Tamor at Mulghat	Regression analysis	Regional flood frequency method
1	**835**		
2	**2144**	1770	1258
5	**3029**	2451	1743
10	**3653**	2914	2063

20	**4278**	3352	2371
50	**5128**	3918	2769
100	**5799**	4342	3068
200	**6499**	4765	3365
500	**7476**	5322	3757
1000	**8259**	5745	4053

Source: UFSR, 2011

Since only 4 out of 15 gauging stations taken for this analysis have a similar catchment size to Kabeli, the regression analysis method has overestimated the flow for the small size catchment like Kabeli. Similarly, the regional flood frequency method has underestimated the flow, as it has not given agood correlation between the mean flood discharge and the catchment area. Therefore, the flood flow estimates derived by the CAR method are considered more reliable.

Tamor River Hydrology at Powerhouse site

The Station 690 at Mulghat,having a long term data of 41 years, is adopted for the estimation of the Tamor River mean monthly flow at the powerhouse site based on the catchment correlation and precipitation ratio. Table 4.10 presents the mean monthly flow of Tamor River at the KAHEP powerhouse site.

Table 4.10: Mean Monthly Flow of Tamor River at KAHEP Powerhouse Site

Months	**KAHEP Powerhouse Site**
January	39.1
February	32.3
March	31.4
April	45.2
May	96.2
June	343.7
July	679.4
August	730.7
September	509.7
October	237.7
November	81.9
December	52.5
Annual Average	**239.98**

Source: Additional Report to UFSR 2012

The contribution of Kabeli River to Tamor River hydrology at the powerhouse site is about 25% of the average annual flow, but its contribution in the dry season flow (March to April) is nearly 30 %. The flood flow for different return periods at the powerhouse sites is already presented in Table 4.9.

Water Sources along Tunnel Alignment

Local people use water from the local springs and streams for various purposes including for drinking and irrigation. Potential impacts to the springs located close to the tunnel alignment and to the downstream of the dam need to be assessed. The survey of the tunnel alignment area shows the following water spings along the tunnel alignment (Table 4.11) used by the local communities. At the time of the field survey, the discharge was considerable and sufficient to meet the community requirement. However, dry season discharges are not known and hence it calls for further monitoring during the dry season (April/May) before the project starts. This matter has been included in the Environmental Management Plan.

Table 4.11: Major Water Sources along the Tunnel Alignment

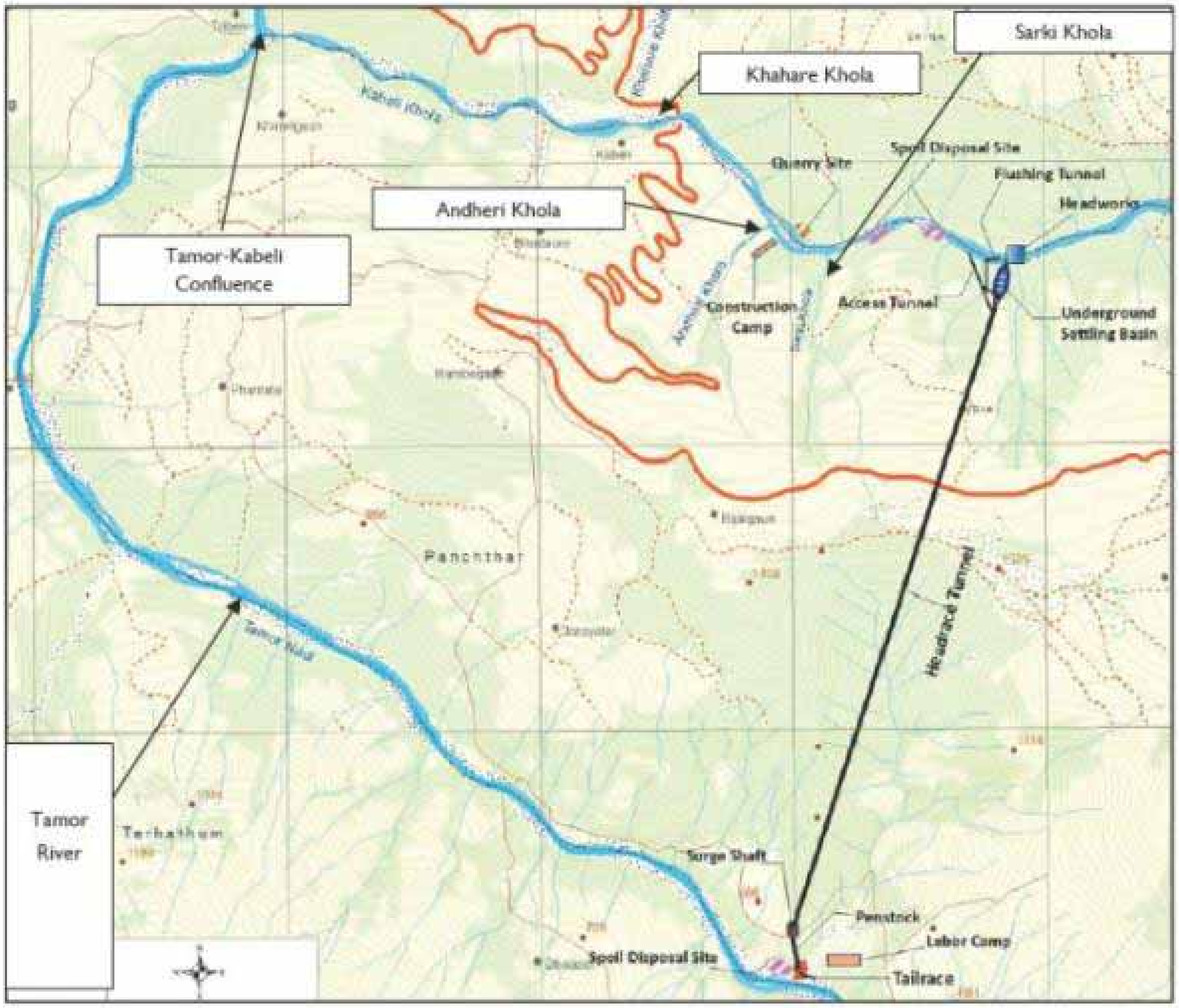
S.N	Name of Water Hole	Use	Village
1	Jor Dhara	drinking water and irrigation	Thulo Dhuseni
2	Jarayotar	drinking	Pinase
3	Faudar Pati Dhara	drinking and irrigation	Rajabesi

Source: Field Survey, 2010

Tributaries in the Dewatered Zone

Three streams drain into the potential critical dewatered zones of the Kabeli in the project area. The location of these streams is presented in Figure 4.6.

Figure 4.6: Streams downstream from the Dam



The average discharge of the streams calculated based on the WECS method is presented in Table 4.12 for the different months of the year.

Table 4.12: The mean monthly flows for the three Kholsis in between Kabeli-A Barrage and Kabeli-Tamor Confluence by WECS Method

Month	Khahare Kholsi (in the way to Taplejung, at 3 km from dam) m^3/s	Sarki Khola, at 1.2 km from dam, Panchthar, m^3/s	Andheri Khola, at 1.6 km from dam, Panchthar, m^3/s	Total flow from three Kholsis m^3/s
Jan	0.1985	0.041	0.0369	0.2763
Feb	0.1695	0.0351	0.0316	0.2361
Mar	0.1459	0.0293	0.0263	0.2015
Apr	0.1328	0.0247	0.022	0.1795
May	0.1591	0.0274	0.0244	0.2109
Jun	0.6413	0.0911	0.0771	0.8095
Jul	2.0404	0.4004	0.3593	2.8001
Aug	2.5384	0.5086	0.4571	3.5041
Sep	1.9804	0.4013	0.3609	2.7426
Oct	0.8728	0.1773	0.1594	1.2095
Nov	0.3824	0.0583	0.0497	0.4904
Dec	0.2539	0.0393	0.0335	0.3266

Source: Additional to UFSR 2011

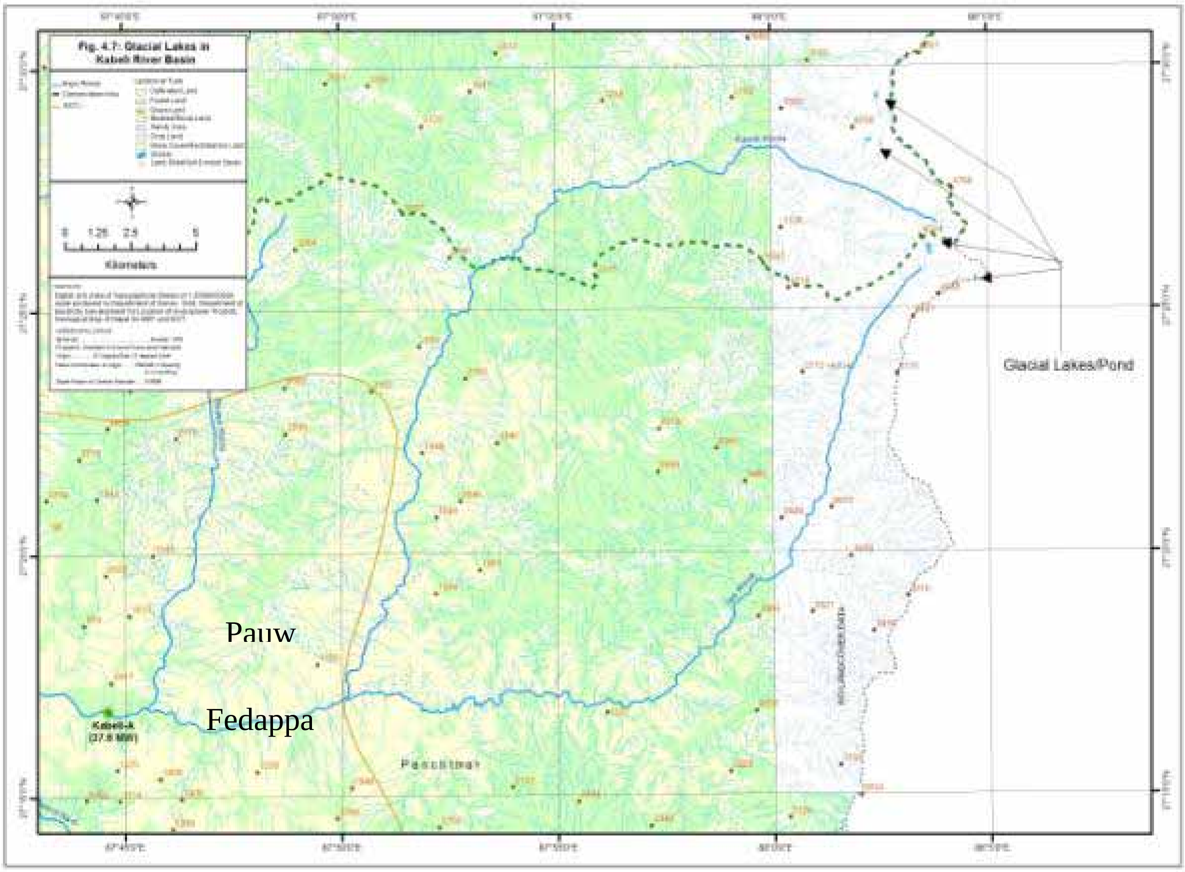
In the peak dry season (April), combined contribution of the three streams to the Kabeli River water flow in the critical dewatered zone is estimated to be 180 liter/second. Sarki, Andheri and Khahare join Kablei at three different points. The Sarki Khola joins at 1.2 km, Khahare Khola joins at 1.6 km and Andheri Khola joins at 3 km downstream from the dam.

4.2.5 Erosion and Sedimentation

The unstable features like landslides, debris flows, gully erosions and rill erosions are the key erosional features within the Kabeli catchment. The monsoon rains and its intensity is the main factor influencing erosion in the elevated mountaineous slopes as well as along the riverine areas.

About 40 to 50 landslides are mapped within the catchments of Kabeli above headworks which are depicted in the Figure 4.7.Most of the landslides are old and seem to be stable at present. However, being a steep and rugged terrain with a complex geology and heavy rainfall in a short period of monsoon, there is always a possibility of triggering landslide in the Himalayas. Slide prone zones are seen in the eastern and northwestern boundary of the catchments, which are 25 to 30 km upstream from the headworks and are envisioned to pose low risk to the project. Two landslips were reported at Fedappa of Amarpur VDC and Pauwa of Thechambu VDC in 1993 (B.S. 2050)July (Shrawan) close to the project. The landslip caused the loss of property and lives. About 22 people died in Fedappa and 28in Pauwa (personnel communication with the villagers). Currently these slides are in a stable condition. There are no recent records ofactive landslides close to the project development sites.

Figure 4.7: Landslide and Glacial Lake Location in the Kabeli Catchment



The Himalayan Rivers are known for the high load of sediment transport and Kabeli is not an exception. The maximum-recorded suspended sediment concentration in Kabeli is13,616 ppm in the monsoon season.The monsoon is the period of high sediment load in the river. The sediment load could be exceptionally high in the event of landslides immediately upstream of the headwork site. The flood of 1987 brought a huge amount of sediment and even scoured the toe slopes of the alluvial terraces causing small-scale debris flows in the entire stretch of Kabeli River and changed the morphology of the active flood plain of Kabeli River. A riverbed morphological change during the monsoon season is a common feature of Kabeli River. With the change in the river bed morphology there is a corresponding change in the wet channel characteristics. The pool sections of the wet channel change into rapids, and rapids covert into pool or run sections annually and aquatic habitats keep on changing accordingly.

4.2.6 Air Quality

There are no industrial sources of air pollution in the project area. There is no monitoring data on the air quality of the project area. Direct observations indicate that the air quality is generally good as the project area lies in a rural setting completely devoid of industrial emissions. However, along the roadside, the air is dusty (high TSP and PM_{10}) because of a frequent vehicles movement along the earthen roads. The fuel wood burning in the houses contributes minimally to the overall air pollution, however, the indoor air quality is considered poor. The other major source of air pollution envisaged is fugitive dust (TSP and PM_{10}) arising from the ground or soil disturbance during dry seasons while preparing fields for agriculture. As dust (TSP and PM_{10}) is a likely problem during the project construction, it is recommended to monitor air quality at the nearby settlements boundary to establish a baseline.

4.2.7 Water Quality

Rapid assessment indicated that the overall chemical water quality of Kabeli River is good. There are no industries discharging effluents in the river directly. However, activities like open defecation and water use for different domestic purposes like bathing, washing utensils are common among the settlements residing along the riverbank and river water is likely to be polluted by microbial contamination. River water in the post monsoon and pre-monsoon seasons (October through May) is clear with low or negligible suspended sediment load. The sediment load is expected to be high (above 5.000 ppm) during the rainy season from July to October. The major contributor of the sediment load is the catchment erosion associated with the high monsoon precipitation.

Water quality monitored during the EIA study in the post monsoon season (October 9-10, 2010)is presented in Table 4.13.

Table4.13: Water Quality of the Kabeli River

SN	Parameters	Test Methods	Observed Values			Water Quality Standards for Protection of Aquatic Ecosystem, GoN 2008
			Site 1 (Upstream of Dam)	Site 2 (Downstream of Dam)	Site 3 (Dewatered Zone)	
1.	pH @ 18°C	pH Meter	7.5	7.7	7.8	-
2.	Temperature. (°C)	Thermometer	18	18	18	-
3.	Total Dissolved Solids, (mg/l)	Gravimetric	83	75	82	**-**
4.	Total Suspended Solids, (mg/l)		<1	<1	<1	-
5.	Total Hardness as $CaCO_3$, (mg/l)		18	19	23	-
6.	Residual Chlorine, (mg/l)	Iodometric Titration	N. D. (<0.05)	N. D. (<0.05)	N. D. (<0.05)	<0.05
7.	Fluoride, (mg/l)	SPANDS	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	1.5
8.	Dissolved Oxygen, (% saturation)	Winkler Azide Modification	80	100	99	60, chronic
9.	Ammonia, (mg/l)	Nesslerisation	**0.05**	N. D. (<0.05)	N. D. (<0.05)	<0.002, chronic
10.	Aluminum, (mg/l)	Erichrome Cyanine - R	0.21	0.001	0.16	20
11.	Nitrate, (mg/l)	UV Screening	1.10	1.25	0.88	-
12.	Nitrite, (mg/l)	NEDA	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	-
13.	Lead, (mg/l)	AAS (FULL FORM)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	1 (medium water)
14.	Copper, (mg/l)		N. D. (<0.002)	**0.01**	N. D. (<0.002)	0.002, chronic
15.	Zinc, (mg/l)		**0.03**	**0.01**	**0.03**	0.004, chronic
16.	Cadmium, (m/l)		N. D. (<0.002)	N. D. (<0.002)	N. D. (<0.002)	0.005 (medium water)
17.	Iron, (mg/l)		1.26	0.26	1.23	
18.	Manganese, (mg/l)		N. D. (<0.02)	N. D. (<0.02)	N. D. (<0.02)	0.37, chronic
19.	Dissolved Phosphorus, (mg/l)	Ascorbic Acid	N. D. (<0.05)	N. D. (<0.05)	N. D. (<0.05)	-
20.	Arsenic, (mg/l)	Hydride Generation	N. D. (<0.002)	N. D. (<0.002)	N. D. (<0.002)	<0.002, chronic

Source: Field Survey 2010 *N. D.: Not Detected*

Note:

AAS: Atomic Absorption Spectrophotometer

Remarks: The observed values for ammonia and zinc in site 1; copper and zinc in site 2; zinc in site 3 exceeded the prescribed standards for protection of aquatic ecosystem. However, the percent saturation dissolved oxygen level exceeded by 60 (chronic level).

With the present level of settlements and agro-economic practices in the Kabeli catchment, water quality of Kabeli River is not expected to change drastically. Ongoing land degradation in the catchment area is of concern related to a potential increase in the sediment load and turbidity associated with monsoon rains in the future. During construction works, it is of interest to measure aliphatic compound and pesticides. This sampling of data should start before construction works start.

Water quality, presence and growth of biota in rivers are connected directly to the river water temperature. Strong connections are often seen between life cycles of fish, amphibians and invertebrates. Adaption to temperature is the major environmental factor in the general adaptation process of different species to local population, and changes in their geographical habitats.

An example is physiological qualities developed to give an animal energy to benefit through fine-tuning of metabolism according to the temperature. This energy producing capacity will be reflected in the fish ability to move or migrate in cold or warm waters. Some fish species need temperatures above a certain level to be able to migrate upstream water falls and rapids. As a consequence, water temperatures play an important role in describing potential impacts from a hydropower development.

The microbiological analysis was carried out in four sampling stations of Kabeli and Tamor rivers in July 2013. The results indicate that the population of total coliform (total coliform, faecal coliform and E coli) is present in all sampling stations except for one (Kabeli-Tamor confluence where E coli is not present). However, Giardia, Cyst, Eggs/Ova and Larvae were not recorded at any site (Table 4.14).

Table 4.14: Micro-biological analysis of Kabeli and Tamor Rivers water quality

SN	Sampling Stations	Total coliform	E coli	Giardia	Cyst	Eggs/Ova	Larvae
1	Dam site	240	240	Absent	Absent	Absent	Absent
2	Before tailrace confluence	150	48	Absent	Absent	Absent	Absent
3	After tailrace confluence	460	93	Absent	Absent	Absent	Absent
4	Kabeli confluence at Tamor	4	Nil	Absent	Absent	Absent	Absent

Source: Field survey July 2013

Note: E Coli count is for (MPN index/100 ml)

Coliform bacteria are organisms, which are present in environment and in the faeces of all worm blooded animals and human. Coliform bacteria will not likely cause illness. However, their presence in drinking water indicates that disease causing organisms (pathogens) could be in the water system. Presence of coliform bacteria indicates a relatively high density of human as well as animals in the project area. In addition, since the sampling was done in July, the increased runoff during the monsoon might have also augmented the presence of the coliform due to a surface run off in the river because of rain.

The coliform level in the Kabeli and Tamor Rivers water exceeds the National Drinking Water Quality Standard (2005), EU's drinking water Standard (1998), and the drinking water standard of WHO

(2008). Even though, there is no presence of Giardia, Cyst, Egg/Ova and larvae, the water of Kabeli and Tamor Rivers is not recommended for human consumption.

4.2.8 Noise Level

Localized noise problems were observed during day time at the Bazaar areas along the Mechi Highway due to the frequent movements of vehicles. Other noise problems were not observed in the entire project area because of the absence of any industrial activities. Day time noise levels were measured at different sites. The measured spot day time noise level at the existing access road (near Kabeli Bazar) ranges between 45 and 60 dBA. The noise level at the dam site is between 40 and 45 dBA. Likewise, the noise level at the powerhouse is between 40 and 50 dBA. As per prevailing trends of the settlements, roads and agro-economic practices, the area is not likely to experience measurable change in the noise levels in the near future except in some pocket areas (roadside markets).

4.2.9 Water Uses and Water Rights

Currently water in the downstream area of the dam site is not used for irrigation or water mill operations. Potential use of the Kabeli River water for irrigation or water mills is highly unlikely even in the future because of the topographic constraints. The only water use of Kabeli River is downstream of the dam site for occasional bathing, swimming and ritual purposes such as cremation of dead bodies by local communities. There are three cremation sites in the downstream area:(i) the first - below at Khola Kharka immediately below the dam; (ii) the second - 2.5 km downstream of weir; (iii)the third - 3.5 km downstream in Sirupa area. Most of the above mentioned water uses are non-consumptive. However, for these uses a minimum water flow has to be guaranteed to keep the area in a minimum threshold of sanitation cleanliness. There are no water right conflicts downstream of the headworks in the critical dewatered zone (i.e.Kabeli river between the dam and conflunece of Kabeli and Tamor Rivers). Impacts of water diversion on the dewateerd zone is described in Chapter 6.

Water use and rights in Tamor River is very similar to Kabeli River. The water use upstream and downstream of the powerhouse is limited to occasional bathing, swimming and ritual purposes, such as cremation of dead bodies. Due to topographical locations of settlements onthe higher elevation, the Tamor water is not used for irrigation, water supply or water mill operations. KAHEP is a peaking RoR project, hence the release of tailrace water, after power generation, will cause flow fluctuations in Tamor River due to peaking releases. Impacts of the peaking plant operations are described in the Chapter 6.

4.2.10 Land Use

The terrain in the project area exhibits wide variations of slope gradient with settlements, cultivated land and forests at different locations (Figure 4.8). The large land portion of the project VDCs is used for agricultural purposes followed by forest vegetation *(*Table 4.15). Settlements are scattered and are located at variable distances from the project construction sites (see Table 4.1). The topography of the project VDCs shows that the flat low lands and gentle mountainous slopes are used for cultivation and are extensively terraced. Generally, the slopes of thick colluvial soil are used for settlments and cutivation. Relatively steep slopes with poor soil development are covered with scarce bushy vegetation with few trees.

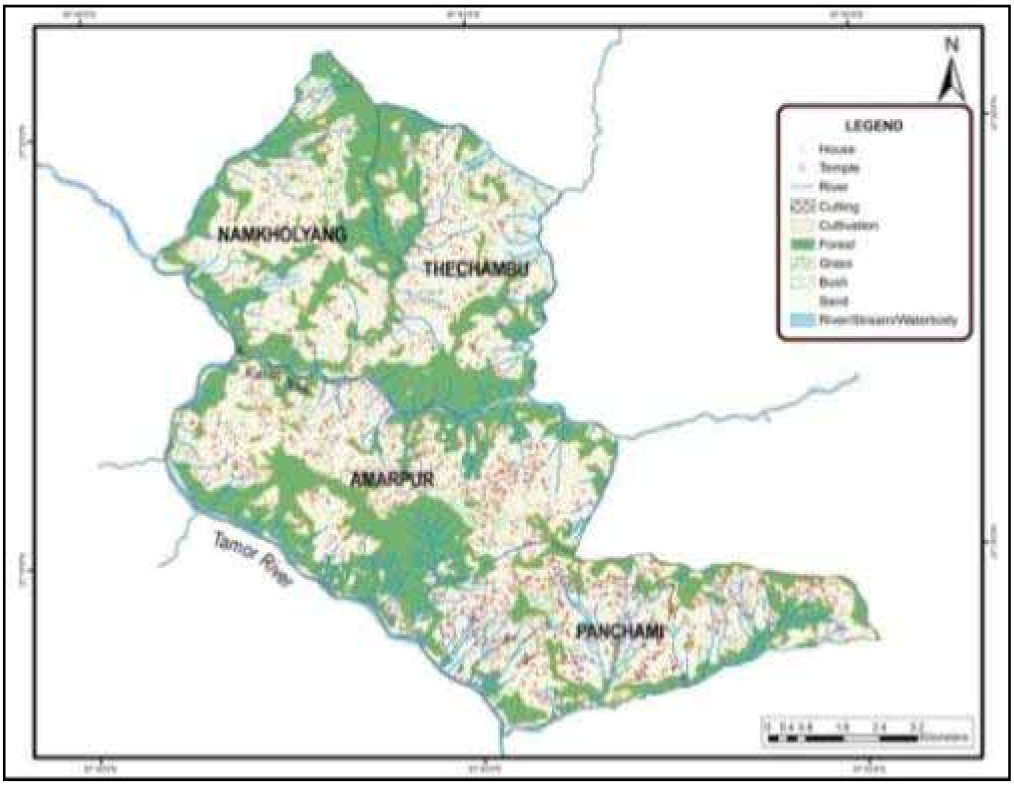
The penstock and part of the powerhouse area lie on the leasehold forestland. The headworks site is dominated by forestland. The camp sites are located in the agricutural lands,the quarry site and the muck/spoil disposal area are located within the river flood plain area ofKabeli and TamorRivers.

Table 4.15: Land use of Affected VDCs (Area Km^2)

VDCs	Cutting Cliff	Cultivation	Forest	Grass	Bush	Sand	River/ Stream Waterbody	Total	%
Amarpur	0.00	18.84	13.32	0.38	0.51	0.47	0.47	33.99	34.07
Namkholyang	0.01	11.43	8.36	0.44	0.42	0.13	0.18	20.98	21.03
Panchami	0.04	16.93	6.32	0.48	0.13	0.15	0.08	24.12	24.17
Thechambu		10.95	7.58	0.10	1.79	0.17	0.09	20.68	20.73
Total	0.05	58.15	35.59	1.39	2.85	0.92	0.82	99.77	100.00
%	0.05	58.29	35.67	1.39	2.86	0.92	0.82	100.00	100.23

Source: Topographic Maps

Figure 4.8: Land Use of the Project VDCs



4.2.11 Seismicity

UNDP/UNCHS Seismicity Hazards Mapping and Risk Assessment Mapping for Nepal have divided Nepal into three uniform seismicity zones based on the seismic characteristics and tectonic features of the respective regions. Based on this division, the KAHEP area falls into the seismicity area-3 close to its border with the seismicity area-2.The seismic area-3 is characterized by the relatively low distribution of seismicity where the subduction zone lies at the deeper portion. The earthquakes generated around the project area are mostly of a magnitude less than 4. However, 4 great earthquakes are known to have occurred recently within the distance of 60km to 130km from the project area. Among them, the great Bihar-Nepal earthquake of 1934 of 8.3 Richter scale. The epicenter at Chainpur is the nearest one, which is about 70km away in the WNW direction from the project area. Although its damages in Nepal and Bihar were considerable, the actual intense damages occurred around the proposed project area are not known. Damage information is also available on the Udaipur earthquake (1988), magnitude of M 6.6.Its damage intensity around the project area is ofthe Modified Mercari scale V, whereas, at the epicenter zone it was of the upper VII. Other neighboring earthquakes of a magnitude greater than 6.1 occured in 1980 and 1996 at a distance of 100km east on the Indianterritory and not in Nepal (*HCPL, 2010).*Finally, the Sikkim earthquake of September 2011 was felt in the region with some damage of the built structures.

Based on the recorded seismicity characteristics and historical earthquakes of the project area surrounding regions, the KAHEParea seems to be within a moderate seismicity recurrence area. The estimated Bedrock Peak Ground Horizontal Acceleration in the project area is about 200gal. Considering the reservoir capacity, dam height, and the historical earthquake records, the seismic risk factor for the project is estimated to be of a low order.

4.2.12 Glacial Lake and Glacial Lake Outbrust Floods (GLOF)

There are a few glacial lakes identified in the Kabeli basin. All the lakes are located below 4.200maslaltitude. The identified lakes are shown in Table 4.16 and Figure 4.7.

Table 4.16: Glacial Lake/ Pond within the Catchment of the Kabeli River

SN	Glacial	Elevation (masl)	Dimension (m)	Aerial Distance(km)
	Lake/pond	(Approximate)	(Approximate)	(Approximate)
1	Timbu Pokhari	4330	220*450	35
2	Hadi Pokhari	4220	754*115	36
3	Suke Pokhari	4350	156*190	36
4	Lam Pokhari	4360	250*140	36
5	Chhahare Pokhari	4440	290*167	36

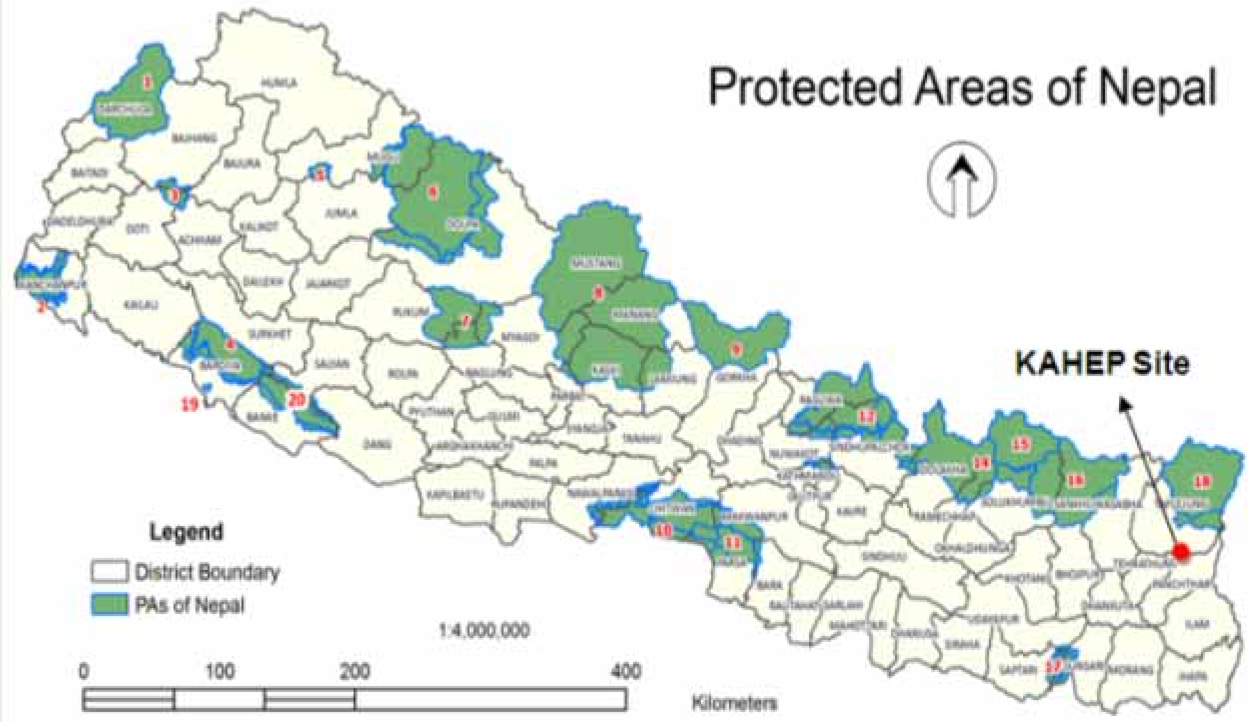
Source: UFSR, 2011

Most of the glacial lakes of the catchment area are small. None of these lakes is identified as a potentially dangerous in the study conducted by ICIMOD and UNEP in 2001; there is no evidence of GLOF in the Kabeli basin in the past either. However, apossibility of GLOF in the future cannot be ignoredin the context of the ongoing rapid global warming. Since the glacial lakes are very small with a potential water discharge of about 1.100m^3/s from the largest glacial lake Timbu Pokhari, there is no immediate threat of the glacial lake on the barrage structure at Kabeli River as it also has a higher design discharge capacity.

4.3 BIOLOGICAL ENVIRONMENT

The project area lies outside the biodiversity conservation sites (National Parks, Wildlife Reserves, Conservation Areas, Strict Nature Reserves, Hunting Reserves and Buffer Zones) officially declared by the GoN. There is no plan to propose protection or conservation areas by the local and central government in the project VDCs. The nearest conservation area is the Kanchanjunga Conservation Area (KCA) about 25km aerial distance to the north from the project development site (Figure 4.9).. In addition, GoN is in the process of declearing the Tinjure Milke Jaljale (TMJ) forest (also known as Guranse danda Forest) as a protected forest that is about 10 km aerial distance from the KAHEP development site. Both KAC and TMJ, are in remote mountainous regions and are accessible by trekking only. From the KAHEP site, KAC could be reached in two days full trek, while TMJ takes a day and half trek. Both KAC and TMJ are unlikely to be affected by the KAHEP

Figure 4.9: Location of the KAHEP in relation to Protected Areas of Nepal



SN	Name of PA	SN	Name of PA	SN	Name of PA
1	Api Nampa Conservation Area	8	Annapurna Conservation Area	15	Sagarmatha National Park
2	Shukla Phant Wild Life Reserve	9	Manaslu Conservation Area	16	Makalu Barun National Park
3	Khaptad National Park	10	Chitwan National Park	17	Koshi Tappu Wild Life Reserve
4	Bardia National Park	11	Parsa Wild Life Reserve	18	Kanchanjunga Conservation Area
5	Rara National Park	12	Langtang National Park	19	Blackbuck Conservation Area
6	She-Phoksundo National Park	13	Shivapuri Nagarjun National Park	20	Banke National Park
7	Dhorpatan Hunting Reserve	14	Gaurishankar Conservation Area		

4.3.1 Forest and Plant Diversity

Forested areas distribution in the project affected VDCs is presented in the Figure 4.8 above along with other land use types.

4.3.1.1 Regional Characteristics

The construction area for the KAHEP components lies in the upper tropical to sub-tropical zone (400 to 1.200m) of Nepal. Phytogeographically, and in the regional concept, this area falls in the eastern part of Nepal. Panchthar district, one of the two project district, has 18.3% upper tropical region and 66.9% subtropical region, while Taplejung has 2.4% upper tropical and 14.8% sub-tropical region. The flora within the project area is representative of the upper tropical and sub-tropical areas.

The dominant tree species in the upper tropical zone is *Shorea robusta* and other major associated species are *Adina cordifolia, Lagerstroemia parviflora, Terminalia alata, T. chebula*, *T. bellirica*. *Pinus roxburghii*is is a dominant tree species in the subtropical region. The major associated tree species are *Schima wallichii, Pyrus pashia, Juglans regia, Lyonia ovalifolia* while *Hypericum cordifolium, Colebrookea oppositifolia, Zizyphus mauritiana, Woodfordia fruticosa*is the major shrub species in the tropical region and*Berberis aristata, Rubus ellipticus, Melastoma melabathricum, Trichilia connaroides* are the major shrub species in the sub tropical region. Among herbs species, *Imperata cylindrical, Phramites karka,* and *Arundo donax* grow densely in the tropical region while *Ageratum conyzoides, Bidens pilosa, Cheilanthes bicolor, Cissampelos pareira, Sida cordata* etc. are key species in the sub-tropical region. The plant species found in this region are presented in Annex 4.1.

As shown in the land use map (refer Figure 4.8), the forests in the project VDCs are mostly of patchy nature and are found only in the steeper sections of the land (valley sections) or along the ridge summit of the hills and mountains. Only about 35% of the total land use is occupied by the forests. Most of the forested areas are degraded or are under the extreme influence of human and grazing animals. The present forest status, however, is better than it was a few decades ago. This positive trend in the forest quality and coverage is due to the community forestry and leasehold forestry intervention. A large tract of the forested areas was handed over to the communities and marginalized people for the community forestry and leasehold forestry in the recent years. In the future, with the present forest policy, it is envisaged that more and more government forest areas will be handed over to the local communities for the management. If this trend continues, the status of the existing forests shall be better than the present in the coming years.

4.3.1.2 Local Characteristics

There is a little different scenario in the local flora of the project sites in comparison to the regional vegetation discussed above. There is less flora diversity in the project area compared to the regional flora. Plant species recorded in the project sites are presented in Annex 4.2. A comparison of Annex 4.1 and 4.2 reveals the differences in the vegetation diversity in the project sites and regional context.

The status of the forest close to the project sites is similar to the regional forest status. In the vicinity of the project sites, most of the forest tracts are either under the community or private forestry (refer section 4.3.1.4) and are improving in the stock quality and biodiversity.

4.3.1.3 Flora of the Key Project Sites

a) Head Pond, Intake Canal and Headworks Site

These sites need to acquire the private land, private forests and community forests. The right bank of the site has private land and forest of Thechumbu VDC of Taplejung district. The major part of the left bank has community forests (Kabeli Garjite CF and Thulo Dhuseni CF) with some private land. The common tree species of the area are *Shorea robusta, Bombax ceiba, Adina cordifolia, Mallotus philippensis, Terminalia alata* while other associated species are *Duabanga grandiflora, Rhus javanica, Oroxylum indicum, Geruga pinnata*. The ground vegetation includes *Woodfordia fruticosa, Bauhinia vahlli, Hypericum cordifolium, Vitex negundo, Pogonatherum incans, Crysopogon gryllys, Themeda triandra.* Large tree species of are *Bombax ceiba*, *Geruga pinnata, Adina cordifolia* (DBH-86 -48cm), and other tree species are of medium and small sizes. The maximum height of 24m was recorded for *Geruga pinnata.* Detailedplots characteristics are presented in Annex 4.3 (Sample Plot 1, 2, 3, 4, 5, and 6). The forests are open, with little or moderate ground vegetation. The trees are highly lopped by human intervention. The conditions of the private forests are better than those of the community forests.

b. Material Quarry Site

The material quarry sites are located in the Thechumbu VDC of Taplejung district on the right bank of Kabeli River'sflood plain. The area close to the quarry sites is a private forest. *Shorea robusta* is the most dominant tree species. The associated tree species are *Bombax ceiba, Adina cordifolia, Terminalia alata, Mallotus philippensis, Geruga pinnata, Lagerstroemia parviflora,Terminali chebula, Terminalia bellirica.* Some pole sized trees of *Acacia catechu* also found in the river bank. Ground vegetation comprises *Lantana camara, Woodfordia fruticosa, Bauhinia vahlli, Colebrookea oppositifolia, Hypericum cordifolium, Crysopogon gryllys, Pogonatherum incans, Eulaliopsis binata, Digitaria ciliaris.* About 60% of the trees are mature with diameter up to 70 cm and 22m height

(*Bombax ceiba)*, up to 42cm DBH (*Shorea robusta*) and 43cm DBH (*Adina cordifolia*). Pole sized trees of *Shorea robusta; Adina cordifolia and Lagestroaemia parviflora* are more common in these sites.

c. Access Road to Headworks

The proposed road alignment follows the existing motorable earthen tract. The Thulo Dhuseni community forestis adjacent to the motorable corridor. The vegetation in this community forests is more luxuriant in comparison to the vegetation in the nearby sites. This community forests contain mature tree species. *Shorea robusta* is the most dominant tree species in this site. The major associated species are *Terminalia chebula, Mallotus philippensis, Rhus wallichii, Pinus roxburghii, Holoptelea integrifolia, Sapium insigne, Acer ablongum*. Prominent shrub species of this site include *Woodfordia fruticosa, Colebrookea oppositifolia, Lantana camara, Hypericum cordifolium, Bauhinia vahlli, Mussaenda macrophylla*. The common herbs are *Themeda triandra, Leucas cephalotes, Cissampelos pareira, Asparagus racemosus, Ampelocissus divaricata*. The common ferns are *Cheilanthes bicolor, Nephrolepis cordifolia* and *Dryopteris cochleata*. Annex 4.3, sample plots 10, 11 and 12 present the plot measurements, which clearly demonstrate the status and conditions of the forests along the access roads.

d. Headworks Labor Camp

The proposed headworks labor camp completely lies in the private agricultural land with few trees of *Adina cordifolia and Schima wallichi.*

e. Access Road to Powerhouse

The access road to the powerhouse starts from the Bhanu Chock of the Mechi highway. The existing motorable earthen track passes through the Bijulibhanjyang Community Forest, Madibung Salleri Community Forest and the private land. Bijulibhanjyang Community Forestis a pure pine forest dominated by *Pinus roxburghii* while major associated tree species are *Lyonia ovalifolia, Castanopsis indica, Engelhardtia spicata, Schima wallichii, Rhus javanica*. Most of the pine trees are mature with 12 to 80 cm diameter and with the ecologically sound regeneration status. Major shrub species are *Woodfordia fruticosa, Melastoma melabathricum, Rubus ellipticus, and Berberis aristata*. Important herbaceous species are *Cyperus cylindrical, Eupatorium adenophorum, Pogonatherum incans, Leucas cephalotes, and Sida cordata.* Different species of lichens are also common in this area.

The upper part of the Madibung Salleri Community Forest is dominated by *Pinus roxburghii,* while the lower part is dominated by Sal forest. *Shorea robusta* is the dominant tree and the major associated trees are *Terminalia alata, Lagerstroemia Parviflora, Terminalia chebula, Terminalia bellirica, Semecarpus anacardium*. Due to a steep slope and rocky cliffs the vegetation is not luxuriant in comparison to the other sites. Most of the tree species are large and medium sized and record diameter (55cm) was found of*Shorea robusta*. The common shrub species are *Woodfordia fruticosa, Desmodium oojeinense, Colebrookea oppositifolia* and *Bauhinia vahlli,*while *Desmodium multiflorum, Themeda triandra, Eulaliopsis binata, Pogonatherum incans, Calopogonium mucunoides* are the most common herb species. *Cheilanthes bicolor* is the most common among the fern species.

f. Powerhouse Site

Some part of the powerhouse site is located in the Pinase Leasehold Forest, which was recently leased by the District Forest Office of Panchthar District to the Pinase community. The area has a few tree species with some cultivated land and is located on the right bank of Tamor River. There is a large *Bombax ceiba* tree with the diameter of 92 cm and a few medium sized *Shorea robusta, Lagerstroemia parviflora, Adina cordifolia*. The major shrub species are *Woodfordia fruticosa, Colebrookea oppositifolia, Lantana camara, Vitex negundo*and *Pogonatherum incans, Eupatorium odoratum, Leucas* *cephalotes, Eulaliopsis binata, Ageratum conyzoides* etc are the major herbs. *Dryopteris cochleata* and *Cheilanthes bicolor* are common ferns. Annex 4.3, Sample Plot 7 presents the plot measurements in the powerhouse area and signifies the forest characteristics and the area status.

g. Penstock Portal and Surge Shaft

The penstock portal lies in the Pinase leasehold forest while the surge shaft lies in the private forest with a similar type of vegetation. The vegetation status of these forests is slightly degraded compared to that of the community forests. *Shorea robusta* is the dominant tree species. Other common associated trees are *Adina cordifolia, Terminalia alata, Lagerstroemia parviflora, Acacia catechu*. *Woodfordia fruticosa, Colebrookea oppositifolia, Antidesma bunius* etc are major shrub species while herb species are *Heteropogon contortus, Eupatorium odoratum, Bidens pilosa, Crysopogon gryllys* etc and *Cheilanthes bicolor* is a common fern. Annex 4.3, Sample Plot 8 and 9 presents the plot measurements of the penstock and surge tank area showing the characteristics and status of the forests in these areas.

h. Engineer’s Camp at Powerhouse

Some parts of the engineer’s camp at the powerhouse lie in the private forest with *Acacia catechu and Shorea robusta* as dominant tree species. The common shrub species are *Lantana camara, Woodfordia fruticosa* and the herb species include *Ageratum conyzoides, Eupatorium odoratum, Eupatorium adenophorum, etc.* Annex 4.3, Sample Plot 12 represents the plot measurement of the forest signifying the type and status of the forests.

4.3.1.4 Forest Management

The forest of the project area is the **National Forest** managed directly and indirectlyunder the supervision of the District Forest Office. There are a few patches of forests in the private land in the Panchthar district which are not officially registered in the District Forest Office.

Within the **National Forest**, there are 3 categories of forests:(i) the first are the forests handed over to the forest user communities under the **Community Forests (CF)**; (ii) the second are the forests handed over to the local people on lease under the **Leasehold Forest (LF);** and (iii) the third are the forests and other **Government Managed Forests (GMF)** directly managed and supervised by the Regional Range Post of the District Forest Office.

The headworks and the headpond area located at the right bank of Kabeli River lie in the community national forest of Thechambu VDC.The headworks and the headpond area located at the left bank of Kabeli River lie in the Kabeli Garjite and Thulo Dhuseni CF of Amarpur VDC. The access road to headworks passes throughThulo Dhuseni CF of Amarpur VDC and the forest along the access road to the powerhouse is the Bijulibhanjyang CF and Madibung Salleri CFof Amarpur VDC. The forest area of the penstock portal and the powerhouse lie in Pinasi LF.

4.3.1.5 Rare/ Endangered/Threatened and Endemic Plants

The community forest located at the project vicinity and within the project sites show the presence of the following species (Table 4.17) listed as Endangered/Threatened or Protected species under the GoN Forest Act 1993and CITES Annexes. However, all listed species of the project area are common species in Nepal and have a wider distribution in the project VDCs and districts.

Table4.17: List of Rare/Endangered/Threatened and Endemic Plants in the Project Region

SN	Botanical Name	Local Name	English Name	CITES list	GON
1	*Shorea robusta*	Sakhuwa	Sal tree		Protected
2	*Bombax ceiba*	Simal	Silk cotton tree		Protected
3	*Dioscorea deltoidea*	Ban tarul	Deltier yam	II	
4	Different lichens species	Jhyau	Lichens		Protected
5	Different species of Orchids	Sungava	Orchids	II	

Note: *Government of Nepal Forest Act (1993): + Protected*
IUCN Red Book: +CT Critically threatened; +V Vulnerable, +R Rare,
CITES: Appendix I (species that are threatened with extinction and are or may be affected by trade), II - Appendix II (species that are not necessarily threatened with extinction, but may become such unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with the survival of the species in the wild), and Appendix III (species that are listed after one member country has asked other CITES Parties for assistance in controlling trade in these species).

4.3.1.6 Agro Biodiversity

The study area comprises traditional farming systems characterized by the integrated crop-livestock production, sub-systems for the subsistence of the households. Farmers cultivate mostly in terraced upland and grow a number of cereals like maize, millets, wheat, Simal tarul (*Manihot esculenta*), various pulses, mustard, vegetables and some perennial crops like fruits, fodder, and timber species mostly for home consumption under rain-fed conditions. Few farmers own some irrigated low lands and grow rice, potato, wheat, mustard and other vegetables under the irrigated conditions.

A mixed cropping pattern is common in the project affected areas. The farming system is traditionally a mixed one in which the farmers grow almost all crops necessary to meet the food requirements of the family, to feed animals and to cash for purchasing other daily necessities. Depending upon landholding size and type, farmers grow 2-3 crops in the same parcel of land. The household has developed its own way of cropping patterns for *Khet land* (irrigated low lands) and *Bari land* (uplands). The cropping pattern in these lands varies with the season. Normally, in the irrigated lands farmers grow three crops in a year: wheat, maize and rice. Some households grow mustard, potatoes and other winter vegetables between rice and maize crops. In uplands maize, millet and manioc/cassava are the most common cereal crops grown by almost all farmers in the upland area. The cropping patterns of the upland are quite different from the irrigated land. Annex 4.4presents the commonly grown varieties of cereals/pseudo cereals, vegetables, fruits, pulses, and spices recorded at the project area. Most of the agro cereals, vegetables, fruits, pulses and spices are common to all upper tropical and subtropical climatic areas of Nepal. The available information does not report the presence of agro-variety worthy of protection from the project sites.

4.3.1.7 Ethno-botany

Ethno-botanical study of the project area was conducted during the field visit. The study showed that local people are dependent on forests and forest based non-timber forest products (NTFP) in the direct and indirect ways. People are using the forest based resources like fuel wood, fodder, vegetables, medicines, timber, wild fruits to partially fulfill their daily needs. Furthermore, the forest products are income sources (partially) of the local people. Collection of wood, wild fruits and vegetables for own consumption and sale in the local market is the common practice in the area. Annex 4.5presents the recorded ethno-botanical uses of various plant species of the project area.

4.3.1.8 Biodiversity andEcological Status of the Forests

The results of the quadrant study of the project's different representative plots (refer Annex 4.3) give the status of the forest vegetation. Altogether 168 plant species are recorded in the project affected areas. Among these species, 61 are trees, 22 shrubs, 62 herbs, 15 climbers, two lichens, four mushrooms and two epiphytic plant species (refer Annex 4.2).

The dominant tree species in the upper tropical region of the project site is *Shorea robusta* and *Pinus roxburghii* - in the sub-tropical region of the project site. The basal area of the measured plots indicates that the forest within the community forest category is more mature than that of the forest managed privately or by the government.

The ground vegetation is very poor in the *Pinus roxburghii*dominant forest in comparison to *Shorea robusta* dominated forest. The regeneration status of tree species is better in the *Shorea robusta* forest.

4.3.2 Terrestrial Wildlife

Kabeli River flows east to west as the bordering river system between two districts Taplejung and Panchthar. The headworks of the project lie in the Kholakharka area (Dhuseni) of the Kabeli village of Amarpur VDC, Panchthar at 560mmasl (Photograph 4..1). A small market place, the Kabeli Bazaar, is just above the bridge of Kabeli River.

Photograph 4.1: Headwater area of Kabeli-A hydroelectric project

The diversion dam, reservoir, intake structure and tunnel intake are among the headworks, which completely lie near Kholakharka area. They are connected through a tunnel into the mountain and the outlet lies near the cemetery area of Pinase (Majhigaun) on the bank of Tamor River (Photograph 4.2).

Photograph 4.2: Powerhouse area of Kabeli hydroelectric project

Currently, the bank of Tamor River at the proposed powerhouse site is barren land and also a part of an agricultural field and a local cemetery. A small patchy forest area exists on the western slope of Majhigaun that joins the banks of the Tamor.The cemetery is not affected by the project.

The dominant forest tree species in the project region is hill sal forests (*Shorea robusta).*In the lower valley areas and in the upper parts they consist of natural and afforested *Pinus roxborghii* or *Pinus wallichiana* forest in the steep slope and in the uphill areas of the valley (Photograph 4.3). However, due to the extension of the agricultural field since the time of local migration, the existing forest is open and in degraded conditions. Tree stands are distributed only in the inclined areas where human settlements and agricultural practices are impossible. Ground vegetation, in the moist valley basin area, is dense while the south facing slope and the landslide area are scarce. These forest areas are not a suitable habitat for medium and large animals and for diverse biodiversity.


Photograph 4.3: Degraded and pine afforested forests patches around Bijuli Danda along the access road

The plant species of the forest patches of the project influence areas include: *Schima wallichii*, Golthakra, Kag Bhalayo, Tanki,*Bauhinia purpurea*, *Bahunia vaheli*, *Phyllanthus embelica*, *Terminalia bellerica*, *Terminalia alata, terminalia chebula*, Sandan, Kapro, Guyelo, Tilke, *Alnus nepalensis*, Syalphusre, Khamari, *lagestroima parviflorea*, Pangre, Birali lahara, tadi, chiuri, *Woodfordia fruiticosa*, Lampate, Karam, *Spatholobus parviflores*, and Rukh bayeramong others. Few scattered *Bombax ceiba* trees are also available in the area. One large Simal tree is protected by the local Majhi people for worshiping their ancestors and it is part of local rituals (Photograph 4.4). This tree is outside of the project boundary and unlikely to be directly impacted by the project activities. There is a possibility to impact the tree due to workers presence and sanitation/ open defecation etc. It shall be controlled and the conditions around the tree shall be monitored.

The slope facing west of the eastern part of Majhigaun is very poor, because of both the dry ground conditions and excessive cattle grazing. People are dependent on this forest for their daily cattle grazing and the fuel wood supply. There is no perennial source of water in the slopes and the top soil is very thin. The less moisture content in the rocky parts of the slope cause dryness in the village area and it seems to hinder the growth of tree species other than pines. Therefore, the forests consist of stunted, thin trees that are scattered. The area is not suitable for wildlife habitat except for a few solitary animals such as ghorals and barking deers. Some seasonal bird species visit the area. Herpeto-fauna is scarce, representing only a few common snakes and lizard species.

Photograph 4.4: Simal tree and Amala fruiting in the Pinase (Majhigaun) near the power house area

4.3.2.1 Mammals

The project development sites houses just a few animal species as the forest area is scattered due to the excessive population density and agricultural encroachment. However, a list of mammalian diversity reported in the project region is presented in the Table 4. 18. The project development site, especially the headworks, reservoir and access road have noticeable forests only at the north-facing slope due to the influence of local water resources (Photograph 4.5). It is not a prime habitat or a migratory route of conservationally or economically important mammals, though a few animals seasonally might visit forests in the vicinity of the project area.

Typical habitat in the project area is a sparsely distributed forest which in some parts can be rated as degraded or scattered and the remaining landmass is either barren land or an agricultural field. Local people anecdotes and observations during the field visits indicate that there is a remote possibility of finding solitary animals such as barking deer or ghoral in such habitats. The Himalayan black bear, porcupine, jackal, civet and monkey species are considered as pest animals by farmers, as they are seasonal crop raiders in the agricultural fields and orchard farms. Leopards are considered cattle baby lifters, so are the wild cats. Therefore, the villagers drive away the “nuisance” animals and sometimes react by killing wild animals and consequently become the cause behind the reduction of the wild animals population of in these forests. It appears that occasionally a few wild mammals visit the project development area for different purposes, perhaps as a seasonal migratory route, or for occasional feeding purposes, or for a temporary habitat, or for socially driven animals *(Neofelis nebulosa, Panthera pardus, Semnopithecus hector, Macaca mulatta, Martes flavigula,* and even jackals and jungle cats, etc). Occasionally, the protected pangolin species were seen in the project area in the past raising human sensitivity for the wild animals. Special measures (a compensatory forestation program, work schedules restrictions and workers behavior codes) will be implemented during the construction period and included in the EMP.


Photograph 4.5: A small patch of forest near Headwork and thin vegetation near Quarry Site

Table4.18: Mammals Recorded in Project Sites (participatory information from locals)

SN	Common Names	Scientific Names	Status of occurrence			Habitat				Migratory Status/ season		Reported location
			Common	Sparse	Rare	F	B	O	A	M/R/V	S	
1	Indian Hare	*Lepus nigricollis*	√			√				R		F
2	Particoloured Flying Squirrel	*Hylopetes alboniger*		√		√			√	R		F
3	House Rat	*Rattus rattus*	√						√	R		A
4	Brown Rat	*Rattus norvegicus*	√						√	R		A
5	Indian Crested Porcupine	*Hystrix indica*	√			√				R		F,A
6	Chinese Pangolin	*Manis pentadactyla*		√		√				R		F
7	Jungle cat	*Felis chaus*	√			√				R		F
8	Small Indian Mongoose	*Herpestes auropunctatus*	√			√			√	R		F,A
9	Bengal Fox	*Vulpes bengalensis*			√	√				M	S	F
10	Golden Jackal	*Canis aureus*			√	√				M	S	F
11	Mountain Weasel	*Mustella altaica*		√		√				R		F
12	Asian Mouse Shrew	*Suncus murinus*	√						√	R		F
13	Indian Flying Fox	*Pteropus giganteus*	√			√				R	S	F
14	Tarai Grey Langur	*Semnopithecus hector*	√			√				R		F,A
15	Rhesus Macaque	*Macaca mulatta*	√			√				R		F,A
16	Barking Deer	*Muntiacus muntjak*	√			√				R		F
17	Common Goral	*Naemorhedus goral*	√			√				R		F

SN	Common Names	Scientific Names	Status of occurrence			Habitat				Migratory Status/ season		Reported location
			Common	Sparse	Rare	F	B	O	A	M/R/V	S	
18	Himalayan Black bear	*Ursus thibetanus*			√	√				M		F
19	Large Civet	*Viverra zibetha*		√		√				R		F
20	Small Civet	*Viverricula indica*		√		√	√			R		F, A
21	Clouded Leopard	*Neofelis nebulosa*			√	√				M		F
20	Common Leopard	*Panthera pardus*		√		√	√			M		F
21	Yellow-Throated Marten	*Martes flavigula*	√				√	√	√	R		A
22	Bat	*Scotophilus heathi*	√				√			R	S	F

Note: Habitats = F- forest, B – Bush, O- Open grass land, A – Agricultural land, Migratory status and season = M – Migratory, R = Resident, V = Visitor occasionally, S – migration season Reported Location: F- Forest, A- Agricultural Land.

4.3.2.2 Avi-fauna

The habitat observed for the project site is dominated either by the small girth *Shorea robusta* or by *Pinus roxburghii*. As noted above, the forest observations confirmed that forests managed by communities have more mature individual trees than forests managed privately of by the GoN. The ground vegetation is very poor especially in the *Pinus roxburghii* dominant forests. Birds and other mammals are attracted with fruiting, flowerings and young leaves for their food. The project sites do not seem to have such plant species that could attract avi-fauna. Adjoining community forests and government forests are dominated by the non-palatable species. Indeed, the habitat diversity does not support the diversity of bird species. The degraded area can only sustain a few bird species diversity. The present study shows that the high bird's diversity in the project area (Table 4.19) is due to incorporation of the species passing through the project area seasonally during their migration.

Table 4.19: Avi-fauna recorded for Project sites (participatory information from locals)

SN	Common Names	Scientific Names	Status of occurrence			Habitat				Migratory Status/ season		Reported location
			C	Sp	Ra	F	B	O	A	M/R/V	S	
1	Red Jungle fowl	*Gallus gallus*	√				√			R		Forest
2	Small Button quail	*Turnix sylvatica*		√			√			R		Forest
3	Kalij Pheasant	*Lophura leucomelanos*		√		√				R		Forest
4	Indian Peafowl	*Pavo cristatus*		√		√				R		Forest
5	Common Shelduck	*Tadorna tadorna*		√		√				M	S	River
6	Rufous Woodpecker	*Celeus brachyurus*	√			√				R		Forest
7	Pale-headed Woodpecker	*Gecinulus grantia*		√		√				R		Forest
8	Great Barbet	*Megalaima virens*	√			√				R		Forest
9	Indian Grey Hornbill	*Ocyceros birostris*			√	√				M	S	Forest
10	Green-billed Malkoha	*Phaenicophaeus tristis*	√			√				R		Forest
11	Alexandrine Parakeet	*Psittacula eupatria*	√			√			√	M	S	Ag. Land
12	Mountain Scoops Owl	*Otus spilocephalus*			√	√				R		Forest
13	Rock Pigeon	*Columba livia*	√						√	R		Settlement

SN	Common Names	Scientific Names	Status of occurrence			Habitat				Migratory Status/ season		Reported location
			C	Sp	Ra	F	B	O	A	M/R/V	S	
14	Oriental Turtle Dove	*Streptopelia orientalis*	√			√			√	R		Ag. Land
15	Spotted Dove	*Streptopelia chinensis*	√			√			√	R		Ag. Land
16	Orange-breasted Green Pigeon	*Treron bicincta*		√		√				R		Forest
17	River Lapwing	*Vanellus duvaucelii*	√							R		Streams
18	Red-wattled Lapwing	*Vanellus indicus*	√							R		Streams
19	Black Kite	*Milvus migrans*		√		√				R		Forest
20	Northern Goshawk	*Accipiter gentilis*	√			√				R		Forest
21	Little Cormorant	*Phalacrocorax niger*		√						M	S	Forest
22	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	√			√				R		Forest
23	Large-billed Crow	*Corvus macrorhynchos*	√						√	R		Settlement
24	Long-tailed Minivet	*Pericrocotus ethologus*		√		√				R		Forest
25	Black Drongo	*Dicrurus macrocercus*	√			√				R		Ag. Land
26	Common Myna	*Acridotheres tristis*	√						√	R		Settlement
27	Red-whiskered Bulbul	*Pycnonotus jocosus*	√			√				R		Ag. Land
28	Himalayan Bulbul	*Pycnonotus leucogenys*	√			√				R		Ag. Land
29	Red-vented Bulbul	*Pycnonotus cafer*	√			√		√	√	R		Ag. Land
30	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	√			√				R		Near Ag. Land
31	Grey-sided Bush Warbler	*Cettia brunnifrons*		√			√			R		Forest
32	House Sparrow	*Passer domesticus*	√						√	R		Settlement
33	Dark kite	*Milvus migrans*	√				√		√	R		Settlement
34	Wooly-necked Stork	*Ciconia episcopus*		√						M		Wetland
35	Common Hoopoe	*Upupa epops*	√					√	√	R		Ag. Land
36	Rose-ringed Parakeet	*Psittacula krameri*	√			√		√	√	R		Ag. Land
37	Long-tailed Shrike	*Lanius schacth*	√				√	√	√	R		Ag. Land
38	Oriental White-eye	*Zosterops palpebrosus*	√				√			R		Open area

Note: Status of Occurrence: C – Common, Sp – Sparse, and Ra - Rare
Habitats = F- forest, B – Bush, O- Open grass land, A – Agricultural land,
Migratory status and season = M – Migratory, R = Resident, V = Visitor occasionally, S – migration season

4.3.2.3 Herpeto-fauna

Because of the high human activities, sparse vegetation and agricultural encroachment, there are very few animal species residing in the project area. The project area with lots of disturbances could not be a safe home for the rare and endangered species. However, some of the herpeto-species diversity is reported in a combined format from the headworks area and the powerhouse site.

The herpeto-fauna in the project region according to the literature is presented in Table 4.20. It comprises frogs, toads, snakes and lizards. Frog is neglected, snake is considered harmful, and lizards are useless for local people. These species are only used by some local healers for rituals. The available species, however, have a great importance to the ecosystem maintenance. Presence of the herpeto-fauna, especially snake species, in the inner valleys of the mountain is strong indication of the sub-tropical ecosystem in the project area. As inner valleys receive frequent chilly northern winds, lowering atmospheric temperature for longer periods, snakes seem to be occasional in the headworks area. However, the powerhouse area is south facing and the average sunshine there is longer, snakes and lizards are frequent while dryness causes the diversity of frogs and toads to decline. Instead local villagers report much more insects from the Pinase area during that season.

Table 4.20: Herpeto-fauna recorded for project sites (participatory information from locals)

S.N	Common Names	Scientific Name	Status of occurrence			Habitat				Migratory Status/ season		Reported location
			C	Sp	Ra	F	B	O	A	M/R/V	S	
1	Himalayan Toad	*Bufo himalayanus*	√			√			√	R		Ag. Land
2	Common Asian Toad	*Bufo melanostictus*		√		√			√	R		Settlement
3	Skittering frog	*Euphlyctis cyanophlyctis*	√						WB	R		Streams
4	Annandale's bush frog	*Philautus annandalii*	√				√			R		Ag. Land
5	Common garden lizard	*Calotes versicolor*	√			√			√	R		Settlement
6	Variegated mountain lizard	*Japalura variegata*		√		√				R		Forest
7	Bengal monitor	*Varanus bengalensis*			√	√				R		Forest
8	Yellow monitor	*Varanus flavescens*			√	√				R		Forest
9	Eastern trinket snake	*Elaphe cantoris*			√				√	R		Settlement
10	Himalayan trinket snake	*Elaphe hodgsonii*	√			√			√	R		Ag. Land
11	Spectacled cobra	*Naja naja*			√	√			√	R		Ag. Land
12	Mounten pit viper	*Ovophis monticola*	√			√			√	R		Settlement
13	Common bronzed-back tree snake	*Dendrelaphis tristis*		√					√	R		Settlement

Note: Status of Occurrence: C – Common, Sp – Sparse, and Ra - Rare
Habitats = F- forest, B – Bush, O- Open grass land, A – Agricultural land, WB- Water bodies
Migratory status and season = M – Migratory, R = Resident, V = Visitor occasionally, S – migration season

4.3.2.4 Terrestrial Wildlife of Conservation Significance

Among the reported terrestrial wildlifein the project site forests, the following are of a conservation significance as per the GoN, IUCN Redbook and CITES Appendices (Table 4.21).As elaborated before, the terrestrial wildlife of a conservation significance visit the project site forests only occasionally.

Table 4.21: Terrestrial Wildlife of Conservation Significance

SN	Scientific Name	Local Name	English Name	CITES Appendix	IUCN Redbook	GON
1	*Macaca mulatta*	Bander	Rhesus Macaque	III	LC	
2	*Neofelis nebulosa*	Dhase chituwa	Clouded Leopard	I	VU	
3	*Panthera pardus*	Chituwa	Common Leopard	I	NT	
4	*Manis pentadactyla*	Kalo Salak	Chinese Pangolin	*II*	EN	√
5	*Semnopithecus hector*	Langur bader	Tarai Grey Langur	I	LC	
6	*Naemorhedus goral*	Ghoral	Common Goral	I	NT	
7	*Canis aureus*	Fauro	Golden Jackel	I	LC	
8	*Pteropus giganteus*	Chamero	Indian Flying Fox	*II*	LC	
9	*Ursus thibetanus*	Kalo Bhalu	Himalayan Black Bear	*I*	VU	
10	*Naja naja*	Kobra	Spectacled cobra	*II*	LC	
11	*Varanus bengalensis*		Variegated mountain lizard	*I*	LC	
12	*Varanus flavescens*		Yellow monitor	*I*	LC	P

Note: *Government of Nepal Forest Act (1993): √Protected*
*IUCN Red Book: **VU** = Vulnerable, **EN**= Endangered, NT = Near threatened, LC = Least concern*

CITES: Appendix I (are species that are threatened with extinction and are or may be affected by trade), II - Appendix II (re species that are not necessarily threatened with extinction, but may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with the survival of the species in the wild), and III - Appendix III (are species that are listed after one member country has asked other CITES Parties for assistance in controlling trade in a species).

4.3.3 Aquatic Flora and Fauna

Surveys on fish and fishermen were carried out in Kabeli River in October 2010 (by the EIA Consultant) and in July 2013 (by KEL's fish expert in coordination with an international fish expert). Continuation will be given to the fish sampling during construction and operation of the project to supplement the information required for fish diversity in the Kabeli basin.

Most of the fishermen reported in the area are part-time fishermen. A majority of them go for fishing for recreational purposes in their leisure time. Only a few households have adopted fishing as a profession but only in the non-agricultural periods.They often sell the caught fish, in excess of self-consumption, to the local markets for economic gains.According to the local fishermen and communities, the fish population of the area has been rapidly declining in recent years due to illegal fishing practices, such as pesticide poisoning and electro-fishing. Fish species knowledge of the community majority relates mainly to the Asala and Kabre, which are considered local delicacies. According to a few people, the name Kabeli to the river is taken after Kabre fish, the population of which is currently practically non-existent.

4.3.3.1 Sampling Sites

The following sampling areas (Table 4.22 and 4.23)were assessed during a field study to evaluate the aquatic flora and fauna of the project affected sites:

Table 4.22: Description of Sampling Station of KAHEP Affected Sites (October 2010)

SN	Station Nos.	Sites	District	VDC	Ward No.	Village	River Bank
1	1	Dam Site	Taplejung	Thechmbu	6	Khimuna	Rightside
2	2	Down stream of Dam site	Panchathar	Amarpur	6	Lekadaha	Leftside
3	3	Upsteram of Kabeli confluence with Tamor	Taplejung	Nangkholyang	6	Khahare	Rightside

Source: EIA Field Survey, 2010

Table 4.23: Description of Sampling Station of KAHEP Affected Sites (July 2013)

SN	Station Nos.	Sites	District	VDC	Ward No.	Village	River Bank
1	1	11 KM upstream of dam site	Taplejung	Panchami	5	Panchami Bazar	Left side
2	2	8 KM upstream of dam site	Panchathar	Therpu	5	Dobhan	Left side
3	3	Downstream of dam	Panchather	Amarpur	6	Lekadaha	Leftside
4	4	Kabeli confluence at Tomor	Taplejung	Nangkholyang	6	Khahare	Rightside

Additional Fish survey July 2013

4.3.3.2 Ecological Conditions of the River Bed and Flood Plain

Kabeli River stretch in the reservoir and the downstream sections to the confluence with Tamor River (directly project affected area) is a fast flowing river with series of rapids, runs and pools (Table 4.24). During the field visits theleft and right banks of the river (depending on the water depth and flow) had a number of spawning and rearing grounds for fishes. This spawning ground information of the selected species will be mapped along the affected stretch of the river and in the river section upstream of the dam site.

However, these sites change year after year especially after the moonsoon floods. The river bed material is comprised of boulders, cobbles and pebbles with sandy admixtures. Occasionally, the river banks and boulders show growth of the green algae.

Table 4.24: Aquatic Habitat Characterization of Kabeli River in the Directly Project Affected Area

Site No. (refer Figure 1.2)	Name of Sampling site	Habitat Characterization (Estimated)	Major spawning area	Major Rearing area
1	Dam Site	Run type of water ▪ Rapid flow (80 %) ▪ Run (10 %) ▪ Deep and shallow pools (5 %) ▪ Riffle (5 %)	Three spawning areas between Dam site to Khimuna hanging bridge	Three rearing grounds in between Dam site to Confluence of Puwa khola
2	Downstream of Dam site	Run type of water ▪ Rapid flow (75 %) ▪ Run (10 %) ▪ Deep and shallow pools (10 %) ▪ Riffle (5 %)	Six spawning areas between Kabeli hanging bridge to Khola Kharka. And Bichbagar daha	Five rearing grounds between Kabeli hangingbridge to Khola Kharka.
3	Upsteram of Kabeli confluence with Tamor	Run type of water ▪ Rapid (70 %) ▪ Run (20 %) ▪ Deep and shallow pools (5 %) ▪ Riffle (5 %)	Five spawning areas between Kakaro to Kabeli hanging bridge	Two rearing grounds in between Kakaro to Kabeli hanging bridge.

(Field visit on October 3-10, 2010)

4.3.3.3 Fish

A total of 31 fish species were recorded during the field survey. Out of 31 recorded species, 12 species were found during the field survey in October 2010 and 9 were registered in July 2013, the remaining 19 species were reported by local residents during interviews in October 2010. *Schizothorzx richardsonii, Schizothorax progastus*, *Botia lohachata, Botia almorhae, Glyptothorax pectinopterus, Glyptothorax cavia, Glyptothorax telchitta, Noemacheilus beavani, Noemacheilus botia, Neolissocheilus hexagonolepis, Tor tor, Tor putitora, Bagarius yarrelli,Garra annandalei*, *Barilius bendelisis*, and *Labeo dero* are the major species observed and reported during the field visit. Tables 4.25 and 4.26 present the number of observed species in the different sampling stations in 2010 and 2013, while Tables 4.27 and 4.28 present the species observed during the sampling period in 2010 and 2013 respectively. Table 4.29 gives the total number of fish species observed and reported in Kabeli River in 2010 .

Table 4.25: Number of Fish Species Recorded and Observed in the Sampling Stations (2010)

Station No	Station	Unit	Field Visit	
			Total Observed	Total Recorded
Site No. 1	Dam Site	Number	6	23
Site No. 2	Down stream of Dam site	Number	10	21
Site No. 3	Upsteram of Kabeli confluence with Tamor	Number	10	21

(Field Survey:October 3-10, 2010)

Table 4.26: Number of Fish Species Recorded and Observed in the Sampling Stations (2013)

Station No	Station	Unit	Field Visit	
			Total species Observed	Total no. of fish Recorded
Site No. 1	11 KM upstream of dam	Number	4	5
Site No. 2	8 KM upstream of dam	Number	3	6
Site No. 3	Downstream of dam	Number	7	13
Site No. 4	Kabeli confluence at Tamor	Number	5	13

(Field Survey: July7- 11, 2013)

Table 4.27: Fish Species Recorded in Sampling Stations (2010)

S.N	Scientific Name of Fish	Local Name of Fish	Site N. 1	Site N. 2	Site N. 3
1	*Barilius bendelisis*	Fakata		+	+
2	*Barilius Vagra*	Faketa		+	+
3	*Crossocheilus latius*	Lohari	+	+	+
4	*Garra annandalei*	Buduna	+	+	+
5	*Garra gotyla*	Buduna	+	+	+
6	*Glyptosterrum blythi*	Tilkabre	+	+	+
7	*Labeo dero*	Gardi	+	+	+
8	*Neolissochilus hexagonolepis*	Katle	+	+	+
9	*Psilorhynchuspseudecheneis*	Tite	+	+	+
10	*Schizothorax progastus*	Chuchche asala	+	+	+
11	*Schizothorax richardsoni*	Buchche asala	+	+	+
12	*Tor putitora*	Sahar		+	+
	Total		**6**	**10**	**10**

(Field Survey:October 3-10, 2010)

Table 4.28 Fish Species Observed in Sampling Stations (2013)

S.N	Scientific Name of Fish	Local Name of Fish	Site N. 1	Site N. 2	Site N. 3	Site N. 4
1	*Barilius bendelisis*	Fakata	+			+
2	*Crossocheilus latius*	Lohari			+	+
3	*Garra gotyla*	Buduna, Hoya	+		+	
4	*Labeo dero*	Gardi				+
5	*Neolissochilus hexagonolepis*	Katle	+	+	+	+

6	*Psilorhynchuspseudecheneis*	Tite		+	+	
7	*Schizothorax richardsonii*	Buchche asala	+	+	+	+
8	*Botia lohachata*	Baghi, Sisne			+	
9	*Pseudecheneis sulcatus*	Kabre			+	
	Total		**4**	**3**	**7**	**5**

(Field Survey:July7-11, 2013)

Table 4.29: Fish Species Observed and Recorded in Sampling Stations (2010)

SN	Scientific Name of Fish	Local Name of Fish	Site N. 1		Site N. 2		Site N. 3	
			Observed Species	Reported Species	Observed Species	Reported Species	Observed Species	Reported Species
1	*Anguilla bengalensis*	Rajbam		+		+		+
2	*Bagarius yarrelli*	Gonch		+		+		+
3	*Barilius barila*	Faketa		+		+		+
4	*Barilius bendelisis*	Fakata		+	+		+	
5	*Barilius shacra*	Fakata		+		+		+
6	*Barilius Vagra*	Faketa		+	+		+	
7	*Botia almorhae*	baghi		+		+		+
8	*Botia lohachata*	Chital baghi		+		+		+
9	*Clupisoma garua*	Jalkapoor		+		+		+
10	*Crossocheilus latius*	Lohari		+	+			+
11	*Garra annandalei*	Buduna	+		+		+	
12	*Garra gotyla*	Buduna	+		+		+	
13	*Glyptosterrum blythi*	tilkabre		+		+	+	
14	*Glyptothorax cavia*	Kabre		+		+		+
15	*Glyptothorax pectinopterus*	Kabre		+		+		+
16	*Glyptothorax telchitta*	Rato kabre		+		+		+
17	*Heteropneustes fossilis*	Singhi		+		+		+
18	*Labeo angra*	Theda		+		+		+
19	*Labeo dero*	Gardi	+		+		+	
20	*Mastacembalus armatus*	Bam		+		+		+
21	*Neolissochilus hexagonolepis*	Katle	+	+	+		+	
22	*Noemachilus beavani*	Gadela		+		+		+
23	*Noemacheilus botia*	Gadela		+		+		+
24	*Psedecheneis sulcatus*	Kabre		+		+		+
25	*Psilorhynchuspseudecheneis*	Tite (Endemic)	+		+			+
26	*Puntius conchonius*	Pothia				+		+
27	*Puntius ticto*	pothia				+		+
28	*Schizothorax progastus*	Chuchche asala		+	+		+	
29	*Schizothorax richardsoni*	Buchche asala	+		+		+	
30	*Tor putitora*	Sahar		+		+	+	
31	*Tor tor*	Sahar		+		+		+
	Total		**6**	**23**	**10**	**21**	**10**	**21**

Source: Field visit, 2010

Though the surveyed river stretch is small, there is a distinct difference in the fish species composition from the upstream to downstream section. The downstream section shows the higher number of fish species compared to the upstream areas. Studies elsewhere in Nepalese Himalaya also show the lower fish species composition in the upstream areas than in the downstream areas (Himal Power Ltd. 2006; EIA Middle Marsyangdi, 2001, T. Petr, 2002).

Depending on the river flow, seasons, water depth, food availability and waster temperature, fish species occupy different river stretches, hence, the sampling survey conducted only twice in three years might not have captured the entire composition of fish diversity as reported by the local fishermen. Therefore, to capture the reported diversity composition of the fish species, the sampling study needs to be expanded to other seasons during early stages of construction periods and through commencement of operations. This sampling will be started during a monsoon season in 2013 and will be followed up in the project's EPM. As part of the EMP, the sampling stations up to 10 km upstream of the headworks are supposed to obtain more information on the fish species gradient in the river (refer Section 6.1.1.2, chapter VI and Section 8.3, Chapter VIII for details of the potential sampling stations).

4.3.3.3.1Key Fish Species of Kabeli Khola

a) Long Distance Migratory:

***i) Tor Putitora* (Sahar)- Golden mahseer**

A commonly known as Sahar fish has the head length greater than the body height; snout long and pointed body color yellow golden dorsally; anal and pelvic fins tips yellow; and is a popular game fish. Among the five long migratory fish species reported in the project area, this is the only long distance migratory fish that was observed during the fish sampling survey at the project site. This fish is omnivorous and feeds on insects, rotifers, and protozoan algae. This specie prefers clear gravel streams (Shaw and Shebbeare 1937), pools and runs of swift gorges (Shrestha, 1990), rapid streams with rocky bottom (Menon, 1999). It normally prefers pools and rapidsfor rearing and spawning. The eggs are laid under the rocks (Daniels, 2002). This species has wide distribution in Nepal and is reported in all river networks of Koshi, Gandaki, and Karnali, the eastern, central and western regions of Nepal. This fish starts an upstream migration in rivers during high floods. Normally Sahar spawns in the confluence areas where smaller streams flow into rivers. High oxygen content and moderate water velocity is preferred. Suitable spawning depth is between 2 and 5 meters, and spawning is reported to take place during July and October. Preferred temperatures for spawning are between 18.5 Cand 33C (Gurung et.al 2002). This species is reported up to the elevation of 1.250masl in the major rivers fed by snow in Nepal (T. Petr, 2002). A mature female of Sahar of 45 cm length can yield from 6,300 to 28,000 eggs.

***Tor putitora* (Sahar)**

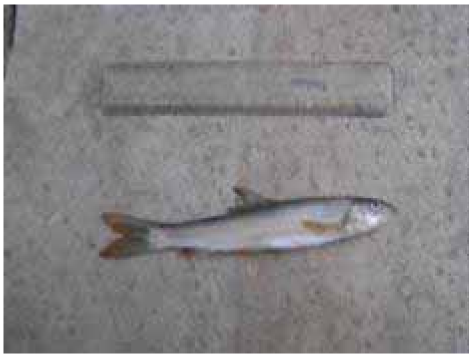
b) Short or Mid- Distance Migratory Species:

i) Schizothorax richardsonii (Blunt–nosed Asala) and Schizothorax progastus (Pointed nose -Asala):

Asala is the dominant fish species in the KAHEP project site. It is an omnivorous fish and feeds on algae, pieces of aquatic plants, diatoms, periphyton and insects. Prefers rocky bottom streams and rivers with moderate current velocities (Edds 2007) on pool, run and riffle habitats. This species hasa wide distribution in Nepal and is reported from all the river networks of Koshi, Gandaki, and Karnali, the eastern, central and western regions of Nepal. It breeds twice a year in autumn (September/October) and in spring (March/April). Normally it breeds after the migration in the upstream areas after the recede of the monsoon floods. The timing of spawning, however, varies with the local thermal regime and flooding conditions (Joshi, 2004). Generally, the Asala can become mature at two years of age and the larger females produce from 30,000 to 50,000 eggs depending on its size. These species have a wide range of distribution in Nepal and are found in altitudes ranging from 200 to >3,000m. To cope with the sharp fall in temperature in the winter months, these species migrate downstream at lower altitudes and as the temperature increases- in the upstream areas in the months of March (Sehgal, 1999).

Schizothorax richardsonii

Schizothorax spp.



Schizothorax richardsonii

ii) Neolissochilus hexagonolepis, Copper Mahseer (Katle):

Neolissochilus hexagonolepis is commonly known as ‘Katle’ in the project site. It prefers streams and rivers with rocky bottoms and moderate currents (Edds, 2007). The species has a wide distribution in Nepal and is found in all river networks of Koshi, Gandaki, and Karnali, the eastern, central and western regions of Nepal. It is an omnivorous species (Daniels, 2002) and feeds on algae, aquatic insects and crustaceans. It is a short to mid-distant migratory fish, which migrates upstream and into the tributaries during the breeding season. The females attain maturity in the months of June - September and release ripe eggs in the month of August to September in pools feed by running water (Daniels, 2002). They breed once a year but fractionally release several batches of eggs during the breeding season. Katle broadcasts ripe eggs in installments in gravel beds. This fish species is commonly found in the altitude of up to 2,000masl in the Himalayan snow feed rivers (T. Petr, 2002).

Neolissocheilus hexagonolepis ***(Katle)***

iii) Labeo dero , river Rohu (Gardi)

Gardi has a deep groove across snout and is covered with pores without any later lobe and with a short maxillary barble. Generally, the body color is silvery on the sides and on the belly. The fins are tinged with red. This is a mid - distance migratory species. This fish is widely distributed throughout Nepal in the Koshi, Gandaki, Karnali and Khakali river systems. It favors moderate currents. When young, feeds heavily on insect larvae and aquatic invertebrates. Large fish eat algal slime, fishes, crustaceans and frogs. The Gardi migrate up to the hill-streams during May-June and spawns in shallow waters over plants and gravel. Altitudinal range for this fish is 150 to 1,000masl.

Labeo dero **(Gardi)**

c) Resident Species:

i) Crossocheilus latius, Ston roller (Lohari)

The body color of this species is generally white with greenish tinge along the upper side of the body with black spots. This species is found in the streams and rivers as well as in lakes on the hills and mountains over the sandy, muddy, and/or rocky substrates (Menon, 1999; Edds, 2007). It is widely distributed in Nepal (Shrestha et.al, 2012). This fish is found in the hights of upto 1,400 masl. Its reproduction behavior is not available in the primary literature.

ii) Garra annandalei, Sucker head (Buduna)

This fish is locally known as ‘Buduna’ with the cylindrical body and a C-shaped mouth. The ventral adhesive disc is used for climbing over rocks and stones. It is reported to prefer clear water streams and hills rivers (Edds, 1986) but it is also reported to have adapted the pools and runs of swift rivers

(Shrestha, 1990). It is a herbivorous species and is widely distributed in the eastern and central Nepal (Shrestha et.al, 2012) in the Koshi and Gandaki river network. Its reproduction behavior is not available in the primary literature. Buduna is found in rivers of upto 1,000 masl, and spawns in late July.

iii) Garra gotyla (Nakata)

This fish is locally known as 'Nakata' and the body is cylindrical with a C-shaped mouth. The ventral adhesive disc is used for climbing over rocks and stones. It becomes mature after 2 years and grows up to 150 mm. This species prefers backwater pools and rocky areas of the hill streams and lakes (Molur and Walker, 1998). It is herbivorous and feeds on algae (Hora and Mukerji, 1936). The spawning season of this fish starts at the end of June, when large numbers of fishes concentrate in the small areas. The female deposits about 20,000 lemon yellow eggs on stony or sandy beds. This fish can be found in all watercourses of Nepal ranging from 100 to 1,400 masl. The species is widely distributed in the river networks of Koshi, Gandaki and Karnali Rivers of eastern, central and western Nepal (Shrestha et.al 2012).

Garra gotyla (Nakata)

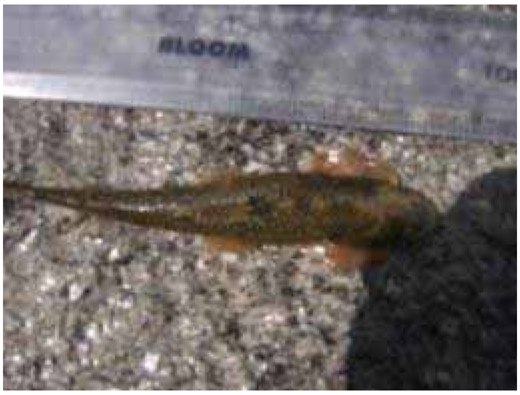
iv) Glyptosternum blythi, Dwarf Catfish(Tilkabre)

This fish is known as 'Tilkabre' in the project site. This is a rare fish from the headwater streams. Its head is depressed with a broad snout. Its lips are broad and continuous. The mouth is round with appellation which helps fish's adhesion on rocks. The body color is yellowish-brown. The dorsal and caudal fins are tinged with black. This species breeds in May and June. The intra-ovarian eggs are very large (1.5 to 1.8 mm) compared to the size of the female fish (5 to 8 cm). It is omnivorous and found in streams having a gravel bottom with copious zoo-benthos. Aquatic insects, tadpoles and earthworms are used as bait for this fish. It is distributed all over the Nepalese river systems. It is an endemic fish to Nepal and has been reported in upto 2,960 masl with the maximum size of 100 mm (Jha, 2006).

Glyptosternum blythi (Tilkabre)

v) Psilorhynchus pseudecheneis, Stone Carp (Tite)

'Tite' is a common name of this fish in the project site. Its body is elongated, depressed and flattened with 3 to 5 distinct transverse folds on the ventral side. Generally, the body color is darker with greenish spangle on the dorsal side. The head is bluish brown while the ventral is yellowish. A light dark band is present along the pectoral fin from just behind the operculum to the base caudal. A few dark blotches and bands are present in front of the dorsal fin as well as behind. Its scales are pigmented black. It is an endemic species of Nepal. It adheres to the surface of rocks in rapid waters and uses a diverse habitat ranging from pools, runs and riffles of the hill stream and rivers (Shrestha, 1990; Menon, 1999; and Edds 2007).The stone carp has been recordedin Roshi, Sunkoshi and Dudhkoshi rivers of the Koshi river network. It grows up to 150 mm, and its main spawning period is in August when the Tite enters into small ephemeral tributaries and moves upstream for spawning. The stone carp has an acrid taste and is therefore called Tite. It has a medical value.



Psilorhynchus pseudochenius (Tite)

vi) Barilius bendelisis (Faketa)

*Barilius bendelisis*is locally known as "Faketa". This fish has small size pores on the snout. The male has paired enlarged, fleshy, and thick fins. The color of these fishis silvery white with black spots on each scale. The species is known to use a diverse habitats ranging from pebbly and rocky substrate stream to rivers of hills and mountains (Edds, 2007; Menon 1999, and Daniels, 2002) and clean gravelly and muddy streams of low lands (Edds 2007).This species is widely distributed in the river networks of Nepal both in hills and low lands (Shrestha et.al. 2012). It is an omnivorous species and feeds on algae and associated insects (Edds, 1987). It breeds from April to June (Badola and Singh, 1984) but the breeding season could extend to monsoon (Hossain and Haque, 2005). It lays eggs between algae and rocks in the shallow waters (Daniels, 2002).

***Barilius bendelisis* (Faketa)**

d) Fish Migration and Migratory Path

Within the limits of the project sites, some fish species of migratory nature were noted based on the interactions with local fishermen, direct observations, and relevant literatures. Table 4.30 presents the list of reported fish species in terms of migratory and residential status.

Table 4.30: Migratory Pattern of Fish Species

SN	Scientific Name	Local Name	Migratory species
1	*Anguilla bengalensis*	Rajbam	LM
2	*Bagarius yarrelli*	Gonch	LM
3	*Barilius barila*	Faketa	R
4	*Barilius bendelisis*	Fakata	R
5	*Barilius shacra*	Fakata	R
6	*Barilius Vagra*	Faketa	R
7	*Botia almorhae*	Baghi	R
8	*Botia lohachata*	Chital baghi	R
9	*Clupisoma garua*	Jalkapoor	LM
10	*Crossocheilus latius*	Lohari	R
11	*Garra annandalei*	Buduna	R
12	*Garra gotyla*	Buduna	R
13	*Glyptosterrum blythi*	Tilkabre	R
14	*Glyptothorax cavia*	Kabre	R
15	*Glyptothorax pectinopterus*	Kabre	R
16	*Glyptothorax telchitta*	Rato kabre	R
17	*Heteropneustes fossilis*	Singhi	R
18	*Labeo angra*	Theda	R
19	*Labeo dero*	Gardi	MM
20	*Mastacembalus armatus*	Bam	R
21	*Neolissoch ilus hexagonolepis*	Katle	MM
22	*Noemacheilus beavani*	Gadela	R
23	*Noemacheilus botia*	Gadela	R
24	*Psedecheneis sulcatus*	Kabre	R
25	*Psilorhynchoides pseudecheneis*	Tite (Endemic)	R
26	*Puntius conchonius*	Pothia	R
27	*Puntius ticto*	Pothia	R
28	*Schizothorax progastus*	Chuchche asala	MM
29	*Schizothorax richardsoni*	Buchche asala	MM
30	*Tor putitora*	Sahar	LM
31	*Tor tor*	Sahar	LM

*Source: Fish Survey 2010 and 2013 (Note: *LM - Long Distance Migratory Fish Species, *MM - Mid Distance Migratory Fish Species, *R - Residence)*

Table 4.31 and Table 4.32 present the migration period and upstream and downstream migration for the long distance and medium distance migratory fish species respectivelly.

Table 4.31: Long migratory Fish Species Migration Pathways in Different Seasons

Fish species	J	F	M	A	M	J	J	A	S	O	N	D
Tor putitora					↑	↑	↑	↑	↓	↓	↓	↓
Tor tor						↑	↑	↑	↑	↓	↓	↓
Anguilla bengalensis		↑	↑	↑	↑	↓	↓	↓				
Bagarius yarrelli			↑	↑	↑	↑	↑	↑	↑	↓	↓	↓
Clupisoma garua							↑	↑	↑	↓	↓	

Note: ↑ upstream migration, ↓ downstream migration

Table 4.32: Medium Distance Migratory Fish Species Migration Pathways in Different Seasons

Fish species	J	F	M	A	M	J	J	A	S	O	N	D
Neolissocheilus hexagonolepis			↑	↑	↑	↑	↑	↑	↓			
Labeo dero			↑	↑	↑	↑	↑	↑	↓			
Schizothorax richardsonii			↑	↑	↑						↓	↓
Schizothorax progastus			↑	↑	↑						↓	↓

Note: ↑ upstream migration, ↓ downstream migration

Among 31 reported fish species, five species are long migratory species (*Tor putitora*, *Tor tor, Bagarius yarrellii, Clupisoma garua and Anguilla bengalensis).* Of the reported five species only one (*Tor putitora)* was observed during the fish sampling survey. Normally, all the migratory fish species should have been captured in the October sampling season, but, surprisingly, only one of the species was caught in the downstream section. It appears that the reported long range species no longer visit the upstream areas of Kabeli, however, further studies in the mid monsoon (August) are required to verify the observation during early stages of construction. This will be included in the EMP.

Of the reported species, four species were medium distance migratory species (*Labeo dero, Neolissoch ilus hexagonolepis, Schizothorax progastus,* and *Schizothorax richardsoni). Labeo dero*and *Neolissochilus hexagonolepis* migrate from downstream to upstream in the project site and above in monsoon, and again migrate downstream with the end of monsoon from the project site as the water volume recedes and water temperature declines. These species visit the area only for spawning and return downstream after spawning. Their presence in the winter season in the project site and upstream areas is doubtful except for juveniles.

The other two species *Schizothorax progastus* and *Schizothorax richardsoni* migrate downstream from the project site and furtherdownstream in the winter to avoid the declining water temperature in the headwater catchment, andmigrate to the interior headwater in the monsoon as the water temperature increases. These *Schizothorax* species are expected to be present in the project site throughout the year because of the location of the site between the upper and lower range of migration.

The remaining species are resident species (Table 4.30). The key resident species observed are *Garra spp*., *Barilius spp*., *Crossocheilus latius*, *Glyptothorax spp*., and *Psilorhnchoides pseudecneis*. These species migration range is limited to a few kilometers only.

4.3.3.3.2 Species Abundance and Fish Composition

A total of 150 fishes of 12 different species were collected from the sampling stations of Kabeli River in 2010 survey. *Barilius bendelisis* (Fakata) contributed 36 % ; *Schizothorax richardsonii* (Buchche Asala) contributed 22.00 %;*Labeo dero (*Gardi)contributed 15.33 %;*Garra gotyla* (Buduna) contributed 9.33 %;

Neolissocheilus hexagonolepis (Katle) contributed 4.00%;*Barilius Vagra* (Faketa) contributed 4.00%; *Psilorhynchoides pseudecheneis* (Tite) contributed 3.33 %*; Schizothorax porgastus* (Chuchche Asala) 2.00 %; *Garra annandalei (*Buduna) contributed 2.00 *%; Crossocheilus latius (Lohari)* contributed 0.67 %*; and Glyptosterrum blythi* (Tilkabre*)* contributed 0.67 *%* ***(***Table 4.33 and 4.34***)***.

Table 4.33: Species Diversity and Distribution Pattern (2010)

S.N.	Scientific Name	Local name	Field visit: No. of fish caught by hired fishermen used Cast net	
			Number of fish caught	No. of fish caught %
1	*Barilius bendelisis*	Fakata	54	36.00
2	*Barilius Vagra*	Faketa	6	4.00
3	*Crossocheilus latius*	Lohari	1	0.67
4	*Garra annandalei*	Buduna	3	2.00
5	*Garra gotyla*	Buduna	14	9.33
6	*Glyptosterrum blythi*	Tilkabre	1	0.67
7	*Labeo dero*	Gardi	23	15.33
8	*Neolissocheilus hexagonolepis*	Katle	6	4.00
9	*Psilorhynchoides pseudecheneis*	Tite	5	3.33
10	*Schizothoraichthys progastus*	Chuchche asala	3	2.00
11	*Schizothorax richardsoni*	Buchche asala	33	22.00
12	*Tor putitora*	Sahar	1	0.67
	Total		**150**	**100.00**

Source: EIA Fish Survey, 2010

Table 4.34: Percentage Abundance at Sampling Stations (Caughtby cast net, 2010)

Station	Sites	Number of Fish Caught	Total Weight of Fish Caught (gms)	Number of Species	Catch Percentage	Percentage of fish caught by Weight
1	Dam Site	28	1805	6	18.67	29.25
2	Down stream of Dam site	58	2942	10	38.67	47.68
3	In Kabeli upstream of the confluence with Tamor	64	1423	10	42.67	23.06
	Total	**150**	**6170**	**12**	**100.00**	**100.00**

Source: EIA Fish Survey, 2010

In July 2013 survey, 37 fishes from nine species were caught (Table 4.35). Out of 37, Asala (*Schizothorax richardsonii*) had the higest capture (32.43 %), Baghi (*Botia Lohachata*), Kabre (*Pseudecheneis sulcatus*) and Gardi (*Labeo dero*) had the lowest capture (2.7 % each). Asala was the second largest capture in 2010. Bagai and Kabre were not caught in 2010 but were reported only in the 2013 survey.

Table 4.35: Species Diversity and Distribution Pattern (2013)

S.N.	Scientific Name	Local name	Field visit	
			No. of fish caught by hired Fishermen used Cast net	
			Number of fish caught	No. of fish caught %
1	*Barilius bendelisis*	Fakata	2	5.41
2	*Crossocheilus latius*	Lohari	5	13.51
3	*Garra gotyla*	Buduna	2	5.41
4	*Labeo dero*	Gardi	1	2.70
5	*Neolissocheilus hexagonolepis*	Katle	11	29.73
6	*Psilorhynchoides pseudecheneis*	Tite	2	5.41
7	*Botia lohachata*	Baghi, Sisne	1	2.70
8	*Schizothorax richardsonii*	Buchche asala	12	32.43
9	*Pseudecheneis sulcatus*	Kabre	1	2.70
	Total		**37**	**100**

Source: Additional Fish survey, July 2013

Table 4.36: Percentage Abundance at Sampling Stations (Caughtby cast net, 2013)

Station	Sites	Number of Fish Caught	Total Weight of Fish Caught (gms)	Number of Species	Percentage of fish caught by Weight
1	11 KM upstream of dam	5	125	4	7.63
2	8 KM upstream of dam	6	205	3	12.55
3	Dam site	13	464	7	28.30
4	Kabeli confluence at Tamor	13	844	5	51.52
	Total	**37**	**1638**	**9**	**100.00**

Source: Additional Fish survey, July 2013

In terms of species dominance the *Schizothorax richardsoni*is the dominant species of the project site, that had the highest capture in both samplings of 2010 and 2013.

4.3.3.3.3 Catch per Unit Effort (CPUE)

A total of 150 fish species were caught at three stations.The catch per unit effort for station no. 1 is 1:0.14, for station no. 2 is 1: 0.29, and for station no. 3 is 1:0.32, with the highest ratio from the downstream to the upstream (Table 4.37). The downstream section of Kabeli closer to the Tamor confluence had the higher number and diversity of the fish species.

In the recent survey conducted in July 2013, a total of 37 fishes were registered by the cast net stations. The catch per unit effort for station no. 1 is 1:0.025, for station no. 2 is 1:0.03, for station no. 3 is 1:0.065 and station no. 4 is 1:0.065 which is the highest value calculated. In the 2013 survey , the downstream section of Kabeli closer to Tamor confluence had the highest number and diversity of the fish species (Table 4.38).

Table 4.37: Catch per Unit Effort (CPUE) at Different Sampling Stations (2010)

Station No.	Sites	Level of Effort	No. of Fish caught	Catch per unit effort (CPUE)	Attempt Catch Ratio
1	Dam Site	200	28	0.14	1:0.14
2	Down stream of Dam site	200	58	0.29	1:0.29
3	De-water Zone	200	64	0.32	1:0.32
Total		**600**	**150**	**0.25**	**1:0.25**

Source: EIA Fish Survey, 2010

Table 4.38: Catch per Unit Effort (CPUE) at Different Sampling Stations (2013)

Station No.	Sites	Level of Effort	No. of Fish caught	Catch per unit effort (CPUE)	Attempt Catch Ratio
1	11 KM upstream of dam	200	5	0.025	1:0.025
2	8 KM upstream of dam	200	6	0.030	1:0.030
3	Dam site	200	13	0.065	1:0.065
4	Kabeli confluence at Tamor	200	13	0.065	1:0.065
Total		**800**	**37**	**0.046**	**1:0.046**

Source: EIA Fish Survey, 2013

The caste net used for the fish sampling shows that the catch per unit effort is low in the upstream section around reservoir, while it improves in the downstream areas below the dam and near the confluence of the Kabeli and Tamor.

4.3.3.4 Fish Composition of Tamor River

Tamor River is a tributary of Koshi River system in the eastern region of Nepal. Kabeli River is one of the tributaries of Tamor River. Tamor River and its tributaries have a rich diversity of the cold-water fish species. Therefore, the information on the Tamor basin fish is required to effectively design mitigation measures for the fish species in KAHEP. In addition, species composition and the quantity of fish have been rapidly decreasing for the last few years in both Tamor and Kabeli Rivers. This study has 31 reported species above the Kabeli-Tamor confluence (refer table 4.29). Additional samplings are being conducted in Tamor River from monsoon 2013 to have a good baseline data on the fish species diversity. Moreover, concerning the decrease of the fish population in the Tamor basin, a survey of the Koshi barrage effect (located approximately 167 kms downstream from Kabeli) is in progress to verify if this dam has any implications on the long migrating fish species in the Tamor and Kabeli river systems. Refer section 7.5.2, Chapter 7 for discussion on fish diversity of the Tamor river basin.

4.3.3.5 Fis migration obstacles- Koshi Barrage

Koshi Barrage is a flood control sluice across Koshi River in Nepal, near the Nepal–Indian border approximately 167 kms downstream of the Kabeli headwork. It was built between 1958 and 1962 and it has 52 gates. As a consequence of the information given by the local fishermen concerning the decrease of the fish population of Kabeli and Tamor Rivers, an evaluation of the Koshi Barrage effect was carried out in July 2013 by KEL to assess the fish migration from lower Kohsi and upstream to the local Tamor and Kabeli river systems. .Preliminary investigations indicate that the Koshi Barrage might have some considerable effects on the upstream fish migratinton, and thereby might impact the run of the long migratory spawners to Tamor and Kabeli Rivers. In the Barrage, there are two fish ladders that, according to the information provided by the operational staff, had been kept closed for a number of years due to the fish ladders unknown effects and due to unclear fish migration across the dam.

4.3.3.6 Fish Species of Conservation Significance

The IUCN red list of 2012 has listed the following five species reported by KAHEP affected sites (Table 4.39).

Table 4.39: Fish Species of Conservation Significance

S.N	Name of the Fish Species	IUCN Red list Category
1	*Tor putitora*	EN
2	*Schizothorax richardsoni*	VU
3	*Bagarius yarrelli*	NT
4	*Neolissochilus hexagonolepis*	NT
5	*Tor tor*	NT

Note: Extinct (EX): No known individuals remaining; Extinct in the Wild (EW): known only to survive in captivity, or as a naturalized population otside its historic range; Critically endangered (CR): Extremely high risk of extinction in the wild; Endangered (EN): High risk of extinction in the wild; Vulnerable (VU): High risk of endangerment in the wild; Near Threatened (NT): Likely to become endangered in the near future, and Least Concern (LC): Lowest risk.

The list includes three reported long distant migrant species, namely *Bagarius yarrelli*, *Tor putitora* and *Tor tor*. However, only one species, *Tor putitora,* was observed during the sampling period in the project site. Among the mid distance migrant fishes, *Schizothorax richardsoni*, and *Neolissochilus hexagonolepis,* observed during the sampling period, are also listed in the IUCN Redlist. Of the listed species, *Tor putitora* is an endangered species and *Schizothorax richardsoni* a vulnerable species while other species being near threatened species. The IUCN Red list is derived from the overall condition of the global population of individual species. The individual species might be in abundance in a particular region but it can be included in the Red list if its global population is decreasing. The same applies to the Red list of Kabeli species. For example, Asala, which is the most common species in almost all river systems in Nepal, is included in the IUCN Red list as a vulnerable species.

In addition, in a society, not all species recorded in a river have the same value, and normally the species in a river will be managed according to local values. Considering this, when dealing with current hydropower developments in Nepal, it is necessary to address some target species for protection and conservation at every hydropower development site. IUCN Red list species, apart from migratory and locally valuable species, are obviously important species. The Red list should be adopted and referred to while desiging and mitigating strategies associated with the hydropower development. The impacts and mitigation of the water diversion on these species are described in the Chapter 6.

4.3.3.7 Phytoplankton, Zooplankton and Aquatic Insects

4.3.3.7.1 Phytoplankton

Phytoplankton is passively floating microscopic plants with or without chlorophyll. A total of twenty six species of phytoplanktons of four different classes were collected in the sampling station -1; total number of 29 species of four different classes were collected in the sampling station-2 and 26 species of four different classes - in the sampling station- 3. The major classes of phytoplankton recorded in three-sampling stations in the field visit are *Bacillariophyceae, Cyanophyceae, Chlorophyceae* and *Xanthophyceae (*Table 4.40 and 4.41).

Table 4.40: Total Number of Phytoplankton

SN	Species	Station 1	Station 2	Station 3
A	*Bacillariophyceae*	14	14	11
B	*Cyanophyceae*	5	6	5
C	*Chlorophyceae*	6	7	8
D	*Xanthophyceae*	1	2	2
	Total	**26**	**29**	**26**

Source: EIA Fish Survey 2010

Table 4.41: Phytoplankton Species Recorded at Different Sampling Stations

SN	Species	Station 1	Station 2	Station 3
A	***Bacillariophyceae***	14	14	11
1	*Fragilaria intermidia*	P	P	A
2	*Fragilaria capucina*	P	P	P
3	*Gyrosigma kutzingii*	P	P	P
4	*Melosira granulata*	P	P	P
5	*Melosira islandica*	A	P	A
6	*Synedra ulna*	P	P	P
7	*Synedra acus*	P	A	A
8	*Nedium affina*	P	A	A
9	*Navicula pusila*	P	P	P
10	*Navicula cuspidata*	A	P	P
11	*Navicula radiosa*	A	P	P
12	*Nitzschia palea*	P	A	A
13	*Cymbella tumida*	A	P	P
14	*Cymbella cistula*	P	P	P
15	*Surirella robusta*	P	P	A
16	*Surirella carponii*	A	P	P
17	*Amphora ovalis*	P	P	A
18	*Tabellaria binalis*	P	A	A
19	*Tabellaria fenestreta*	P	A	P
B	***Cyanophyceae***	5	6	5
20	*Microchate tenera*	P	P	P
21	*Phromidium tenue*	P	P	P
22	*Oscillatoria princeps*	P	P	P
23	*Spirulena major*	A	P	A
24	*Lyngbya limnetica*	P	P	P
25	*Nostochopsis labatus*	P	P	P
C	***Chlorophyceae***	6	7	8
26	*Ulethrix zonata*	P	P	P
27	*Ulethrix variabilis*	P	P	P
28	*Spirogyra weberi*	A	P	P
29	*Spirogyra rhizobrachialis*	P	P	P
30	*Clostarium* sp.	P	P	P
31	*Leptosira mediciana*	A	P	P

SN	Species	Station 1	Station 2	Station 3
32	*Chaetophora incerssata*	P	P	P
33	*Schizogonium murale*	P	A	P
D	***Xanthophyceae***	1	2	2
34	*Tribonema minus*	P	P	P
35	*Characiopsis* sp.	A	P	P

* P- present *A- absent, *Source: EIA Fish Survey, 2010*

Phytoplanktonopulation density in general increases towards the downstream section from the dam site to the de-watered zone (Table 4.42).

Table 4.42: Population Density of Phytoplankton at Different Sampling Stations

SN	Species	Station 1	Station 2	Station 3
A	***Bacillariophyceae***			
1	*Fragilaria intermidia*	250	150	-
2	*Fragilaria capucina*	250	400	600
3	*Gyrosigma kutzingii*	50	100	50
4	*Melosira granulata*	100	300	250
5	*Melosira islandica*	-	100	-
6	*Synedra ulna*	200	100	150
7	*Synedra acus*	50	-	-
8	*Nedium affina*	100	-	-
9	*Navicula pusila*	250	100	150
10	*Navicula cuspidata*	-	50	100
11	*Navicula radiosa*	-	100	100
12	*Nitzschia palea*	50	-	-
13	*Cymbella tumida*	-	100	150
14	*Cymbella cistula*	75	150	100
15	*Surirella robusta*	100	100	-
16	*Surirella carponii*	-	50	100
17	*Amphora ovalis*	50	200	-
18	*Tabellaria binalis*	75	-	-
19	*Tabellaria fenestreta*	75	-	50
B	**Cyanophyceae**			
20	*Microchate tenera*	50	200	250
21	*Phromidium tenue*	50	100	50
22	*Oscillatoria princeps*	100	75	200
23	*Spirulena major*	-	100	-
24	*Lyngbya limnetica*	75	250	150
25	*Nostochopsis labatus*	50	75	150
C	**Chlorophyceae**			
26	*Ulethrix zonata*	75	200	350
27	*Ulethrix variabilis*	50	100	250
28	*Spirogyra weberi*	-	100	100
29	*Spirogyra rhizobrachialis*	100	200	275
30	*Clostarium sp.*	50	100	75

SN	Species	Station 1	Station 2	Station 3
31	*Leptosira mediciana*	-	50	50
32	*Chaetophora incerssata*	150	100	200
33	*Schizogonium murale*	50	-	50
D	**Xanthophyceae**			
34	*Tribonema minus*	50	125	250
35	Characiopsis sp.	-	50	50

Source: EIA Fish Survey, 2010

4.3.3.7.2 Zooplankton

A total of five species of zooplankton of two different orders were found in the sampling stations of Kabeli River during the field visit. The two orders of zooplankton recorded from the project area were Rotifers and Copepoda (Table 4.43 and 4.44).

Table 4.43: Total Zooplankton RecordedinDifferent Sampling Stations

SN	Species	Site 1Kha	Site 2 Kha	Site 4 Kha
A	***Rotifera***	2	1	2
B	***Cladocera***	1	2	2
	Total	**3**	**3**	**4**

Source: EIA Fish Survey, 2010

Table 4.44: Zooplankton Species Recorded at Different Sampling Stations

SN	Species	Station 1	Station 2	Station 3
A	**Rotifera**	2	1	2
1	*Chromogaster ovalis*	P	A	P
2	*Monostyla* sp.	P	A	A
3	*Leane* sp.	A	P	P
B	**Cladocera**	1	2	2
4	*Bosmina* sp.	P	P	P
5	*Ceriodaphina* sp.	A	P	P

* P- present *A- absent, *Source: EIA Fish Survey, 2010*

The population density of the zooplanktons in general increases towards the downstream section from the dam site to the de-watered zone for order Cladocera, whereas pattern for Rotifera is more or less similar (Table 4.45).

Table 4.45: Population Density of Zooplankton at Different Sampling Stations

SN	Species	Station 1	Station 2	Station 3
A	**Rotifera**			
1	*Chromogaster ovalis*	30	-	30
2	*Monostyla* sp.	20	-	-
3	*Leane* sp.	-	20	30
B	**Cladocera**			
4	*Bosmina* sp.	20	30	40
5	*Ceriodaphina* sp.	-	40	50

Source: EIA Fish Survey, 2010

4.3.3.7.3 Aquatic Insects

A total of 20 species and five orders of aquatic insects were recorded from three sampling stations during the field visit. The recorded orders are *Plecoptera, Ephemeroptera, Hemoptera, Trichoptera*and *Coleptera (*Table 4.46 and 4.47) .The number of orders and species in general increase from theupstream to the downstream side.

Table 4.46: Total Aquatic InsectsRecorded in Different Sample Stations

SN	Species	Station 1	Station 2	Station 3
A	Plecoptera	3	4	1
B	Ephemeroptera	5	6	5
C	Hemoptera	1	3	2
D	Trichoptera	1	3	3
E	Coleoptera	-	1	2
	Total	**10**	**13**	**13**

Source: EIA Fish Survey, 2010

Table 4.47: Aquatic Insects Recorded at Different Sampling Stations

SN	Species	Station 1	Station 2	Station 3
A	**Plecoptera**	3	4	1
1	*Isogenus modesta*	P	p	p
2	*Nemoura erratica*	P	P	A
3	*Nemoura venosa*	P	P	A
4	*Pletoperia sp.*	A	P	A
B	**Ephemeroptera**	5	6	5
5	*Ephemerella sp.*	P	p	A
6	*Rhithrogena sp.*	P	p	p
7	*Iron humeralis sp.*	A	p	p
8	*Stenonema frontale*	P	p	p
9	*Baetis sp.*	P	A	p
10	*Epeorus sp*	P	p	p
11	*Ameletus sp.*	A	p	A
C	**Hemoptera**	1	3	2
12	*Plea striola*	A	p	p
13	*Notonecta sp.*	A	p	p
14	*Belostoa sp.*	P	p	A
D	**Trichoptera**	1	3	3
15	*Hydropsyche sp.*	A	p	p
16	*Rhyacophila sp.*	P	p	A
17	*Hesperophylax sp.*	A	p	p
18	*Philopotimus sp.*	A	A	p
E	**Coleoptera**		1	2
19	*Promoresia sp.*	A	p	p
20	*Enochrus sp.*	A	A	p

* P- present *A- absent, *Source: EIA Fish Survey, 2010*

4.3.3.8 Trends of Aquatic Fauna and Flora

Studies of aquatic fauna and flora of Kabeli River are not available in the literature. Discussions and interaction with local communities regarding fishes in Kabeli reveals that the area had abundant fishery resources in the past. Fish population in the recent years, according to the local people, is declining due to the use of electric shocks, detonators, and poison to catch the riverine fishes, including damage to the habitats by sand and aggregate mining, road construction and disposal of the road construction spoils. There are adequate legal system to stop these illegal activities, including sand extraction from the river bed, hence the future trends of the aquatic life in Kabeli River are uncertain.

4.4 Kanchanjunga Conservation Area and Tinjure Milke Jaljale Forest

The Kanchenjunga Conservation Area (KCA) is the only officially protected area in the Tamor-Kabeli basin. GoN is in the process of declearing the Tinjure Milke Jaljale (TMJ) forest as a protected forest. The nearest boundary limit of the KAC is about 25km and of the TMJ is about 10 km aerial distance from the KAHEP development site. Both KAC and TMJ, are in remote mountainous regions and are accessible by trekking only. Both KAC and TMJ are unlikely to be affected by the KAHEP development.

As part of a Cumulative Impact Assessment, some additional information and a discussion on KCA and TMJ are provided in the Chapter 7 of this EIA Report

Chapter V: ALTERNATIVE ANALYSIS

In addition to the "no alternative", this section focuses on the assessment and evaluation of the following aspects of the available alternatives: (i) choice of hydro versus other sources available for power generation in Nepal, including power imports from India; (ii) selection of KAHEP over other hydro projects; (iii) analysis of potential alternative sites for KAHEP; and (iv) design alternatives for KAHEP.

5.1 BACKGROUND

Nepal's level of development with respect to energy is low by global and South Asia regional standards. An estimated 87% of the country's total primary energy demand is met by traditional (non-commercial) forms of energy, reflecting the overwhelmingly rural distribution of population in Nepal[9] and the virtual absence of relatively clean, commercialized forms of energy outside of urban areas. This heavy reliance on traditional energy sources brings with it the well-known problems of limited opportunities for rural economic development; environmental degradation; inefficiency in provision of energy services; and health impacts, particularly for women and children.

As per national census published in 2013, about 75% of the population in Nepal is estimated to have access to electricity (grid and off-grid), with a significant disparity between access levels in urban Nepal (around 90%) and rural Nepal (around 30%). Actual consumption of electricity remains very low, at about 70 kWh per capita, even for urban Nepalese, compared to 733 kWh for India and 2,600 kWh for China, as a result of severe limitations in the electricity supply which has not kept up with the sharp rise in demand of recent years.

Nepal's total grid-connected generation capacity amounts to a meager 713 MW, of which 659 MW is based on hydropower, but the actual available capacity varies seasonally depending on availability of water. In Nepal 80% of rainfall occurs in the monsoon season during the months of June, July, August and September, coinciding with glaciers melting and the installed hydropower plants can run in their full capacity. During winter, the water available can support only 35% of the hydropower capacity to generate power, creating a huge supply-demand gap. This gap has grown sharply in recent years, with about 500 MW of demand not met in 2012. The real deficit could be much higher as the demand growth projection is significantly suppressed due to the constrained supply and the lack of a secure electricity supply strategy of the GoN. Even with the planned addition of around 1.375 MW of hydropower capacity by 2017 (based on Power Purchase Agreements (PPA) concluded projects and projects under construction) a capacity deficit of around 900 MW in dry season is expected.

Energy Crisis: Exacerbating this low level of development is a long-term crisis in the electricity sector. Load-shedding (rationing of electricity to grid-connected consumers) has long been a facet of the hydro-dependent power system in Nepal, where protracted conflict and weak institutions and finances have discouraged investment and hampered the addition of power generation capacity. In the dry season of 2011/12, load-shedding reached 18 hours a day and is expected to remain at this level, or worsen in 2012/2013. Current projections indicate that Nepal could significantly reduce its load-shedding by 2016, assuming timely completion of the first major cross-border high-voltage transmission line between Nepal and India. Until then (and possibly longer), Nepal will continue to be burdened by a heavy reliance on thermal generation which is costly and highly polluting, or to struggle without electricity, at a high cost to its people and its economy.

[9] Despite a high rate of urbanization (estimated at just under 5% per annum over 2005-2010), the rural population in Nepal is believed to account for about 80% of the total population.

The implication of a routine power outage has a big impact on industry, commerce and service sectors. The GDP input from these sectors has correspondingly declined after 2007. Furthermore, there is an overall decline in the consumption of power in the production sector known for its growth with value addition (J. Power 2012).It has also impacted new jobs creation. Nearly 2 million youths are forced to leave their hometown in search for jobs out of country. This is an alarming situation when one considers the economic development of the country through enhancement of industrial, commercial and service sectors. The Independent Power Producers' Association of Nepal (IPPAN) notes in its August 2010 publication 'Hydropower Nepal, Resources, Use and Prospects' that *"never in the history of Nepal has there been so many hours of load-shedding. To say that it is simply a failure is an understatement as in fact it is a huge disaster. With the current load shedding, Nepal is losing almost one billion dollars in revenue a year. For a country whose gross domestic product is a mere 8 billion US Dollars (in 2009), this amount of annual loss of revenue is a serious blow to the economy."*

Response to Load Shedding and Environmental Consequences: As a response to the load shedding of the production sector, captive diesel generation sets has been installed. While no official data is available of the total captive generation capacity, an unofficial estimate suggests that Nepal has about 500 MW of small sized captive generation plants. Business is therefore enduring the high cost of back up diesel generation (in excess of 30 USc/kWh) for essential supply plus lost productivity due to the load shedding.

In recent years, to meet the immediate energy shortfall, Government of Nepal is planning for alternatives such as additional import of electricity from India. Nepal-India cross-border 400 kV transmission line is under implementation for development with the funding from the World Bank. Although a long term objective of the proposed transmission line is for the export of electricity to India, in the absence of adequate investment in the power development in Nepal, this very transmission line is likely to be used for the energy import from India even in the long term.

5.2 CHOICE OF HYDROPOWER VERSUS OTHER SOURCES OF POWER

For the assessment of the alternative power generation in Nepal, available options are thermal power based on coal or fossil fuel, wind power, solar power, and electricity import from India. All theseoptions were compared tothe hydropower generation from the proposed project. These comparisons are made on the overall generic grounds. The purpose of this section is to find and analyze the type of energy that could be used instead of the proposed hydropower project. It is for this purpose, different energy sources available in Nepal and its comparison with hydroelectric project is analyzed below.

5.2.1 Fossil fuels

Petroleum Products: Fossil fuel supply covers nearly 5% of total energy requirements in Nepal. The major fossil fuels used are petroleum products (85%), mainly diesel, gasoline, and coal (15%). Nearly all fossil fuels are imported to Nepal. Nepal doesn't have oil reserves and refineries.

At present two diesel-based thermal plants (53.5 MW in total capacity), are in operation in Nepal. These plants were installed to meet the demand in the peak hours in the evening. To operate the plants, diesel fuel is imported from India and there is scarcity of the fuel even in India. Owing to the lack of sufficient storage capacity within Nepal, the plants face shortage of fuel in the strike periods, which are frequent in Nepal. In the prevailing situation of increasing petroleum product prices, the cost of production is expected to be high and hence not affordable. The cost of unit energy generated from these plants (0.3035 $/kWh) is nearly 5 times of the current retail price of the NEA. NEA is already under a very weak financial position—losing about 3 USc/KWh for each unit of electricity supplied to its consumers—it cannot afford to run the existing diesel plants. For a poor nation like Nepal, it will drain the foreign currency reserve to import the petroleum fuel which otherwise could be effectively used for other developmental purposes. In a country with abundant renewable water resources, the petroleum fuel based thermal plant is not a sustainable option. Apart from this, these plants are facing objections from the adjoining communities due to high noise, air and water pollution. The emission of greenhouse gases from the petroleum fuel based thermal plants is the other disadvantage when compared to the hydro based power plants.

Coal: At present, coal consumption in Nepal is about 1% of the total energy consumptions. Coal deposits within Nepal comprises of scattered deposits of mud-coal, lignite and peat. Further, there is little prospect of finding large coal deposits in Nepal which could be economically exploited for use in thermal power plants. However, there is a possibility of establishing thermal power plant based on the imported coal. Two options of coal import are from India or from a third country. Because of the land locked nature of Nepal, import of coal from India is cheaper than from a third country. The sulphur contentsin of India's coal deposits are high. Coal imported to Nepal from India for the operation of brick kiln in Nepal is already facing serious problems of air pollution and such problem on a bigger scale is very likely with operations of coal based thermal power plants. Similar to the petroleum fuel, coal based thermal plants will make Nepal more dependent on energy from a third country for the basic input. Additionally, environmental costs of air pollution (fly ash and green house gases) are expected to be very high.

Biomass and Solid Waste: there are other options for electricty generation. Electricity generation from biomass and municipal solid waste has become a commercially viable solution in many developed countries.In Nepal, the World Bank and other donors are supporting the review of biomass and solid waste resources for power generation and helping the Government to create an enable the environment for private sector participation. There is potential for biomass, such as agricultural waste and municipal solid waste, to play a complementary role in power generation in the near future. However, given a huge shortage of the power generation capacity in the range of 500-550 MW, uncertainties about available resources, policy and regulatory environment, limited interests of the private sector, and lack of experience and technical capacity in Nepal, it is unrealistic to expect a large scale power generation based on biomass and solid waste to substitute the amount of energy that could be generated by KAHEP, in short and medium terms. There are also other issuesassocaited with theuse of biomass and solid waste for power generation, such as collection of biomass or solid waste, possible negative impacts on air pollution and forest degradation, costs of power generation in the country context, and associated costs to mitigate those environmental impacts.

Conclusions: For the reasons discussed above, the fossil fuel options, including biomass and solid waste, are inappropriate for Nepal on techncial (sustainable supply of these resources), financial, environmental and economic grounds; when evaluationand choice are to be made in conjunction with the hydropower based on renewable water resources currently available in the country.

5.2.2 Solar and Wind power

The possible alternative to hydropower could be grid-connected solar and wind power. In Nepal, solar and wind energy resources potentials are yet to be studied.

Solar for Grid-Connected Power Generation: For the grid-connected solar power generation, several pilot projects were implemented in Nepal, each less than 1 MW, with grant funding from donors. Based on these pilot experiences and experience in other countries, the World Bank with NEA are reviewing a possibility of scaling up a grid-connected solar power generation based on the decentralized roof-top mounted Solar PV in major load centers. Major issues encountered in Nepal for large scale grid-connected solar power generations include: (i) there is no credible data on solar energy resources; (ii) it would be difficult to operate and dispatch solar power generation without a battery system for storage; a grid-connected solar power generation can only supply a grid at the same time with sunshine; (iii) poor quality distribution system in Nepal needs to be enhanced to operate with the decentralized solar power generation facilities; and (iv) whether a grid-connected solar PV for power generation with or without batteries is financially viable in the Nepal. From the pilot projects of a grid-connected solar power generation in Nepal, the capital investment per MW is about 2-3 times of hydropower capacity and the operational hours are about 1/3 to 1/4 of hydropower capacities, resulting in a cost of electricity from solar 5 to 10 times more expensive than from hydro. Giving the current retail tariff, huge government subsidies would be needed for a large scale grid-connected solar power generation if the capital investment cost could not be reduced. Given the economic condition of the country, the Government is not ready to have such financial resources for the subsidies. Therefore, a grid-connected solar power generation has a potential to play a complementary role in the power generation system of Nepal, but it is unrealistic to expect solar to be a major source of power generation in Nepal in short and medium run before the solar generation cost becomes competitive compared to the other generation costs.

Isolated Solar Home Systems(SHS) are widely installed in rural areas. It is believed that about 300,000 SHS have been installed for lighting up the rural households. It has played an important role in rural electrification in areas not covered by NEA grid. Donors are providing the increased funding in scaling up off-grid renewable energy development in Nepal, including SHS, biomass and biogas. While donors and the GoN are improving the enabling environment and increasing funding in off-grid renewable energy, it will help expand access to modern energy services in the vast rural areas, reduce the demand on grid-supplied electricity, but it will not be able to play a major role in the short and medium run in alleviating the acute power shortage in the grid-supplied urban areas in Nepal.

Wind Power is also source of clean energy; however, the potential of wind power, to a large extent depends on the wind velocity unknown in Nepal and subject to further resource mapping. Although the government plan for developing the wind energy sector in Nepal was initiated long ago, it is only after the Alternative Energy Promotion Center (AEPC) establishment in 1996 that serious attention was given for the wind power research and development. Despite all the efforts, the wind energy is still in its infancy in Nepal and only limited data is available for research and modeling. Nepal's rugged geography presents another challenge to wind energy projects. Wind energy development projects carried out by the private sector and NGOs in the past have met limited success, and unfortunately, some of the more viable efforts have folded due to lack of maintenance. For example, the Kagbeni wind power project, one of the biggest projects to date, was installed in 1987 under Danish Government funding. It was able to generate up to 20 kW before lack of maintenance forced it to shut down. The major constraint is that wind power can hardly be regulated.The expereinces of other countries show that a robust power system with a good energy mix may be able to absorb certain share of wind power, from system operation and stability point of view. The power system in Nepal is not very reliable with its poor maintenance. It has a long way before being able to accomodate the intermittent wind power generation. An isolated system with solar and wind hybrid gernation is under piloting in Nepal. It is unrealistic to expect that in short and medimum terms the grid-connected wind power generation can play a major role in supplying grid covered urban areas andload centers.

Providing wind and solar power for large populations in Nepal is technically and financially challenging and cannot be an alternative to hydropower. However, the development and use of renewable energy are actively being exploited in Nepal. The GoN and various donors have a strong committment in renewable energy development, including solar, biomass, biogas and wind. The AEPC was created for this purposes and have started work on developmentof all possible renewable energy resources in Nepal with donors' support. Notable results have been achieved in off-grid micro hydro and solar home system development for the rural electrification. Serious funding by various donors is provided to AEPC to scale up the renewable energy development in Nepal. With all these parallel efforts, the use of solar andwind power and other renewable energy resources is expeceted to play an increasing role in the energy mix in Nepal.

5.2.3 Import of Electricity from Neighboring Countries

From balancing the power supply and demand in Nepal and the regional integration point of views, power import from India will play an important role in medium and long terms. This is because two countries have complementary resources for power generation – Nepal has rich water resources, much more than needed in the country, while India has a coal-dominated power generation system. In the long run, Nepal can sell its surplus generation in wet seasons to help India reduce its coal-fired power generation and the subsequent greenhouse gas emissions. Meanwhile, Nepal can obtain the much needed revenues for its poverty alleviation and growth, and can import power from India in winter time to fill in the gap due to the seasonal fluctuation of hydropower generation in Nepal. This way Nepal will be able to have more run-of-river hydropower capacity and will depend less on the large storage hydropower project to supply the demand in winter time, so as to avoid large reservoir inundation and the associated environmental and social impacts. Integration of the two power systems is part of the agenda of the South Asian regional integration, which is expected to bring more opportunities and synergy for economic growth at less environmental costs. Under this context, a 400 kV, 1.000 MW capacity cross-border transmission line linking the power systems of two countries is under implementation with the World Bank-supported Nepal-India Electricity Transmission and Trade Project (NIETTP). Power flows across the border are expected by June 2015. Both sides have a long-term commitment for a 150 MW power import to Nepal to alleviate the acute power shortage in Nepal; and more power is likely to be imported from India to Nepal on a short-term contract arrangements. While the line can provide a capacity of 1.000 MW for power flows, the exact amount of power import to Nepal is depending upon how much power is needed in Nepal and how much power could be supplied from India. Certainly, power generation from the new capacity in Nepal, such as KAHEP once built, will have a major role in determining a specific amount of energy import.

On the other side, India is starving for energy and much of the energy is based on coal-fired generation, causing serious environmental consequences. From the latest load forecasting and a system planning in India, India will face power shortage during medium and long terms. While some surplus of power in northern India may exist in certain time and can be exported to Nepal through the cross-border lines, it is hard to expect that sufficient amount of energy, at the right time (peaking hours in winter time) will be made available to Nepal. In addition, the cost of power import from India is about twice the cost of power purchase from domestic hydropower IPPs. Therefore, import from India can help alleviate the power shortage in Nepal to some extent, but can only play a complementary role rather than provide a full and sustainable solution to the power shortage in Nepal.

5.3 NO PROJECT ALTERNATIVES

The proposed Project with an installed capacity of 37.6 MW will generate on average about 201 GWh of energy annually. Though the project alone could not meet the current need of power in Nepal but certainly will be a step forward in meeting goals of the national energy security. Without the proposed Project scenario one would expect the followings:

- The gap between the current power demand and supply will widen resulting in additional hours of load shedding;

- Industrial, commercial, and service sector outputs will decline with negative implications on the national GDP output;

- More and more youths will leave their hometowns in search of jobs in the third countries for livelihood earnings due to lack of local opportunities in the industrial, commercial and service sectors

Feasible Alternatives: Additional power generation capacity is urgently needed in Nepal to address the ongoing power crises. Technically other sources for power generation, including solar, biomass, solid waste and wind are not feasible at the present time in local context for large scale power generation to substitute the proposed project. Therefore, in the "no project" scenario, the technically feasible alternatives to KAHEP for grid-connected power generation are:

(i) Thermal power generation based on imported diesel

(ii) Electricity import from India

5.3.1 No Project Alternative - Diesel Power Generation

The same amount of electricity from the proposed project, 201 GWh per annum on long term average, could be generated through the existing captive diesel generators by running them for extended hours, or through installation of a new grid-connected diesel generation plant. This alternative has cost as well as environmental implications.

Financial Viability: In case of the diesel-based power generation, the cost of unit energy generated ($ 0.30/kWh) is nearly 5 times the current retail price of the NEA supplied energy. NEA will need to rely heavily on the Government subsidies for fuel cost to make it financially viable, and it is unlikely that the Government will have the budget for this subsidy. Additionally, diesel is an imported commodity, hence there is a high risk to ensure supply of fuel to keep the plant running. It also requires a stable foreign currency from the national treasury which otherwise could have been used for other infrastructural development works to boost the national economy.

Environmental cost: The environmental concern of the diesel-based power generation is the greenhouse gas emissions, a cause of the global warming. It is estimated that about 160,800 tons of CO_2 would be emitted annually from the diesel-based generation in order to generate an equivalent amount of energy (201 GWh). This estimate is based on the CO_2 emission factor of 800 g CO_2/kWh[10]. In addition, there would be local and regional level environmental impacts due to the emission of particulate matters, SO_2 and NO_x emissions from the diesel plant.

Security of Fuel Supply: As discussed above, supply of fuels for even the existing diesel plants (51.5 MW) cannot be secured to keep the plan running. The risk of interruption of power generation due to the fuel supply issues is substantive.

Given these factors, the "Diesel power Generation" option is rejected.

5.3.2 No Project Alternative – Electricity Import from India

The same amount of electricity from the proposed project, 201 GWh per annum on long term average, could be imported through Nepal-India a cross-border 400 kV transmission line (currently under implementation with the World Bank funding).As indicated, this transmission line, once built, will provide a capacity of 1,000 MW and is expected to be commissioned in 2015-2016. NEA has signed a

[10] CO_2 Baseline Database for the Indian Power Sector: User Guide, Central Electricity Authority, New Delhi 2011.

contract with its Indian counterpart for long term power import of 150 MW to Nepal. Through a short-term contract arrangement, NEA is likely to have incremental energy import from India, in the amount of 201 GWh per annum to avoid KAHEP construction.

Financial Cost and Risk: The cost of incremental electricity import from India based on the short-term contract arrangements would be more expensive than the cost of the 150 MW long-term commitments, which is already about double cost of power purchase from the KAHEP. The risk of price escalation based on the short-term contract arrangement is also high, given the forecasted power shortage in Indian power markets in medium and long runs. The cost of purchase from the proposed project was fixed and determined through a competitive bidding process. It will provide NEA the cheapest source of power among all the existing IPPs and will pose little financial risk in terms of price escalation.

Environment Cost: As India's energy sector is heavily reliant on the coal based thermal power plants, import of energy from India will further promote the greenhouse gas emissions. Without the proposed KAHEP project, the same amount of electricity could be generated in India and exported to Nepal through the being built transmission line. Additional generation of 201 GWh in India will result in about 164,820 tons of additional CO_2 emission annually in India. This estimate of CO_2 emission is based on the average emission factor (820 g CO_2/kWh) of Northern, Eastern, Western and North-Eastern regional grids of India[11]. Though Nepal has insignificant carbon footprint compared to developed nations, any actions that promotes greenhouse gas could be avoided if there is plausible alternatives for energy development based on the renewable resources such as hydropower.

Security of Power Supply: As discussed above, India will also be in shortage of power supply according to the system expansion planning in India. The system analysis conducted for the cross-border NIETTP project supported by the World Bank indicate that the Northern grid in India will be able to generate additional power at certain time of the year, but will not be able to guarantee power export to Nepal in the amount and at the time when the power is needed. Therefore, Nepal cannot purely depend upon the power import to meet its domestic supply and demand shortage.

Given all these factors, the "Incremental Power Import from India" option is rejected.

In the above context, "no project" scenario is more alarming, both at national and local levels, while with the project in place. Many local environmental and social concerns could be addressed effectively with the contribution to the regional, national and global levels, though in a small way. Therefore the "no project" option was rejected in favor of the project. A summary of the assessment presented above can be found in the Table 5.1.

Table 5.1: Summary of Project Alternatives.

SN	Alternatives	Major Conclusions
1	No Project	The gap between current power demand and supply will widen resulting to additional hours of load shedding, with serious socio-economic consequences. Market response to the load shedding would be a continued installation of a small captive diesel generation.
2	Fossil fuel based Power Plant	Cost of generation will be (at about 0.30 $/kWh) nearly 5 times of the current retail tariff, and not affordable by NEA/consumers. GHG emissions are estimated at about 160,800 tons of CO_2 annually in order to generate an equivalent amount of energy

[11] CO_2 Baseline Database for the Indian Power Sector: User Guide, Central Electricity Authority, New Delhi 2011.

		(201 GWh), based on the CO_2 emission factor of 800 g CO_2/kWh. In addition, there would be local and regional level environmental impacts due to the emissions of particulate matters, SO_2, NO_x, and the emissions from the diesel plant.
3	Additional power import from India	Currently an additional power import from India cannot be secured and the cost is high. In the long run, Nepal will need import the coal based power from India in dry seasons, and export surplus hydropower to India in wet seasons. Additional generation of 201 GWh in India will result in about 164,820 tons of additional CO_2 emission annually, based on the average emission factor of 820 g CO_2/kWh of Northern, Eastern, Western and North-Eastern regional grids of Indian.
4	Solar	Cost of generation is much higher than the current retail tariff. Subsidies are needed to make it financially viable and unlikely to be available.
5	Wind	Technically, the power system in Nepal is not able to accommodate the intermittent wind power generation; Cost of generation is also much higher than the current retail tariff. Subsidies needed to make it financially viable are not available.
6	Other hydropower as alternatives	The proposed Project is one of seven projects/sites selected for a full feasibility/EIA study through a screening of 138 sites, including a rigorous environmental and social screening. Various alternatives on location and dam design were reviewed and the proposed Project was selected as a result of the maximum optimization.

5.4 Selection of KAHEP in the Context of Hydropower Projects in Nepal - Medium Hydropower Study Project

To evaluate the KAHEP selection criteria, a study "A Sectoral Environmental Assessment (SEA), 1997" was reviewed. This study was jointly conducted by the Ministry of Population and Environment (MOPE, now Ministry of Science, Technology and Environment, MoSTE), the Ministry of Water Resources (MOWR, now Ministry of Energy, MoE), assisted by NEAwith the Medium Hydropower Study Project (MHSP) with support of the World Bank. Under this SEA, all potential projects above 10 MW installed capacity have been evaluated on the environmental and social grounds for sub-project funding under the Power Development Fund (PDF) of the Power Development Project. The study evaluated the candidate projects for funding through a screening and ranking process using a multiple set of indicators and criteria. The MHSP selected the Kabeli "A" (KAHEP) as one of the most potential sub-projects for the development and funding by the World Bank Group through PDF.

The concept of Comprehensive Assessment of Options (COA) as one of the seven priorities followed by the World Commission on Dam (1998-2000) was applied prior to release of the report by the WCD for the project identification and prioritization for development by the MHSP. The MHSP has made full use of stakeholder participation in identification of additional options and selection of ranking criteria. The geographical balance in the development of hydropower projects was also given a due emphasis.

The MHSP exercise included a nation-wide inventory of hydropower sites in the 10 to 300 MW range. While preparing the inventories, the projects already identified by NEA, projects identified under basin studies and projects identified directly by stakeholders were also included to increase the regional spread of sites and to expand the number of projects/sites. A total of 138 optional project/sites were identified. The multipurpose projects were eliminated from the project inventory list to primarily focus on the power development projects for further analysis and screening. Table 5.2 presents the steps in MHSP exercise and the final outcome of the analysis.

Table 5.2: Steps in MHSP Exercise.

<table>
<tr><th></th><th>Options Inventory</th><th>Screening</th><th>Coarse Ranking</th><th>Fine Ranking</th></tr>
<tr><td>Site Selection</td><td>Expanded the initial inventory of 60 sites to 138 sites</td><td>Eliminated 94 sites out of 138 to base ranking on 44 sites</td><td>Coarse ranked 44 sites and selected 22 for fine ranking</td><td>Ranked 22 sites and selected 7 projects to proceed to full feasibility/EIA study</td></tr>
<tr><td>Stakeholder Involvement</td><td>Stakeholders defined criteria and adding sites proposed by stakeholders</td><td>Multi-criteria screening. Stakeholders reviewed sites and results</td><td colspan="2">Multi-criteria analysis framework. Stakeholders involved in the developing criteria and criteria weights, project scoring method and reviewing ranking results presented in a series of preference matrix for all scales of options.</td></tr>
</table>

Source: ESMAP and Bank-Netherlands Water Partnership Program (July 2003)

Screening criteria were formulated in consultation with the stakeholders and NEA before finalizing them. The criteria were publicized, comments received from the stakeholders. The finalized screening criteria reflected:

- congruence with regional development policies;
- access road;
- transmissions access;
- hydrology and cost;
- watershed conditions;
- World Bank Group and national safeguard policies on social and environmental aspects;
- indices, such as persons resettled and land take per MW, biodiversity impacts;
- current level of study.

Based on the above screening criteria, 44 projects/sites were selected for a coarse ranking. Coarse ranking of sites was based on the multi-criteria analysis using a composite technical/economic criterion and a composite environmental/social criterion, which are summarized in Tables 5.3 and 5.4.

Table 5.3: Coarse Ranking Composite Technical/Economic Criterion

<table>
<tr><th>Criteria</th><th colspan="2">Scoring System</th><th>Weighting</th></tr>
<tr><td>Economic Supply Cost (75%)</td><td colspan="2">Discounted cost/Discounted energy (in USD/kWh), inclusive of civil, E&M, transmission, access road, environmental mitigation and cost contingencies</td><td>75%</td></tr>
<tr><td rowspan="4">System Fit for Medium-Term Supply (25%)</td><td>Project size</td><td>Installed capacity in three size ranges reflecting what is needed in the project basket for system planning</td><td>3%</td></tr>
<tr><td>Firm Energy Contribution</td><td>Ratio of firm energy to average energy production from the project</td><td>10%</td></tr>
<tr><td>Flexibility of dispatch</td><td>Storage and ability to dispatch at peak or seasonally</td><td>7%</td></tr>
<tr><td>Regional Location</td><td>Regional supply-demand balance</td><td>5%</td></tr>
<tr><td colspan="3"></td><td>100%</td></tr>
</table>

Source: Imran, Mudassar and Tjaarda P. Storm van Leeuwen (2006)

Table 5.4: Coarse Ranking Composite Environmental/Social Criterion

Criteria	Scoring System		Weighting	
			Run-of-River Project	**Storage Project**
Physical Environment	Land take	Amount of land required for the project facilities, reservoir and access roads	17%	14%
	Watershed conditions	ICIMOD classification of watersheds in Nepal	17%	14%
	Downstream impacts	Potential of adverse downstream impacts	-	14%
Biological Environment	Biodiversity Impact	Potential for the project to adversely impact sensitive biological areas	14%	14%
	Aquatic System Impact	Length of river stretch and aquatic habitat adversely affected	14%	14%
Socio-Cultural Environment	Number of project-affected people	Estimated number of persons directly or indirectly affected by the project in terms of relocation or other disturbance	27%	33%
	Cultural Sensitivity	Potential for adverse socio-cultural impacts	8%	7%
			100%	100%

Source: Imran, Mudassar and Tjaarda P. Storm van Leeuwen (2006)

Based on the coarse ranking, 22 sites were identified to proceed to fine ranking and comments were invited from the concerned stakeholders and NGOs before finalizing the list of projects.

At fine ranking, further site visits and surveys were conducted to (i) collect additional data to prepare reconnaissance level project layouts with standardized methods for design, quantities and unit rates and (ii) prepare environmental and social impact assessments that were in effect with rapid appraisals and initial EIA scoping exercises. In parallel, meetings and workshops were held with national level civil society and professional groups to refine the fine screening criteria and weights. Additional criteria, such as project risk criteria, were introduced. Based on the above criteria, 7 projects/sites were selected for a full feasibility/EIA study. The KAHEP is one of them.

The KAHEP was selected by MHSP using the above criteria and the decision for its development was made. A rigorous environmental and social screening was applied by MHSP prior to KAHEP selection based on the local and national contexts. This way, KAHEP was found to be one of the most viable projects for the development from every perspective.

5.5 ALTERNATIVE ANALYSIS OF PROJECT LAYOUT

The Kabeli River has a number of potential HEPsites. Since the selection of the project location option is restricted within the geographic coordinates approved by DoED, the project location option is evaluated in terms of the project type and corresponding location of thelayouts within the assigned geographical coordinates.Given the constraint of the geographical grid, run-of-the-river (ROR), peaking run-of-the-river (PROR) and storage projects options were considered for evaluation.

The storage project was rejected as the submergence area within the licensed geographical grid along the Kabeli River is small and could accommodate only a small volume of live storage to operate the project as a reservoir project.

Considering the ongoing power crisis, particularly in the dry season, run of the river cum peaking storage project was preferred against the ROR project. Even though, the loss of forest and agricultural lands was estimated higher for the PROR type project compared to the ROR, the option PROR was favored because it ensures peaking power production to meet the power crisis, though in a small way.

Based on the PROR concept; the location and the design of the various structural component layouts were analyzed. Geological factors and topographical conditions were considered while selecting the key structural sites and their respective layouts. In total, four alternative layouts were considered before the KAHEP, alternative IV, was finalized.

From the environmental perspective, this alternative was considered (i) the least damaging, (ii) minimizing private land acquisition, loss of forest area, wildlife habitat, number of affected families, (iii) having no displacement of population etc. ***Annex 5.1*** presents the comparative assessment of the Alternative I (the worst alternative) with Alternative IV (the selected alternative) on environmental, social and technical aspects. The other alternatives (II and III) fall between the alternative I and IV. Section 5.6 below highlights on the location and designs of the various alternatives.

5.6 LOCATION AND DESIGN ALTERNATIVES OF PROJECT STRUCTURES AND ANCILLARY FACILITIES

Selection of location and design, particularly of the dam, powerhouse, settling basin, approach tunnel, surge shaft, penstock pipe, access roads, camps, and spoil disposal sites were considered and evaluated on the environmental grounds.

5.6.1 Dam Site

Alternative I (1998 Study)*:* In this alternative, the diversion structure is proposed just downstream of a major bend in the Kabeli River. The right bank consists of a good rock but the left bank has colluviums deposits. Since the dam has to store peaking water, sealing and stability of the reservoir is questionable as it is unlikely to construct a guide wall to connect the rock face and the left bank. The colluviums may be prone to seepage and water logging. Water logging in the long run may jeopardize the stability of the reservoir. The immediate upstream of the dam is a wide flood plain and is suitable to propose a ponding reservoir. However, the full supply level of 569.2 m (as proposed previously) is lower by about 8 m in comparison to the Phawa Khola-Kabeli river confluence. If the dam is selected at this location, this head will remain untapped. The settling basin was proposed at the left bank of the Kabeli River on a steep hill toe which is almost entirely exposed to excavation. This area was selected in 1998 study by considering the good rock exposure suitable for tunnel inlet portal as well. However, the proposed settling basin requires hill toe cutting to locate the desander of about 3.000 m^2 surface areas. Enormous slope protection works are needed. The valleys are sharp with the depth of valley at least 10 m in cross-section. Additionally, the basin is in the vicinity to the Kabeli River and is not free from the risk of floods. Flood protection structures will be required. Therefore, this alternative analysis shows that the location of the settling basin is unfavorable and a better location should be explored.

Alternative II*:* This alternative has attempted to take advantage of rocks in both banks, to utilize the wide flood plain for the settling basin and to gain head. The diversion structure is proposed to shift about 400 m upstream of the dam axis of the Alternative I. This axis comprises of granite rock on both banks and the left bank immediately downstream of it is a wide flood plain suitable for placing the settling basin. However, the width has a negative side too; the axis is quite wide and the cost of headworks is likely to increase. Also, the river gradient in this location is locally gentler than the average river gradient of 1 in 90. Locating the dam axis in a steeper gradient would provide more room for the flushing head to flush settling basin for the same dam height than in the gentler gradient. Since, the Kabeli River is quite flat, this point remains vital in influencing the cost of the project.

***Alternative III**:* The Alternative III is proposed as a modification of Alternative II in which the only difference is that the dam axis is moved upstream by about 250 m, and an inclined tunnel at the powerhouse side to serve as adit during construction and surge shaft during operation. This alternative, as the Alternative II, comprises of rock outcrops in both banks but the axis would be shorter by about 12 m. Also, the rock slopes are steep to prevent the increase in the dam length substantially as the height increases. The axis is at a bend of the river with the flow concentrated on the left bank (intake bank). Even though the bend effect may vanish after construction of the reservoir, the effect of the bend, if it prevails, should be favorable to the intake. Another prominent feature with this alternative is that the river gradient is locally steeper with about 1:60 gradient against 1:90 as the average river gradient. This gradient gives a gain of 2.5 m higher river bed as compared to the intermediate dam axis of the Alternative II. This head can be utilized for increasing the project head for energy production and flushing head for the settling basin. A dam with the same height as in the Alternative II would locate FSL at 575m thereby leaving only about 2 m of untapped head up to the Phawa confluence. The length effect, rock condition and gain in head are attractive features of this alternative in comparison to the Alternative II. This alternative, having a fairly wide dam axis, has a possibility for a surface diversion during construction if the dam is constructed in part by diverting the river on the next bank of construction. Also, if the diversion during construction is preferred through a diversion tunnel, this alternative is the best among all. The right bank of the river has granite exposure both up and downstream of the dam area and also comprises a curvature that makes possible to have a shorter diversion tunnel (360 m) than the de-watered portion of the river length (400 m).

Alternative IV:The Alternative IV is proposed as a modification to the Alternative III with the only difference being the change of the settling basin location from surface to underground and the necessary changes in the accompanying accessories. The headworks location at the upstream axis was concluded being the best among the available alternatives. Due to the flat river posing, the risk of the large amount of seepage water along the length of the coffer dam and a comparable cost of the coffer dam with that of the diversion tunnel, the diversion during construction was preferred for the tunnel option. A comparison of both surfaces versus the underground alternative was made.The underground option appeared to be cheaper, even though this option is associated with the risk of the little known underground rock mass. However, the risk of going underground will not be obviated even with the surface settling basin as the headrace tunnel in the same rock mass has to be constructed. Moreover, the settling basin was aligned with the favorable excavation direction in relation to the discontinuities and the risk of the Kabeli flood.

Environmental Comparison: The alternatives III and IV are same from the structure location aspect. The only difference between the two options is the configuration of the water way structure and desilting basin. Alternative III has a surface desilting basin while alternative IV proposes an underground desilting basin.

Out of four alternatives, the Alternative IV was selected based on the geological as well as environmental grounds. The alternative IV has advantages in locating the dam axis and in connecting waterway structures to favorable geological conditions to avoid the likely risks of land failure and stability of structures. Additionally, this alternative involves less damage to the forest land and the agricultural private lands compared to the alternative I, II and III due to underground location of the desilting basin.

Dam Design:

Among four alternatives of the dam design (concrete dam, rock-fill dam with concrete top and barrage), the barrage option is selected as the best alternative. Some of the environmental reasons for selecting the barrage type damming structure for KAHEP are:

- easy mechanism for sediment sluicing,
- best for reservoir longevity,
- good for bed load exclusion,
- least fluctuation in headwater levels as it can be controlled by the gates.

5.6.2 Powerhouse Site

Alternative I: The powerhouse in this option was proposed along the left bank of the Tamor River, at the corner of an apparently attractive flat terrace. The 1998 study selected this option and proposed to locate the powerhouse after removing the 20 m thick terrace deposit, although the extent of the excavation seems to be a big challenge. The location happened to be a remnant of an old landslide during geological investigations. Therefore, the area is vulnerable towards triggering slopefailures in response to a 20 m deep excavation along the slope.

Alternative II: The powerhouse in this option was proposed along the left bank of the Tamor River.The ridge downstream needed ridge protection against wash-outs during extreme floods. The ridge has outcrops of a phyllite rock in the upper part and a relatively flat terrace area in the lower part. This area, though has a risk from a small tributary called Piple Khola, was envisioned as a much safer location compared to the Tamor river flood risk. Piple Khola has a catchment of 5.4 km^2 and its risk could be viably controlled by constructing protection and retention structures. The benefit of this area for tailrace is that it can be drained out diagonally but not perpendicularly to Tamor River. The disturbance of Tamor River in excavation during construction of the tailrace will be minimized too. In this alternative, geological and topographical conditions were preferred to establish the powerhouse not directly on the bank facing Tamor River but on the ridge area against Tamor River.

Alternative III: Powerhouse location under Alternative III is the same as that of the Alternative II.

Alternative IV Powerhouse: The proposed powerhouse, as in the Alternative II, is a surface powerhouse located on the right bank of PipleKhola, Ward number 9 at Amarpur VDC, Panchthar district with about 93.10 m long tailrace canal following PipleKhola till Tamor River. The outside dimension of the powerhouse is 31.95 m long and 16.92 m wide. The excavated material will be used to construct the earthen bund at the Tamor side. In respect to the Tamor's flood, the area lies on the leeward side of a phyllitic rock forming spur nose. The rocky spur nose can be effectively utilized as a flood protection structure. However, the area is adjacent to the flood plain of Piple Khola and needs flood protection structures.

Environmental Comparison: Alternative I was rejected as this alternative lies in the old landslide zone with potential risks of landslide rejuvenation on environmental grounds. Further, the site has a risk of floods from Tamor River. Alternative II, III, and IV has the same location and has the risk of Piple Khola erosion. The advantage of the site is that it is protected by the spur nose from the Tamor River flood. The difference in II, III and IV alternative is on the structural layout. With the proposed protection structures and the tailrace layout, the Alternative IV has the minimum risk of erosion from Piple Khola compared to the Alternatives II and III. Therefore, the Alternative IV is also selected based on the environmental grounds.

5.6.3 Approach Canal vs. Approach Tunnel

Regarding the approach canal and the approach tunnel options to link the settling basin to the intake, the tunnel option was selected considering the surface geological conditions of the canal option. Further, the choice of a canal vs. tunnel is related to the choice of the surface vs. underground settling basin. Since an underground settling basin was selected based on the geological stability grounds (refer section 5.6.4 below), the canal option was rejected.

Environmental Comparison: Environmentally, the tunnel option has the least risk of the ground stability compared to the canal option. Additionally, the tunnel option minimizes the land acquisition needs, affect on people and on the forest land area.

5.6.4 Alternatives for Settling Basin

There are two options for the settling basin: surface and underground settling basin. In case of a surface settling basin, a canal of 235m was required. It should be capable of carrying full discharge without sedimentation in the canal floor. The geological investigation of the site for the surface settling basin revealed the lack of bed rock up to 20m below the surface. So, a settling basin has to be constructed on alluvial deposits of Kabeli River which posed a great risk to the basin stability. The settling basin location is intersected by a small gulley named Tyapuje Kholsi. Kholsi can discharge only in monsoon but it is vulnerable for the whole structure because occasionally it brings huge debris during monsoon. So, for Kholsi protection a large protection wall is required, but in case of an underground settling basin, the site proposed for it contains granite of fairly good quality. Moreover, the settling basin was aligned to the favorable excavation direction in relation to the discontinuities. In addition, the risk of Kabeli flood, Kholsi debris, weak foundation and slope stability will be avoided.

For these reasons the underground settling basin was selected. In terms of number of settling basins, two potential options are studied: two or three basins. It t was found that the most appropriate option is two settling basins, factoring in the associated costs. The cost of three basins of 10.3 m width exceeded the cost of two basins of 15.8 m width. Hence, two basins of 15.8 m width were selected based on the financial grounds.

Environmental Comparison: The underground settling basin has the following environmental advantages against the surface alternative:

- Minimize the private and forest land acquisition
- Avoid the number of people affected
- Avoid surface excavation and steep open cutting with the risks of land failure
- Avoid additional protection structures
- Avoid seepage water loss and basin structural stability

5.6.5 Penstock Pipe Alternatives

Regarding the penstock design, two options were evaluated: the exposed penstock pipe arrangement and the buried penstock pipe arrangement. In the exposed typed, four anchor blocks were fixed with spacing no more than approximately 56m. One bifurcation unit was also fixed near the powerhouse. In this option, as the tunnel outlet portal invert level is 535.75 m and the original ground level of that point is 567.009m, the huge amount of soil excavation took place while maintaining the final ground stability. For the buried penstock option with the same alignment and the same main anchor block configuration, the cost is cheaper than with the exposed option. The buried option also has a number of environmental advantages over the exposed one. Therefore, the buried option was selected.

Environmental Comparison: There are numerous advantages of the buried type penstock design against the exposed type:

- It protects the penstock against adverse effects of temperature variations.
- It protects the water from freezing due to the low air temperatures.
- It protects the pipe from falling debris and trees.
- It protects the pipe from tempering and vandalism.
- It eliminates support piers.
- Anchor blocks are not required if bends are small.
- The landscape is not affected like in the surface exposed case.

5.6.7 Access Road to Headworks

Two alternative access road alignments to the headworks were identified that branch from the MechiHighwayat different chainages. The Alternative I is along the left bank of the river that branches from the highway at chainage 59+900 from Phidim. The Alternative II is along the hilly terrain that branches from the chainage 50+00 with approximate length of 7.4 km including a number of bends. The length of the Alternative I is comparatively less than that of the Alternative II. The alternative I will require opening of the new road corridor for its entire length, while the Alternative II is the existing motorable road along the edge of the forested area and only requires some upgrading. Also, the local communities of the area were demanding the existing road upgrades. Therefore, the Alternative II was selected for the access road to the headworks.

Environmental Comparison: The Alternative II has the following environmental advantages against the Alternative I:

- Avoid acquisition of the prime agricultural land
- Avoid economic displacement of additional households
- Avoid agricultural production losses
- Establish a project–people relationship as it meets the community request to upgrade the existing road.

5.6.8 Access Road to the Powerhouse

There were three options considered for the access road to the powerhouse: (i) Madibung Alternative, (ii) Panchami Alternative and (iii) Subhang Alternative. All alternatives connect the powerhouse site to Mechi Highway at different chainages. Amongthe three proposed alternatives, the Panchami Alternative II, starting from Bhanuchouk at chainage of 48+000 from Phidim, already had a motorable track opened by the communities, while other alternatives (I and III) will require opening of a new road corridor for the entire length. Further, there is a strong community demand for the existing road upgrades and the project will upgrade the total of 15 km if the Alternative II is selected as the project access road. Hence, the Panchami Alternative II was considered as the best alternative for the development based on the environmental grounds.

Environmental Comparison: Panchami Alternative II has the following environmental advantages compared to the Madibung Alternative I and Subhang Alternative III:

- Avoid permanent acquisition of the forest and agricultural land
- Avoid economic displacement of households

- Avoid loss of standing forest vegetation and wildlife habitat
- Avoid forest fragmentation
- Avoid additional land degradation, erosion and landslides.
- Establish project – people relationship as it meets the community demand for the road upgrading.

5.6.9 Alternatives to Camps at Powerhouse and Headwork

The ancillary facilities (temporary and permanent) could lead to the environmental degradation of the project area surroundings if the sites were not selected and fixed considering the local environmental conditions. To avoid the unforeseen environmental degradation and to ensure that the project contractors do not infringe on the local environment by making choices on the site selection to suite their benefits, he camp sites were selected and fixed for the project. The selection criteria for the camps (contractors, engineers and labors etc.) are primarily based on the followings:

- Proximity to the worksites – the sites are as near to the construction work areas as possible, so the access to the construction sites is easy and within the walking distance;
- The camp location does not interfere the construction works and also maintains safety of the individuals living at the camps;
- The camp location should be at a distance from the local community residential areas;
- The establishment of camps minimizes the loss of the standing forest vegetation and does not involve substantial landscape change; and
- The camp location lies in a stable area free from landslide and flood risks.

Based on these criteria, the camp locations at powerhouse and headwork site were selected after the thorough field checks. The proposed camp sites meet the above criteria and the contractors will have to comply with the selected sites for the establishment of the camp facilities. The powerhouse camp site is located on the old alluvial fan of Piple Khola. On the ground of the observation made at the site from its geomorphic make up and the potential activities derived from the historical evidence of Piple Khola in the monsoon rainy season, the site is considered safe from the Piple Khola floods. For the headworks area, one temporary contractor/labor camp site will be located at Rajabesi village near the headworks area of Amarpur VDC.

5.6.10 Alternatives for Quarry, and Spoil Disposal Sites

Considering the availability of aggregates, there were two alternatives for the project. The first alternative was to mine the required aggregates from the bedrocks and the second alternative was to mine the aggregates from the flood plains of Kabeli and Tamor Rivers. The first alternative will involve direct impacts on the existing forest and agricultural lands, the main source of livelihood of the local people, whereas the second alternative will avoid such impacts on the land resource of public use but will have limitations on the mine operation in the rainy season. Based on the assessment, the second is the best alternative from the environmental and social stand point with a few measures to be implemented for the protection of the river water quality. The contractors will have to comply with the selected option and the sites, including with the mining methods for the aggregate extraction.

Considerations for the spoil disposal sites selection is based on the following criteria:

- Avoid change of the productive land use;
- Avoid erosion enhancement;

- Maximize opportunities for the productive land development

In the local area context, the wide floods plains of the Kabeli and Tamor are the best suitable sites with measures to protect against the riverine erosion, and to plan for the productive land development. It is for this reasons that the elevated flood plain areas above the normal annual high flood level were selected for the spoil disposal and management. The contractors will have to comply with the selected sites for the spoil management.

5.7 NO FOREST ALTERNATIVE

The forest guideline 2006 of the GoN mandates no forest alternative as one of the criteria for the project site selection to minimize forest losses. To comply with the guideline provisions, one of the considerations while selecting the project structure and project support facility sites is to minimize the forest areas as far as possible. The selected structure and ancillary facility sites locations (refer section 5.6 above) are the locations which impose the least impacts on the forest and are the most suitable locations from the power output and geological/ geotechnical stability prospective. The selected site is therefore considered to have insignificant impacts on the area green cover.

5.8 ASSOCIATED RISKS

The project design was given a due consideration to avoid risks both in terms of natural and social resources. While doing so, the efforts were made to minimize the project's costs. Most of the waterways in KAHEP have been designed as the underground structures including settling basin, headrace tunnel and surge shaft. The underground settling basin and headrace tunnel was designed based on the surface geological investigations and has the risks associated with the cost overrun during the construction due to possible changes in the geological formations properties.

Similarly, the powerhouse area is located partly on an elevated terrace of the Tamor River and the fan deposit of Piple Khola. It was designed considering 1,000 years return period flood level of Tamor River. The risk of GLOF has also been considered by referring to the potential GLOF discharge estimates. Protection structures were designed for two extreme floods with the assumption that both of them will not occur simultaneously. Even though the risk associated with GLOF is not prevalent in the Tamor basins as per a recent study on GLOF by ICIMOD (2001), there is a potential hazard of flooding of the powerhouse in an extreme case due to the lack of data on GLOF events.

Protection structures to safeguard the powerhouse have been envisaged from the undercutting and sediment deposition from the Piple Khola torrent. The Piple Khola has been cutting and depositing sediment loads in the vicinity of the powerhouse area in the past. The proposed protection structure assumed to avoid the risk of such events.

Another major item to consider is the risk of the peaking reservoir. A reservoir with the designed storage capacity is not envisaged to pose risks to the downstream population and other natural and environmental resources in the event of normal operation. However, risks due to improper regulation, malfunctioning of regulation structures and dam breaking, at the worst, may pose threats to the downstream reaches. Preliminary calculations show that the spontaneous discharge due to dam breaking is 1084.1 m^3/s at FSL 575.3 m and 1217.931m^3/s at FSL 578.3 m that is much lower than the design flood of 1860m^3/s at Q100. Therefore, the risk of inundating the downstream even during a dam break event is low. Still, the ponding reservoir and its regulation might have the consequences and pose some risks, like discharging water to the downstream without adequate warning which may sweep humans and cattle on the downstream reach. An adequate warning system should be designed to minimize such avoidable risks.

5.9 TECHNOLOGY, OPERATION, PROCEDURES, TIME SCHEDULES AND RAW MATERIALS TO BE USED

To provide the maximum job opportunities to the locals, the selected construction technology alternative is based on a mix of labor and machine. The machine only or maximum machine based construction technology is rejected because of its potential environmental management difficulties and the minimum job opportunities to the locals. The power plant operation will make the optimal utilization of the available hydrology. A consideration is given to the environmental requirements to release the environmental flow from the dam according to the local legal provisions. As far as possible, raw materials required for the project will be sourced from the local area except for timber and fuel wood.

Chapter VI: POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

This Chapter discusses the environmental issues identified during the ToR stage of the study for the prediction of the potential environmental impacts in the project area in the absence of mitigation measures. The section also identifies the mitigation measures to avoid, minimize, and compensate the adverse environmental impacts with additional enhancement measures to maximize the benefits of the positive impacts. The project proponent is committed to the implementation of all mitigation and enhancement measures illustrated in this section at different phases of project implementation and operation. The proponent understands that any additional measures required to avoid, minimize and compensate the adverse environmental effect unforeseen in this section are also its responsibility.

6.1 ADVERSE ISSUES

The prioritized adverse issues that are likely to occur by the implementation of the project are presented below.

6.1.1 Primary Issues

6.1.1.1 Construction Phase

I. Impacts on vegetation due to the site clearance for the project activities and offsite activities of construction works and associated workforce

a. Loss of Forest and Site Clearance for Project Structures and Facilities

The site clearance activities, for the construction of project structures (such as headworks, tunnel inlet, surge-shaft, penstock & powerhouse) and project facilities will result in the loss of vegetation as parts of these structures and facilities are situated in forest lands. The forestlands to be acquired are small areas scatted in several locations for various project works. Out of total 1.57 ha forest land required, 0.21 ha area belongs to Thulo Dhuseni Community Forest (CF), 0.12 ha belongs to Kabeli Garjite CF, 0.97 ha belongs to Pinasi Leasehold Forest (LF) and 0.27 is the communal national forest land**.**Table 6.1 presents the loss of forest areas by the construction of different project structures and facilities.

Table 6.1: Loss of Forest Vegetation in Different Project Structures and Facilities

SN	Name of Project Structure and Facilities	Land Area (ha)	Name of the Forest
1	Reservoir	0.57	Kabeli Gargete CF, Thulo Dhuseni CF, Communal Forest
2	Barrage, Operating Platform, Intake	0.03	Thulo Dhuseni CF
3	Powerhouse and Switchyard	0.27	Pinasi Leasehold
4	Penstock Pipe and Surge Shaft	0.7	Pinasi Leasehold
Total		**1.57**	

Note: As the internal access roads have an existing community developed motorable track, the forest clearance is not envisaged. Similarly, quarry sites, camps and spoil disposal site lie outside the forested areas.
Source: Field Survey, 2010

The loss of tree species, pole, sapling and seedling in the different forest areas is presented in Table 6.2.

Table 6.2: Loss of Forest Resources in Different Forest Areas by KAHEP Forest Land Acquisition

S.N	Type /Name of Forest	Project Structure /Facility and Location	Loss of Vegetation (Nos.)					Biomass Loss (MT)				Key Vegetation Species
			Se	Sa	P	T	Total	TS	TB	TF	Total	
1	Private Forest	Reservoir (Amarpur ,2)	1	2	2	2	7	7.046	2.080	0.243	9.369	*Mallotus philippensis, Geruga pinnata, Ficus hispida, Duabanga grandiflora*
2	Private Forest	Reservoir (Thechambu,6)	0	24	16	20	60	14.950	3.827	0.688	19.465	*Geruga pinnata, Adina cordifolia, Shorea robusta, Terminalia alata*
3	Community Forest/Kabeli Garjite	Reservoir (Amarpur,2)	8	10	8	6	32	3.970	1.016	0.183	5.169	*Lagerstroemia Parviflora, Geruga pinnata, Mallotus philippensis, Terminalia alata*
4	Community Forest /Thulo Dhuseni	Reservoir (Amarpur, 5)	45	48	21	9	123	6.138	1.571	0.282	7.991	*Rhus javanica, Terminalia alata, Schima wallichii, Shorea robusta, Duabanga grandiflora*
5	Private Forest	Barrage, Operating Platform, Intake Area (Thechambu,6)	12	6	2	3	23	1.540	0.394	0.071	2.005	*Shorea robusta, Terminalia alata, Adina cordifolia, Lagerstroemia parviflora,*
6	Community Forest /Thulo Dhuseni	Barrage, Operating Platform, Intake Area (Amarpur, 5)	4	7	0	5	16	27.790	8.257	0.941	36.988	*Shores robusta, Rhus wallichii, Mallotus philippensis, Pinus roxburghii, Lagerstroemia parviflora*
7	Leasehold Forest/Pinase	Powerhouse and Switchyard (Amarpur,9)	28	32	20	16	96	30.986	8.977	1.117	41.080	*Shorea robusta, Bombax ceiba, Lagerstroemia parviflora, Adina cordifolia*
8	Leasehold Forest/Pinase	Penstock (Amarpur ,9)	253	88	66	121	528	65.788	17.976	2.691	86.455	*Shorea robusta, Terminalia alata, Lagerstroemia parviflora, Mangifera indica, Rhus wallichii*

S.N	Type /Name of Forest	Project Structure /Facility and Location	Loss of Vegetation (Nos.)					Biomass Loss (MT)				Key Vegetation Species
			Se	Sa	P	T	Total	TS	TB	TF	Total	
9	Private Forest	Surge Shaft (Amarpur ,9)	33	90	18	18	159	13.224	3.699	0.516	17.439	*Shorea robusta, Lagerstroemia parviflora, Acacia catechu, Adina cordifolia, Phyllanthus emblica*
Total			384	307	153	200	1044	171.432	47.797	6.732	225.961	

Note: Se-Seedling, Sa-Sapling, P-Pole, T-Tree; TS-Total Stem, TB-Total Branch, TF-Total Foliage
** Avg. DBH and Range of DBH to be given for Pole and Tree Class*
*** Seedling_0-4 cm DBH; Sapling_4-10 cm DBH; Pole Class_10-30 cm DBH; Tree Class_>30 cm DBH*
Source: Field Survey, 2010

It is estimated that a total of 200 trees and 153 pole size vegetation would be cleared from the forest land areas occupied by the project permanent structures and facilities.

None of the floral species to be cleared by the project in the occupied forestlands are listed in the IUCN Red Book or CITES Appendices. The Government of Nepal, under the Forest Act 1993, has protected many plant species which are banned for transportation, export and felling for commercial purposes. In the project impact area, there are some floral species listed by the Government of Nepal as protected based on their economic value. Table 6.3 presents the list of the floral species "protected" under Forest Act and available in the project impact zones that would have to be cut for the construction of the project. All of the protected species are the commonly found species within the project area.

Table 6.3: Loss of GON Protected Floral Species in the Forestland Occupied by the Project

S.N	Type /Name of Forest	Project Structure/Facility and Location	Name of Species	Loss of Vegetation (Nos.)					Remarks
				Se	Sa	P	T	Total	
1	Private Forest	Reservoir (Thechambu,6)	*Shorea robusta*	0	0	0	4	4	*GoN Protected*
2	Community Forest /Thulo Dhuseni	Reservoir (Amarpur, 5)	*Shorea robusta*	18	6	0	3	27	*GoN Protected*
3	Private Forest	Barrage, Operating Platform, Intake Area (Thechambu,6)	*Shorea robusta*	2	1	1	1	5	*GoN Protected*
4	Community Forest /Thulo Dhuseni	Barrage, Operating Platform, Intake Area (Amarpur, 5)	*Shorea robusta*	3	0	0	1	4	*GoN Protected*
5	Leasehold Forest/Pinase	Powerhouse and Switchyard (Amarpur,9)	*Bombax ceiba*	0	0	0	4	4	*GoN Protected*
			Shorea robusta	24	12	12	8	56	*GoN Protected*
6	Leasehold Forest/Pinase	Penstock (Amarpur ,9)	*Shorea robusta*	66	22	33	66	187	*GoN Protected*
7	Private Forest	Surge Shaft (Amarpur ,9)	*Shorea robusta*	21	42	15	15	93	*GoN Protected*
Sub Total			***Shorea robusta***	**134**	**83**	**61**	98	376	***GoN Protected***
			Bombax ceiba	**0**	0	**0**	4	4	
Total				134	83	61	102	380	

Note: Se-Seedling, Sa-Sapling, P-Pole, T-Tree
Source: Field Survey, 2010

It is estimated that 102 trees and 61-pole size vegetation of GON protected category will be cleared from the forestland areas occupied by the project. Cutting/ clearing of the protected species for commercial purpose is not permissible. However, cutting/ clearing of these species for non-commercial/ development purpose is allowed and a subject to clearance from the competent authority (i.e. Ministry of Forest and Soil Conservation), and compensatory plantation at the ratio of 1: 25 (i.e. 1 tree cut: 25 sapling planted and taken care for 5 years at the least).

The clearance of forest in monetary terms is valuated in Table 6.4. A total of NRs 2,228,293is the estimated monetary value of the lost forest area resources.

Table 6.4: Monetary Value of the Lost Forest Resources

S.N	Botanical Name	Value of Timber Loss (NRs)		Value of fuel wood Loss (NRs)	Value of fodder loss (NRs.)	Total (NRs)
		Pole Class	Tree Class			
1	*Acacia catechu*	5,580	16,008.4	2,431.02	46.5	24,065.92
2	*Adina cordifolia*	6,417	2,15,288.2	17,023.34	300.7	2,39,029.2
3	*Aesandra butyracea*	620	0	543.12	10.54	1,173.66
4	*Bischofia javanica*	0	7,720.86	1,420.42	19.22	9,160.5
5	*Bombax ceiba*	0	1,49,042.4	27,423.84	376.34	1,76,842.6
6	*Celtis australis*	310	0	91.14	1.86	403
7	*Duabanga grandiflora*	837	1,55,923.2	10,721.66	164.92	1,67,646.8
8	*Engelhardtia spicata*	0	1,44,755.7	26,635.2	375.72	1,71,766.7
9	*Ficus hispida*	155	0	195.3	3.72	354.02
10	*Ficus semicordata*	620	0	93.62	1.86	715.48
11	*Geruga pinnata*	1,860	65,175.02	14,013.24	223.2	81,271.46
12	*Hymenodictyon excelsum*	465	0	234.98	4.34	704.32
13	*Lagerstroemia parviflora*	5,115	65,691.48	15,110.64	284.58	86,201.7
14	*Mallotus philippensis*	465	5,666.18	1,195.36	22.94	7,349.48
15	*Oroxylum indicum*	620	6,187.6	1,693.22	32.24	8,533.06
16	*Pinus roxburghii*	0	1,31,428.8	24,183.1	342.86	1,55,954.8
17	*Rhus javanica*	465	4,952.56	1,122.82	21.7	6,562.08
18	*Rhus wallichii*	620	7,119.46	1,789.94	34.1	9,563.5
19	*Sapium insigne*	1,240	3,274.22	1,331.14	25.42	5,870.78
20	*Schima wallichii*	1,705	14,367.88	3,736.12	71.3	19,880.3
21	*Shorea robusta*	20,925	9,17,668.8	67,566.98	1,138.32	10,07,299
22	*Syzygium cumini*	1,705	0	1,354.7	26.04	3,085.74
23	*Terminalia alata*	2,945	23,116.7	5,721.98	109.74	31,893.42
24	*Terminalia bellirica*	0	10,451.96	1,923.24	26.66	12,401.86
25	*Terminalia chebula*	310	0	248.62	4.96	563.58
	Total	**52,979**	**19,43,840**	**2,27,804.7**	**3,669.78**	**22,28,293**

Note: Pole Ku Kath = NRs. 250/pole, Sukath NRs 450/pole; Timber, KuKath - NRs 125/cft (NRs.4411.25/ cum), SuKath NRs 350/cf (NRs.12351.50/cum) [Sukath- Acacia catechu, Adina cordifolia, Duabanga grandiflora, Shorea robusta]; Fuel Wood - Lumpsum NRs 11500/Chatta; Fodder – Lump sum NRs 0.5/kg
Source: EIA Survey, 2010

As elaborated in the baseline environment (Chapter 4, section 4.2.1.8), the forest in the project area is degraded and encroached by the local communities for cattle grazing and collection of firewood, fodder, and litter, and hence it has lost the characteristics of a natural forest. Though the community forest is better preserved than a government forest, it has very little or limited significance for wildlife habitat. Despite this fact, these degraded forest patches have provided ecological services (groundwater recharge, soil moisture, spring flows, soil nutrient budget etc.) to sustain the agro-economic practices.

The loss of 1.57 ha forest due to the project is scattered in several locations and occurs only along the boundary areas of the existing forest and does not involve large scale fragmentation across the core forested area. In addition, the road leading to the headworks developed by the local communities already has some adverse implications due to forest fragmentation at outer boundaries of the forest and erosion compared to other areas of forest losses. Considering the occasional nature of the wildlife (mostly raider animals) movement (for feeding only) across these areas the envisaged impact is assessed as insignificant, because the raider wildlife have already established an ecological relationship with the agro-economic activities of the nearby communities.

Mitigation

Enormous efforts have been made to minimize the forest area and vegetation loss while planning the project structures and facilities. However, complete avoidance of the forested areas and vegetation is not possible due to the key structural locations of the project, which are largely determined by geology and other design parameters. It is, therefore, in the given geographic setting, some small loss of the forested area and vegetation by the project structures and facilities is unavoidable. However, to minimize the loss of forest area and vegetation and to mitigate the impacts, the following abatement measures, already agreed with local communities, will be implemented in the project VDCs.

1. ***Compensatory afforestation as per the Forest Guideline (2006):*** Discussions with the local communities, forest user groups, and the District Forest Office (DFO) were held during the EIA study phase for the identification of the afforestation areas. It has been proposed to plant 25 trees for every tree lost and take care of them for 5 years to ensure the growth of the planted sapling. Local forest user groups were interested in planting the trees in nearby open lands and were ready to provide the area required. Similarly, the plantations on either side of the access roads will be undertaken. Plantation is also recommended near the reservoir area and along the riverbanks (particularly in the dewatered stretch of the Kablei River between dam and confluence with Tamor River), Hence further discussions during the early implementation phase of the project are required to plan a site specific compensatory afforestation plan. Estimated mitigation cost for the compensatory afforestation as per the Forest Guideline, 2006 is NRs 936,250.By 30 years, it is envisaged that the lost vegetation diversity and forest area will be recovered to reinstate the previous ecological conditions or to make it better than the present.

2. ***Lease Compensation to the Forest Land Area***: For the lost forest area, in addition to compensatory afforestation, lease compensation, as per the Forest Act and Regulation, is ensured by the proponent for the project period of 30 years to comply with the provisions of Forest Guidelines 2006. The cost estimated for the lease compensation to the lost forest area is NRs278,915.

3. ***Clearing of the forest vegetation and stockpiling the vegetation products before handover:*** The standing forest resources such as timber, firewood, litter and fodder has high value. Therefore, the project will clear the forest and stockpile the materials as per the guideline of Forest Produces Collection, Sale and Distribution Guidelines, (1998) and will be handed over to the respective owners. Estimated cost for clearance and stockpiling is NRs 467,000.

4. ***Clearing of the forest vegetation as per the requirement of project structures and facilities only:*** The project sites requiring forest clearance will be demarcated and each tree and pole size vegetation will be marked and documented through joint inspection conducted by the DFO, community forest and leasehold forest user groups, and project environmental officer as per the prevailing forest legislation. The contractor will be given orders in the work specifications to make a clear felling (avoiding "domino" effect on adjacent trees) of the only designated sites and tree and pole species under the strict supervision of the project

environmental officer. Estimated cost of joint supervision is NRs.225,000.00 Such actions are envisaged to minimize the loss of unnecessary trees and poles in the project structure and facility sites. Further, in the project camps, the exiting trees and poles will be kept intact by felling only trees and poles required for the placement of housing structures.

5. ***Technical and financial assistance to the Affected Community Forests and Leasehold Forest User Groups:*** The User groups of the affected community and leasehold forest will be provided technical assistance for the management of the community and leasehold forests. A forester will be hired to prepare a plan to maximize the benefit from the existing forest areas without impinging upon the existing ecological status. Financial assistance for NTFP and plantation of local species in the degraded forest area will be provided to upgrade the economic conditions of the user groups and improve the ecological status of the existing forest areas under the group holding. Estimated costs for the technical and financial assistance to the affected community and leasehold forest user group are NRs 1,100,000

b. Loss of vegetation due to the offsite activities of construction works and associated workforce

The project development site at headworks and powerhouse will have the presence of a relatively large construction workforce both local as well as outsiders. Nearly 600 to 800 people will be in the project site during the peak construction period (which is normal for a project of this magnitude in Nepal such as the Middle Marsyagdi Project). Traditionally for cooking and other heating purposes, firewood is used in Nepal. If no other alternatives are offered, the construction workers in the Kabeli project will also use the firewood for cooking. The obvious sources of the firewood are the local forests. The local forests have a limited regeneration capacity to meet the required firewood annually. The construction work force family or the local merchants/villagers are likely to cut the trees from the local forest to supplement the firewood requirement of the construction workforce**.** *This might have a long-term impact on the ecological goods and services provided by the forest if not mitigated properly.*

The experience in other hydropower projects recently developed shows that many of the outside workers do not cook their food themselves and were dependent upon the nearby hotels and restaurants opened by outsiders or the locals to grab the economic opportunity (Consultant's Middle Marsyangdi HEP experience). The hoteliers, as they burden the energy cost of cooking to the consumer, prefer LPG gas for cooking and cause very little damage to the forest areas for cooking purposes. This might be the case in the proposed project as it is facilitated with motorable road and people are already habituated to using LPG stoves for cooking. But one cannot be sure about the likely impacts based on the experience in other socio-economic setting and hence the environmental impacts of the associated project workforce could not be overlooked. Non-Timber Forest Products (NTFPs) are available in the upper reaches of the surrounding forests, which are away from the project facility sites. Although there will be no direct impacts on the NTFPs by project facility, possibility of increased demand or induced impact on the NTFP due to increased number of people during construction may not be ruled out.

<u>Mitigation</u>

1. ***Preference to the local for project employment*****:** One of the options to minimize the impacts related to outside workforce is to provide maximum job opportunity to the local communities. As they are living in the same area, it will not pose an extra burden to the exiting forest areas and resources. As most of the people in the project are employed by the contractors, there is a need of an obligatory contractual clause in the contract document to ensure maximum local employment by the contractor. The skill training related to the construction works to the local community, as proposed in the social assessment report, is also envisaged to maximize the local employment in the project. However, there will still be few hundred outside workforce as the local villages in walking distance for daily works are not in a position to supplement the required workforce. An additional cost for the above management is not envisaged.

2. ***Provisioning of canteen facility within the camp for locals*:** Tea and light refreshment items are expected to be in high demand by the construction workforce in the morning and afternoon hours. To meet this demand, the outside economic opportunity seekers open a number of tea stalls with provisions of light refreshments close to the construction sites. It is these outside economic opportunity seekers who are responsible for the use of local firewood and degradation of the local forests. To offset this impact on forest, the local interested business people should be given opportunity for the opening of canteen within the camp and construction area to meet the construction force requirement. Selection of the interested individual or groups is based on competitive basis with restriction on the use of firewood for operating the canteen.

3. ***Provisioning of LPG depot at the project site*:** To minimize the use of the local firewood even by the outside economic opportunity seekers in the hotel and tea stall business, the contractor will provision a LPG depot at the project site to ensure the availability of the LPG at the local area on actual cost basis.

4. ***Provision of kerosene to the workforce for cooking*:** To minimize the use of firewood a provision of rationing of kerosene to the outside workforce is one of the options. But this option is difficult from cost and management perspective. Contractor should be made responsible for the above arrangements contractually, if he/she chooses to opt for the outside workforce for the construction works.

5. ***Provision for camp lodging to the outside workforce with a common LPG cooking facility, a canteen and a grocery shop*:** Though the provision impinges upon the freedom to choose their own lodging facility, this could ensure avoidance of firewood for cooking by the outside workforce. The role of the developer and contractor is very crucial in this matter. To abide by the provision, the developer/contractor needs to make this provision as one of the criteria for project employment to the outside workforce. Apart from the common cooking facilities, a canteen provisioned with Kerosene or LPG fuel within the camp preferably operated by the local entrepreneur on competitive bidding will also be one of the options to minimize the use of fire wood from the local area. As camp to workforce is already included in the contract document of the contractor, no extra cost is envisaged.

6. ***Prohibition on the sale and purchase of the local NTFP and fishes in the camps:*** In the project area, the people having hard currency are the project staff and workers. They are the biggest buyer of the local products of high value. The project management and contractor should impose complete prohibition on the purchase, sale and storage of the local high value NTFP and fishes within the camps. Anyone found with local high value NTFP in the camps should be penalized. This is a management task and no extra cost is envisaged.

7. ***Prohibition in roaming in the local forest area by the outside workforce:*** Project management and contractor management should inform the outside workforce about the prohibition of roaming in the local forest areas without the permission of the management at the time of their appointment. Notice on this regard will be posted in the camp notice boards on permanent basis. Anyone found exploiting forest resources should be penalizedas per the employment rules and regulations.This

restriction should be posted around the camps and work sites and included in the Code of Conduct of workers. Penalties should be included for contractor.

8. ***Creation of joint monitoring mechanism with local VDCs*:** Contractor in coordination with the project environmental officer will arrange for posting security guards and patrols, engaging VDCs and CFUGs to ensure vigilance and prompt action to address (6) and (7) above.

Despite the above measures, there will be some residual ecological effects of forest clearance for the structures and facilities and will remain as residual impact for a period of 20 to 30 years till the afforested forest matures.

c. Impacts on protected species of flora and fauna

None of the floral species to be cleared by the project, in the occupied forestlands, are listed in the IUCN Red Book or CITES Appendices. The GON protected plant species namely *Shorea robusta*, *Bombax ceiba* and different species of lichens & orchids attached on the trunks and branches of the trees to be cleared will be affected by the construction of project structures and facilities. The impact to the protected species of flora (pole and tree) is considered low, as listed species are categorized as protected on economic grounds only (Table 6.4).

The project development site is not the prime habitat of the conservational or economical important mammals or any other animal life. However few wild mammals visit the project development area for different purposes- perhaps the area is used as alternate seasonal migratory route, occasional feeding purpose, or temporary habitat for socially driven animals[12], etc. The baseline study finding reveals that the project affected sites are the occasional feeding grounds particularly of the raider mammals. Nonetheless, the loss of 1.57 ha forest due to the project is scattered in several locations and does not involve large scale fragmentation across the core forested area; *this impact is not envisaged to be significant.*

<u>Mitigation</u>

1. Compensatory forestation program will emphasize on the plantation of the lost GON protected floral species of the area (25 saplings will be planted for a tree cut). Before felling, each tree and pole size vegetation that needs to be cleared, will be marked and documented through joint inspection conducted by the DFO, community forest and leasehold forest user groups, and project environmental officer.

2. Restriction on the noisy construction activities during night time to allow wild animals to use the forested areas

3. Restriction on construction workers to wander in the forested areas; and

4. Prohibition on the trade of wild animals' meat and other products in the construction camps and by the construction workforce.

The last three measures will be included in the specifications for the Contractor and in the Code of Conduct for workers.

d. Impact on the community and leasehold forests due to construction of dam, access road and powerhouse structures

The project is only acquiring 1.1 % (0.21 ha out of total 19 ha) forest land of Thulo Dhuseni CF; and 0.32% (0.12 ha out of total 36.5 ha) forest land of Kabeli Garjite CF along the boundary areas at the

[12]Those animals, albeit sporadic visitors to the area, however, can be affected by noise from construction and illegal hunting by workers.

headwork site. The acquisition of forest lands are in small pieces on the edges of the forest areas and will not create fragmentation across the core-forested area. *Therefore, the loss of community forest to the user group is not considered significant.*

Apart from that, the construction of powerhouse, switchyard and penstock will result in the loss of 0.97 ha of leasehold forest which belongs to the seven local inhabitants of Pinase village. As this forest is already in a degraded condition and there are options of other community forests to these users, the impact on the leasehold forest is not considered significant, while the quarry area, camps, and spoil disposal sites will not affect the forest.

Mitigation

1. For the loss of timber and fodder in the community and leasehold forests, the user groups will be compensated 5 years production potential of the lost trees and poles in terms of wood volume, fuel wood and fodder. It is envisaged that the compensatory afforestation and other forest enhancement programs associated with this project will be sufficient to generate the expected annual loss after five years to meet the requirements. The cost for such compensation is estimated to be NRs 1,586,012 The felled trees poles and fodder/fuel wood will be the property of the community user groups.

2. The forest user groups will be assisted for forestry enhancement programs. The cost for technical and financial assistance to lease hold and community forest user groups have been already set aside (refer mitigation for Loss of Forest and Site Clearance for Project Structures and Facilities)

3. The compensation measures have been agreed with local communities.

6.1.1.2 Operation Phase

I. Disturbance to fish and aquatic species and its habitat due to the obstruction created by the proposed weir

The diversion structure and creation of reservoir in the operation phase divide the exiting river morphology into following sections:

- Undisturbed section upstream of the reservoir tail
- Reservoir section (about 1.385km length upstream of dam)
- Dewatered section of about 5.6 km length(from dam to the Kabeli – Tamor confluence)
- Tamor from confluence with Kabeli to powerhouse (approximately 10 km)
- Discharge fluctuation zone (downstream of powerhouse) about 2-3 km from the tailrace outlet

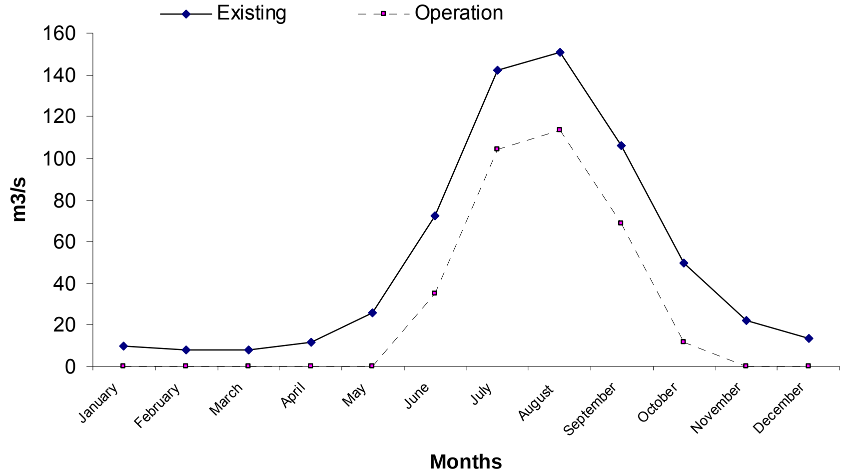
As the existing aquatic life co-exists with the undisturbed river morphology and natural flow regime, once in operation, there will be some level of disturbance in their lifecycle due to morphological changes and water conditions on the modified river stretches. Changes in aquatic life are likely to occur in the reservoir section, the dewatered section and the discharge fluctuation zone, especially from November to May every year. In these months, thewater in the dewatered section will come mainly from the environmental flow release from the diversion weir, and the water level and discharge fluctuation below the tailrace will fluctuate on a daily basis. In the reservoir section, the water will show twice a day water level fluctuations varying between 3 to 4.8m (refer Table 2.4, section 2.4.1.2 and Annex 2.1, 2.2 and 2.3).

a. Dewatered Section

Impact

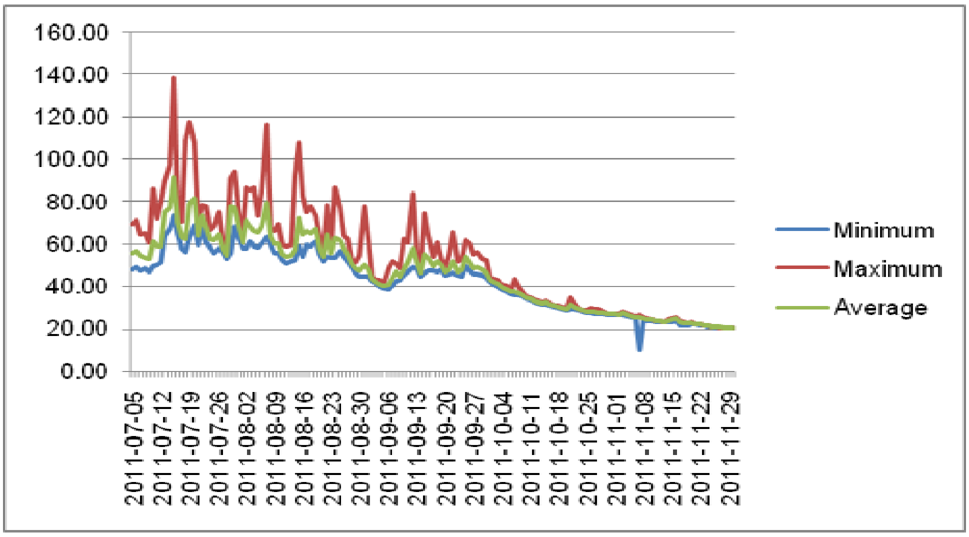
Figure 6.1 shows the comparative account of the mean annual hydrograph of the Kabeli River in the dewatered section for the existing conditions and during operation period if all the water is diverted to design capacity to maximize power production. The graph shows that during the dry months, most of the water will be diverted except for the allocated minimum ecological release.

Figure 6.1: Comparative Hydrograph Existing and Operation Periods in the Dewatered Section



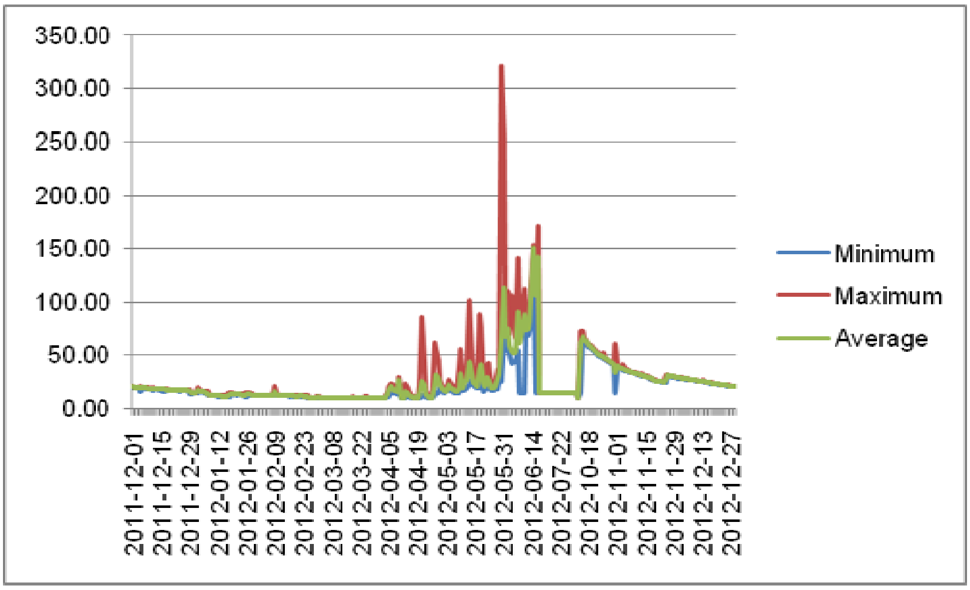
To give more precise information on the effect of water withdrawal to the Kabeli A powerhouse, we should consider measured flows, which are now available for Kabeli for the past three years. KEL installed a gauging station in Kabeli in 2010. Figures 6.2 and 6.3 show all flows measured in 2011 and 2012 respectively. Also, refer to Figure 4.5 (Chapter 4). More data will be available from the monitoring of flow in the coming years that can be used to further develop mitigation measures for the flow management in the dewatered section.

Figures 6.2: Observedreal time flow data for 2011



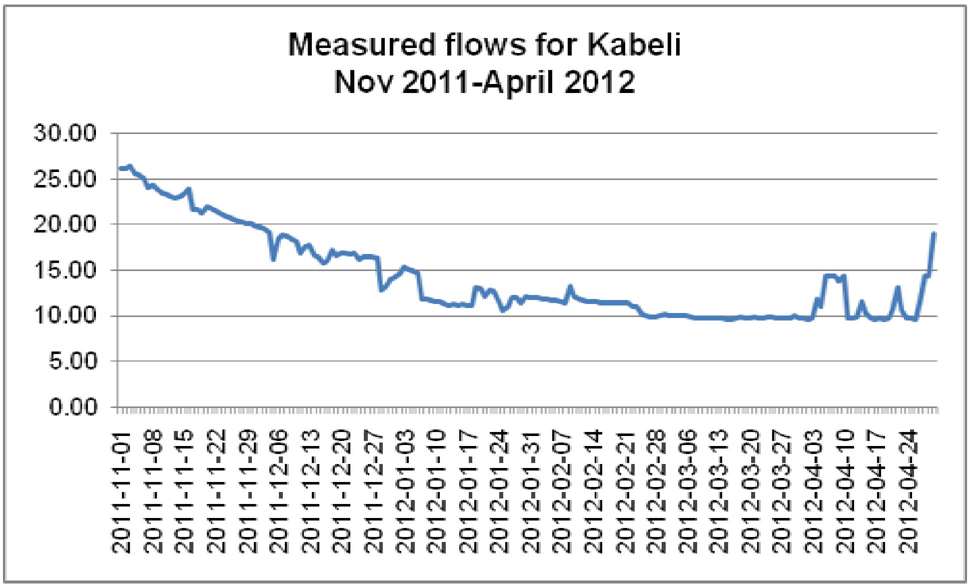
Source: KEL, 2013

Figure 6.3: Observed real time flow data for 2012



Source: KEL, 2013

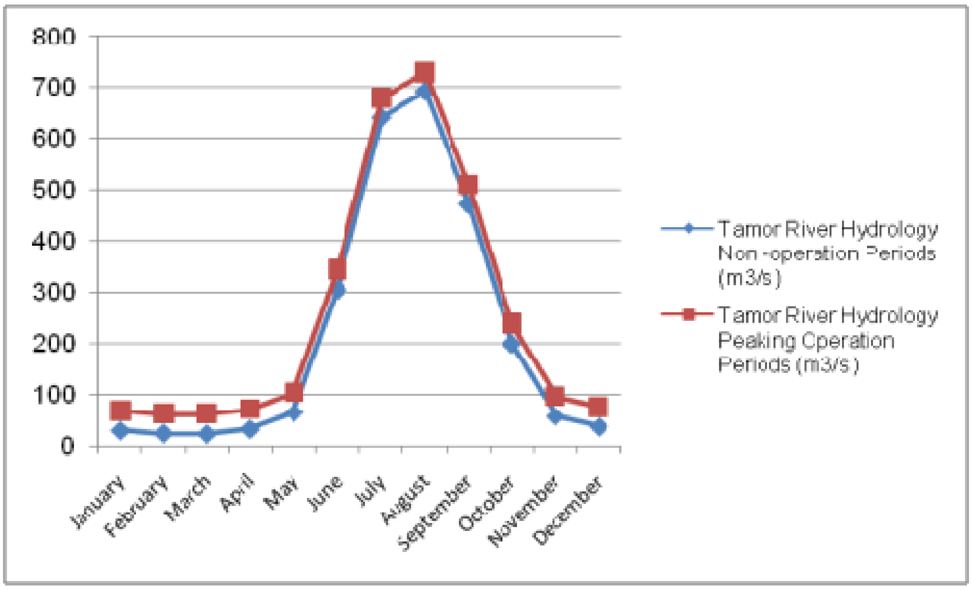
Figure 6.4: Actual flow data for dry months (November 2011-May 2012)



Source: KEL, 2013

The project is planned as a peaking Run-of-River (PRoR) type project with a reservoir of 2 and 4 hours of morning and evening peaking capacity. Figure 6.5 demonstrates how the peaking operation will be run during a typical day. The water from Kabeli will be diverted to Tamor River for power generation. Therefore, the peaking operations will not affect the dewatered section in the Kabeli River. At the powerhouse site, the operations of the power station will affect the Tamor River through the water added by the tailrace channel. The resulting hydrograph is shown in Figure 6.5.

Figure 6.5: Tamor River flow data below the Kabeli-A a tailrace with and without operation.



Source: KEL, 2013

Blue lines shows the natural flow in Tamor and the red line shows the natural flow and the additional peaking flow from the power house.

If all water at dam site will be diverted, there will be only seepage, groundwater and discharge from the three small streams in Kabeli downstream the dam (Refer Table 4.12).The available seepage and groundwater in the river will not be sufficient to sustain the existing aquatic life. Three small streams (Sarki Khola at 1.2 km, Andheri Khola at 1.6 km, and Khahare Khola at 3 km downstream from the dam) join Kabeli with total flow contribution of 0.18 m^3/s during the dry month of April. Without any mitigation measures, the dewatered section of Kabeli River to the confluence of Tamor River would likely to be devoid of majority of the existing aquatic life for nearly 7 months in a year. However, after the confluence (5.6 km downstream from the dam), the flow in the Tamor River is high enough to maintain the existing aquatic life and community water requirements. The minimum flow in the Tamor River before confluence with Kabeli is estimated to be about 23 m^3/s in the month of March. Therefore, the expected long term aquatic habitat conversion will occur at the Kabeli river diversion (dewatered section) and at the Tamor downstream from the powerhouse's tailrace due to daily discharge fluctuation during peak generation.

Mitigation

1. ***Environmental flow: Continuous flow release from the dam in the dry seven months (November through May):***

According to Dyson et.al (2003), the downstream release flow regime commonly referred to as the Ecological Flow, is "the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated". How this flow is determined is a question of debate among ecologists, developers and other water user stakeholders. However, all stakeholders agree that the choice of environmental flow requirements should be based on informed scientific decision and broad societal acceptance.

For Kabeli-A, the objective of releasing the downstream environmental flow is to keep the ecological river corridor open and to secure survival of substantial amounts of fry and fingerlings of target species in the dewatered zone (refer Table 6.10 for selected target species). For a social point of view, the objective is to ensure continuation of the local people's traditional activities connected to the river.

The question of environmental flow management particularly related to hydropower development (run of the River or Reservoir projects) is at the central arena of discussion in Nepal. The downstream flow management has become a critical issue particularly in rivers where survey license for hydropower development are issued in a cascade fashion.

The existing legal instruments (Aquatic Animal Protection Act, 1998 and Hydropower Development Policy, 2001) have set ad-hoc environmental flow requirements downstream the water diversion points without any scientific basis. Again, the legally purposed environmental flow differs widely. Aquatic Animal Protection Act stipulates a provision of minimum 5% of yearly minimum flow, whereas the Hydropower Development Policy recommends 10% of the minimum monthly average discharge of the river/stream or the minimum required quantum as identified in the EIA study report. By the amount of water volume, the provisions of the Hydropower Development Policy is better than the Aquatic Animal Protection Act, however, still lacks a scientific basis in setting the environmental flow regime requirements to sustain the rivers' natural social and ecological functions.

The discussion on the downstream environmental flow requirements in the sections below the dam is limited to the KAHEP project. The environmental flow requirements objectives for KAHEP are based on the following project features and baseline.

- The project is a run of the river project with a limited peaking reservoir of 2 and 4 hours of morning and evening peaking capacity in the dry season (November through May).
- Hydrology ofKabeli and Tamor Rivers.

- River diversion dewaters 5.6 km river stretch of Kabeli in the dry season (from November through May). The dewatered section opens to the principle river Tamor in the downstream section.
- In the wet season (June through October) nearly 64% of the existing average wet season flow passes through the dewatered section.
- Kabeli River provides habitat for 31 species of fish (12 observed and 19 reported). Of the total species, 5 species are long distance migrant, 4 species are mid-range migrant and remaining are resident fish species
- Upstream migration of fish species occurs normally from late spring and through monsoon, while the downstream migration normally takes place for most species during monsoon and late monsoon. Spawning season for most of the fish species present in Kabeli occurs in the wet season. Some species spawn also before monsoon.
- The documented hydrological records shows wide ranging seasonal fluctuations in the water discharge in the Kabeli River(refer Figure 6.1)
- Kabeli is a warmer river and with less sediment load than Tamor
- There is no consumptive water use requirements (irrigation, drinking water etc.) in the dewatered section
- There are religious water requirement for holy bath in the dewatered section. Hindu pilgrims from the surrounding VDCs come to take religious bath at Tamor and Kabeli Rivers to worship in every religious day like *Aushi, Kuse Aushi*, and *Matatirtha* as per their accessibility. In addition, Hindu communities cremate their dead ones at the banks of Kabeli and the cremation is followed by bathing through dipping in the river water. There are three cremation sites: Kholakharka cremation site, Kabeli cremation site and Sirupa cremation site (Figure 6.6) located in the dewater stretch. The Kabeli cremation site is one of the most common sites in the dewater stretch located about 2.5 km downstream at Kabeli Bazzar. The altered river flows will impact the Kabeli cremation site to some extent.In the dry season, reduced flow at dewater stretch will affect this activity related with Kabeli River

Project features and baseline reflect that the environmental flow requirement for the project is mainly for the dry season (November through May) when the project design flow requirement is higher than the Kabeli River natural discharge. In this period, if water is not released from the dam, there will not be enough water in the dewatered section of the Kabeli for community non-consumptive uses (mainly cremation, religious bath etc.),nor for the maintenance of the ecological corridor in the Kabeli and to secure survival of fry and fingerlings of the target species (refer Table 6.10) in the dewatered section.

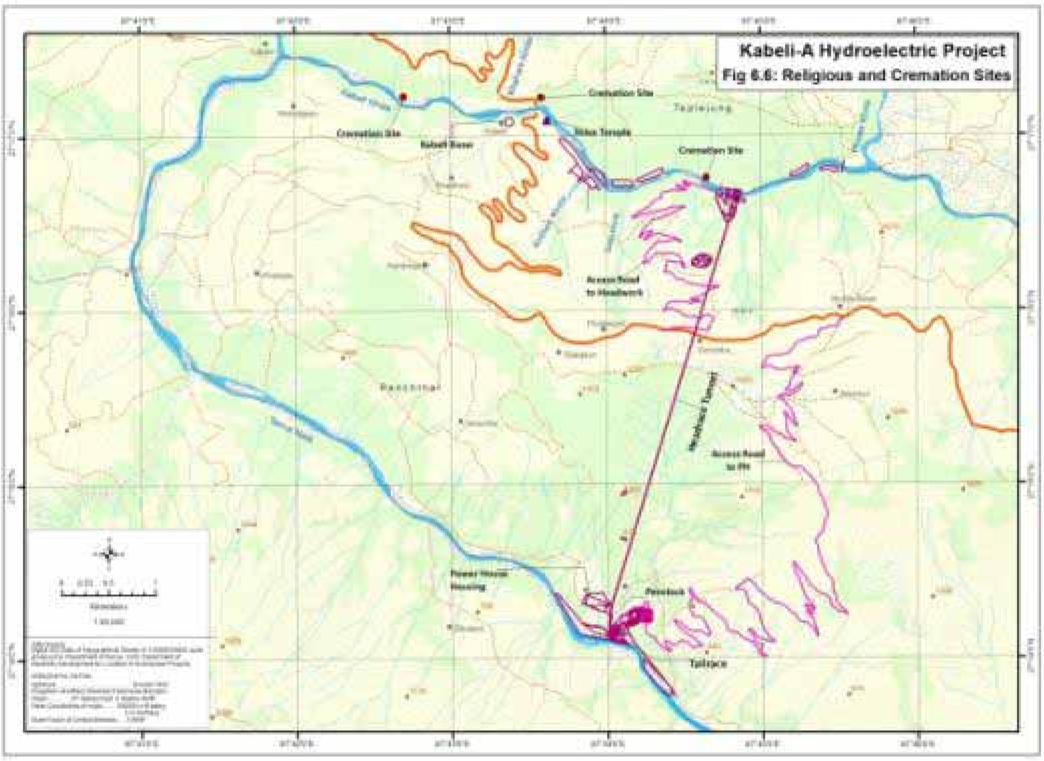
During wet season, it seems likely that the flow regime will be enough for migration and spawning to take place as if under natural flow conditions.

With the above objectives, the environmental flow requirement is analyzed and evaluated in the section below:

i) Recreation/Religious and Cremation requirements

The diversion of the flow for power generation will affect religious and cultural activities in the riverbank and cremation sites "*Ghats*" where dead bodies are burnt. Flowing water with certain depth (usually waist depth) is required to perform cultural and religious activities like bathing through dipping in the river and for throwing the burnt ashes of the dead bodies. The waist deep water may be created in pool or channel. The water requirement for the above purpose is broadly defined as non-consumptive use. This means, there will be no loss of water even after use and is available for further downstream users. In this context, cleanliness requirement, i.e. the minimum discharge of water to keep the river wet stretch clean is the water quality requirement for the above uses. The location of religious and cremation sites is shown in Figure 6.6.

Figure 6.6: Location of Religious and Cremation Sites downstream the Dam



ii) Aquatic Fauna and Flora requirements

Flow, water quality, temperature, energy spiral, gravel bed composition and sediment load are key factors in formation of the river ecosystems. The matter of complexity concerning number of species is a function of their ability to migrate into certain areas, and a function of the species requirements for ecosystem services and completion of their life cycles. The species flexibility and adaption capacity are key factors on the gene pool level of a population and on its overall resilience to disturbances. Tamor and Kabeli seem to have high species diversity. The productivity in the river ecosystems will typically come from input of organic matter. This organic matter might be produced within the river by algae, moss and macrophytes or it might be riparian organic matter originating from the surroundings. The latter is normally the main source of primary productivity in river ecosystems.

In the affected sections of Kabeli and Tamor Rivers, the environmental conditions significantly differ. Understanding the differences is crucial to determine sources of primary and secondary productivity, and define the overall ecological integrity of the affected segments:

- **Reservoir section** with deep waters, good temperatures, fluctuating water level and less sediment load than in Tamor, but potentially a higher level of fine sediments in the bottom areas than in other sections of Kabeli.

- **The dewatered section** with a significantly reduced flow, good water quality, and potentially slightly higher temperatures during low flow season. Sediment load is expected to be less than in Tamor, and it is likely to provide good fish habitats and high flow gradients through a year cycle.

- **Tamor stretch between confluence and down to powerhouse** will get flow reductions due to less water from Kabeli and reduction in water temperatures in dry season due to less input of warm water from Kabeli. The change in sediment load will be of low order.

- **The Tamor river stretch downstream of powerhouse**will be mainly influenced by peaking operation in the morning and evening during low flow season (2 hrs in the morning and 4 hrs in the evening). There will be fluctuations in the water level and change in temperature at the areas downstream of the tailrace. During monsoon there will be almost no differences compared to the natural conditions. The effect of peaking will gradually decrease downstream from the tailrace.

An effect of flow in river systems is related to the allocation of energy components to the food chain along the river. Organic matter is the main source of energy and "building blocks" to the formation of biomass in the river ecosystems. Since allochtonous matter is the dominating energy source to the food chain, river flow regime is crucial to the transformation of organic matter to biomass. High velocity waters give low local effectiveness in transformation from organic matter to biomass due to shorter retention periods. In low velocity sections of the river, as in the dewatered section, it is reasonable to assume that the organic matter from the surroundings will have a higher transformation rate to biomass during low flow season. This difference in water velocity is one of the main reasons for explaining why small rivers tend to be more productive than bigger rivers.

In Himalayan Rivers, the hydrological fluctuations over the year cycle are significant. Monsoon with high flow and high sediment load is normal and the fauna and flora has adapted their lifecycle to these conditions. The temperature is crucial to metabolism and growth in aquatic environment and the temperature gradients in the rivers are the basis for development of key cues and features of these species life cycles and their adaption to cold and warm waters.

The KAHEP is a RoR project with a limited daily peaking reservoir in the dry season (November through May). Even during the low flow regulated conditions without precipitation in the dry season, there will normally be groundwater inlet to the river and flow from three small tributaries. There might also be limited seepage from the reservoir. At this early, stage it is hard to assess if these would represent a significant contribution to environmental flow in the dewatered section.

It must be noted that even without any environmental flow release from the Kabeli-A dam, the flow after Kabeli Bazzar (about 3 km downstream of the dam) during the lowest flow conditions has been estimated to be about 0.48 m^3/s. The tributaries below dam (refer Table 4.12, Table 6.11 and Figure 4.6) are expected to contribute to nearly 0.18 m^3/s of discharge, and an additional 0.3 m^3/s discharge is expected from groundwater contribution(personal experience of the consultant from Lower Marsyangdi dewatered section - Refer EIA study MMHEP, 2001).

Calculations of Environmental flow

Calculation of Environmental flow can be done through a number of methods. This EIA has approached this calculation in an evolving fashion. Initially, based on Nepali current practice and existing legal instruments (Aquatic Animal Protection Act, 1998 and Hydropower Development Policy, 2001),it started with a modified Tenant Method approach. However, this analysis evolved and was refined based on consultation with global experts and experience and data from other projects in Nepal.

Keeping in view the expected flow variations in the KAHEP, reviews of the environmental flow methodologies applied in Nepal and elsewhere were examined for the Environmental flow (EF) estimations. The methodologies are differentiated into hydrological, hydraulic rating, habitat simulation and holistic methodologies, with a further two categories representing combination-type and other approaches (Tharme 2003).

All the methodologies have targeted objectives of environmental flow and cover broader to specific ecological and/or social issues. The choice of methodology for the analysis of environmental flow is a choice of the set of objectives for a development project. Without setting objectives of the environmental flow, random application of the available EF methodologies could lead to confusion or ineffective solutions. In this context, what is important is to understand the local hydrological conditions (flow variations – daily, monthly, and yearly) in relation to human water uses/ needs and the thriving ecology of the targeted fauna and flora while applying the environmental flow methodologies developed in distant parts of the world with different set of hydrology and socio-ecological relationship and needs.

A few projects such as Kali Gandaki "A" and Middle Marsyangdi in Nepal have applied the hydrological methods established by Tenant also called Tenant Method (1975) with some modifications to estimate the environmental flow. These hydrological methodologies rely primarily on the use of hydrological data, usually in the form of naturalized, historical monthly or daily flow records, for making environmental flow recommendations (Tharme 2003). These methods are often referred to as fixed-percentage or look-up table methodologies, where a set proportion of flow, often termed the minimum flow represents the EF intended to maintain the freshwater fishery, other highlighted ecological or social features, or river integrity at some acceptable level, usually on an annual, seasonal or monthly basis.

The modification of the Tenant Method (1975) was envisaged because direct application of the hydrological method as adopted by Tenant in North America, using only the average six monthly flows (October to March and April to September) and applied only to salmonids of the US, could not address the hydrological fluctuations of the Nepalese rivers. Table 6.5 and Table 6.6 present the differences of the Tenant Method (1975) and Modified Tenant Method (EIA Kali Gandaki "A" and Middle Marsyangdi) when applied to the KAHEP.

Table 6.5: In-stream flow for fish, wildlife, and recreation (Tennant 1975)

Narrative Description of flows	**Recommended base flow regimens**	
	Oct.-Mar.	**Apr.-Sept.**
Flushing or maximum	200% of the average flow	200% of the average flow
Optimum range	60%-100% of the average flow	60%-100% of the average flow
Outstanding	40% of the average flow	60% of the average flow
Excellent	30% of the average flow	50% of the average flow
Good	20% of the average flow	30% of the average flow
Fair or degrading	10% of the average flow	20% of the average flow
Poor or minimum	10% of the average flow	10% of the average flow
Severe degradation	10% to Zero of the average flow	10% to Zero of the average flow
Computation of Tenant, 1975 to Kabeli River for fair and degrading EF		
Average Flow (m^3/s)	21.23	101.54
Fair or degrading (m^3/s)	2.12	20.30

Table 6.6: In stream Flow regimens for fish, Wildlife, Recreation and Related Environmental Resources Based on the Modified Tennant Method (Kali Gandaki "A" EIA Study)

Description	**Monthly Average Flow**	**Rating or Score**
Flushing or Maximum	200%	100
Optimum Range	60-100%	100

Description	Monthly Average Flow	Rating or Score
Outstanding	40-59%	90
Excellent	30-39%	80
Good	20-29%	70
Fair or Degrading	10-19%	26-50
Poor or Minimum	10%	25
Severe Degradation	0-9%	0-20
Computation of Modified Tenant to Kabeli for fair and degrading EF		
Fair or Degrading – Jan (m^3/s)	1.03 – 1.96	26-50
Fair or Degrading – Feb (m^3/s)	0.86 – 1.64	26-50
Fair or Degrading – Mar (m^3/s)	0.89 -1.69	26-50
Fair or Degrading – Apl. (m^3/s)	1.33 – 2.53	26-50
Fair or Degrading – May (m^3/s)	3.16 – 6.01	26-50
Fair or Degrading – Jun (m^3/s)	8.63 – 16.93	26-50
Fair or Degrading – Jul (m^3/s)	16.90 – 32.10	26-50
Fair or Degrading – Aug (m^3/s)	18.17 – 34.52	26-50
Fair or Degrading – Sept. (m^3/s)	12.74 – 24.21	26-50
Fair or Degrading – Oct. (m^3/s)	5.81 – 11.04	26-50
Fair or Degrading – Nov. (m^3/s)	2.53 – 4.80	26-50
Fair or Degrading – Dec (m^3/s)	1.62 – 3.07	26-50

The modified Tenant Method in Kali Gandaki "A" and Middle Marsyangdi project for EF estimation used the minimum threshold flow of the driest month to maintain the riverine ecology to fair or degrading levelbut without analysing the ecological requirements of the targeted fish species to sustain the juveniles in the affected river stretch. This approach lead a number of unresolved questions against the modified Tenant method applied in these projects.

For the KAHEP, EF estimation of the modified Tenant method applied was cross-checked with the ecological requirements of the Target fish species of the river. To analyze required minimum environmental conditions of the target fish species juvenile in the affected stretch, hydraulic rating curve method is examined in conjunction with the physical habitat simulation model (PHABSIM) of the In stream Flow Incremental Methodologies (IFIM).

'Hydraulic rating' (also known as habitat retention) methodologies use changes in simple hydraulic variables, such as wetted perimeter or maximum depth, usually measured across single or multiple limiting river cross-sections (e.g. riffles), as a surrogate for habitat factors known or assumed to be limiting to target biota (Lohar et.al 1986). The implicit assumption is; ensuring some threshold value of the selected hydraulic parameter at altered flows will maintain the biota and/or ecosystem integrity. For the evaluation of ecological conditions 29 cross section of the affected dewatered stretch (from dam to the confluence with Tamor) were examined for the 10 per cent of the average monthly flow of the driest month February as EF. Table 6.7 presents the status of hydraulic variables in the Kabeli dewatered stretch river cross-sections.

Table 6.7: Hydraulic Variables in the Dewatered Stretch at 10% discharge of the Average Monthly Flow of February as EF

SN	Location	Chainage	Water depth (m)	Discharge (m^3/S)	Top waterway width (m)	Velocity (m/s)
1	Dam axis	0+0	1.14	0.86	0.63	2.39
2		0+200	0.71	0.86	16.98	0.14
3		0+400	0.68	0.86	20.96	0.12
4		0+600	0.63	0.86	14.29	0.19
5		0+800	0.34	0.86	6.64	0.76
6		1+0	0.37	0.86	3.45	1.36
7	Sarki Kholsi	1+200	3.58	0.882	51.715	0.01
8		1+400	0.58	0.882	39.823	0.08
9	Andheri Khola	1+600	0.56	0.907	34.751	0.09
10		1+800	0.52	0.907	20.646	0.17
11		2+0	0.18	0.907	10.419	0.96
12		2+200	0.72	0.907	18.378	0.14
13	Shiva Mandir	2+400	0.69	0.907	20.517	0.13
14		2+600	0.63	0.907	15.728	0.18
15		2+800	0.42	0.907	7.6	0.57
16	Kabeli Bazar and Khahare Khola	3+0	0.24	1.04	16.688	0.84
17	Sirupa Ghat	3+200	0.31	1.04	6.953	0.97
18		3+400	0.36	1.04	6.147	0.93
19		3+600	0.4	1.04	4.572	1.14
20		3+800	0.6	1.04	2.859	1.21
21		4+0	0.18	1.04	13.334	0.95
22		4+200	0.73	1.04	31.795	0.09
23		4+400	0.7	1.04	18.691	0.16
24		4+600	0.64	1.04	18.218	0.18
25		4+800	0.6	1.04	37.461	0.09
26		5+0	0.56	1.04	22.454	0.16

SN	Location	Chainage	Water depth (m)	Discharge (m^3/S)	Top waterway width (m)	Velocity (m/s)
27		5+200	0.28	1.04	6.33	1.18
28		5+400	0.75	1.04	3.434	0.81
29	Tamor confluence	5+600	0.35	1.04	5.749	1.03

Source: KEL, 2011

The observed hydraulic variables (surrogates of the fishery habitats) were then cross –checked with the IFIM established values elsewhere in the region.

Determining habitat conditions using the IFIM method requires very intensive data and needs duration of 2-5 years for its assessment (World Bank 2003) which is not possible in present context. Therefore, habitat conditions established by the IFIM for comparable fish assemblage with Kabeli River are used for the assessment purpose. The IFIM assessment in the Western Ghat (Arunachalam M, 2000) has fish assemblages comparable to the Kabeli River. Table 6.8 presents the habitat requirements in the Western Ghat for the comparable fish species of the Kabeli River.

Table- 6.8: Flow condition and habitat suitability for fishes

	Depth used		**Velocity used**		**Related species in Kabeli**	
Species at WB	**Depth (m)**	**His**	**Velocity (m/S)**	**HSI**	**Species**	**Migratory status**
Barilius bendelisis (India)	0.32 - 0.42	0.4 - 0.5	0.13 – 0.28	1.0 – 0.55	*Barilius bendelisis, Barilius barila, Barilius shacra, Barilius vagra*	Residence
Puntius ticto (India)	0.14 – 0.4	0.2 – 1.0	0.03 – 0.11	0.3 – 1.0	*Puntius ticto, Puntius conchonius*	Resident
Garra mullya (India)	0.16 – 0.32	0.21 – 1.0	0.03 – 0.13	0.21 – 1.0	*Garra annandalei, Garra gotyla gotyla*	Resident
Labeo calbasu (India)	0.25 – 0.49	0.15 – 0.8	0.05 – 0.09	0.5 – 1.0	*Labeo dero, Labeo angra*	Mid-range
Tor khudree (India)	0.16 – 0.32	0.21 – 1.0	0.03 – 0.13	0.21 – 1.0	*Tor tor, Tor putitora*	Long-range
Salmo trutta (Brown trout) (Europe)	0.10 – 0.70		0.18 – 0.90	Moderate	Snow trout (*Schizothoraichthys progastus, Schizothorax plagiostomus, Schizothorax richardsoni, Schizothorax sinuatus)*	Mid-range

Note : HSI - Habitat Suitability Index, low quality (HSI ≤ 0.2), medium quality (0.2 < HSI = 0.5), good quality (0.5 < HSI = 0.8), and high quality (HSI > 0.8).
Source: Arunachalam M (2000)

A comparison of Tables 6.7 and 6.*8*suggests that the available habitat determined by the hydraulic rating curve method on the 29 measured cross sections of the Kabeli River in the affected stretch with a 10 percent flow of the average driest month flow generally meets the required habitats conditions for the target fish species of the Kabeli River. Two cross section (Chainage 2+0 km and 4+0), however, show HIS less than 0.2 for Barilius *bendelisis, Barilius barila, Barilius shacra, Barilius vagra, Labeo dero, and Labeo angra*. However, this constitutes a small section of the affected stretch and is not expected to impart significant impact on the species of the river stretch**.** It is to be noted that the groundwater, small tributaries, and dam seepage contribution to the river flow is not added to the river flow in Table 6.7. If these additional contributions are added successively in the downstream areas, it is likely that required habitat conditions will be fulfilled even in the section showing low quality HSI.

The above assessment of the EF requirements for KAHEP is also supported by the monitoring studies of the fish populations in the regulated flow conditions in Nepal. The recent monitoring study of the fisheries in the regulated flows across the dam (Jha, 2006) at Aandhikhola Hydel and Rural Electrification Project (AHREP), Synagja; Sundarijal Hydropower Plants, Kathmandu; and Tinau Hydropower Project, Butwal is an interesting piece of study related to the impact on fish populations above and below the diversion point. The study covers a period of one year and monitoring in four distinct seasons namely spring, winter, pre-monsoon and monsoon. Table 6.9 presents the salient features of the monitored hydropower projects.

Table 6.9: Salient features of the Monitored Projects

S.N	Project Features	Adhi Khola HEP	Sundarijal HEP	Tinau HEP
1	Minimum Flow	1.4 m^3/s	0.24 m^3/s	2.4 m^3/s
2	Average Discharge		1.37 m^3/s	54 m^3/s
3	Design Discharge	2.7 m^3/s	0.72 m^3/s	2.4 m^3/s
4	Dam Length	65 m	4m	65 m
5	Dam Height	6 m	24 m	8 m
6	Dam Type	Concrete Gravity	Carbon Concrete Gravity Pipeline	R.C.C. and Stone Masonry
7	Environmental Flow	10% of the minimum flow	No Provision	No Provision
8	Project Type	Run off the River with daily peaking in dry season	Run of the river	Run off the river

Source: Jha, 2006

The monitoring study (Jha 2006) concludes: "there were not visible differences in terms of both the abundance and the number of species between upstream and downstream sites of the dams. Similarly, nonparametric Mann-Whitney test showed no significant impacts due to the dam in terms of the abundance of fish ($P > 0.5$). The parametric one-way ANOVA test in terms of the number of species too showed no significance".

The Khimti Khola Hydropower project with hydrological conditions similar to Kabeli in eastern Nepal and releasing 10% of the driest month flow (0.5m^3/s) as EF is monitored for the fish across the dam structures on the Khimti River since 1994 (HPC , 2006). The observation of the monitoring suggests that the species diversity, dominance and the share between the species in all the monitoring location upstream and downstream of the diversion structures are stable and comparable to the pre-project conditions.

From the findings of the monitoring results, it is therefore, assumed that even in the worst regulated flow conditions downstream of the dam (Sundarijal and Tinau), the fish abundance and numbers of species are not compromised in the run-off-the-river projects. In the run-off-the-river projects, probably, the connectivity of the dewatered stretch with the major river downstream plays a vital role in maintaining the fish abundance and number of species. Further wet season flushing discharge, even after the diversion of design discharge, maintains the river connectivity with the upstream regions while up keeping the river morphology, flood banks, sediment and nutrient transport in the dewatered portion and provide suitable ecological grounds as in the unregulated conditions for spawning and other life cycle activities of the existing fish species.

***Downstream Environmental Flow based on International Expert's Opinion and data from current project* experiences in Nepal:**

Downstream Environmental flows describe the timing, quantity and quality of water flows required to sustain healthy river ecosystems, human livelihoods and well-being that depend on these ecosystems. Environmental flows do not necessarily require restoring the natural, pristine flow patterns but are instead intended to produce a broader set of values and benefits from rivers that can satisfy both the vital functions in the river ecosystem and the human needs for water supply, energy, recreation, or flood control. Ideally, ecological flow determinations in rivers require detailed and comprehensive data on hydrology, hydraulics, temperatures, species diversity, biotope availability and ecosystem services. A robust historical monitoring data set is necessary to assess the long-term consequences of hydropower development.

When using data from another river to determine ecological flows or to assess minimum flow impacts over its ecology, significant care must be taken to ensure that the two rivers share similar characteristics and have comparable river system conditions.

In Nepal Khimti Khola has a relatively long history of data from the period before and after the start of 60 MW Khimti hydropower Project with 11 km long dewatered section and has minimum downstream release of water is $0.5m^3/s$ and is close to 10% of mean monthly flow of April.

Khimti Khola is comparable to Kabeli concerning sediment load and temperatures, and both rivers flow into glacier fed colder rivers with higher sediment load. Khimti has a steeper gradient from the dam site to the confluence, and the dewatered section is twice the length of what is planned for the KAHEP. Even though there may be some differences in biodiversity between both river systems, the snow trout species is present and is the most important fish species for the local population in both rivers. Using experiences from Khimti khola does not provide us with a tool to calculate the ecological flow, but it does provide knowledge on impacts from hydropower development, from mitigating measures and from long run use of minimum flow as basis to evaluate the potential environmental and social effects from the environmental flow regime proposed for the Kabeli-A project.

As pointed out, there are not many examples from Nepal to be used as a basis for the evaluation of effects from minimum environmental flow in the case of the KAHEP. The primary reason is that many of the regulated rivers have weak baseline data, short and insufficient data from monitoring programs after hydropower regulation, and most of the regulated rivers do not have functional fish ladders or fish paths. Nevertheless, Khimti has a good baseline data and data from a relative long monitoring program before and after start of the power generation. International institutions financed the Project, so it has followed EMP and monitoring program strictly in accordance with good international practice. First data set was obtained during 1993 and continued for over 10 year's through 2007 (HPL 2008).

In conclusion, the Khimti Khola is the best comparable example of a regulated river in Nepal for understanding the effect of minimum downstream release in a regulated river of the Khimti/Kabeli conditions.

Quoted from the Khimti Khola Report (2007)

"During the first years of the project the fish population seemed to be stable and showed a high degree of survival in spite of the low flow during wintertime. A fish population with migrating pattern that seasonally has a part of the population in other areas than the local river can stabilize the local population by immigration to the nurse river."

"During the low flow season the wetted area in the river is reduced by 55%. The effect is increased water temperature and increased pool area in the regulated section of Khimti. No change in water chemistry is registered. Illegal fishing by herbal and artificial poison is a serious threat to the fish population""Fish are

able to pass the intake weir at low flow conditions with 0,5m^3/s passing the weir, but signs of changes in the fish migration patterns are observed."

"The overall scientific results show a fish population in slow change which expresses that Khimti River has a vigorous fish population with high grade of stabilising properties. Fish density and fish biodiversity are stable.

"The fish population of Khimti khola seems under normal regulated conditions to be strong with high survival rate and high reproduction capacity."

To be able to talk about the ecological and social requirements for which the downstream environmental flow can be addressed, it is necessary to establish the target species and what ecological services shall be selected as the goals for determining the appropriate environmental flow regime.

Selection of Target Species of KAHEP

For KAHEP, environmental flow assessment studies based on international experts opinion have recommended that the minimum flow and other hydropower development conditions influencing the natural river system shall be mitigated by releasing flow and construct facilities so as to keep the ecological corridor open and to secure survival of substantial amounts of fry and fingerlings of the target species in the dewatered section of Kabeli. A premise is that the target species is in the planned dewatered section before the hydropower development. In addition, enough water should also be released to assure that local populations can continue to perform their traditional burial rituals and other religious ceremonies undisturbed.

In a society, not all species recorded in a river have the same value, and normally the species in a river will be managed according to local values. Considering this, when dealing with today's hydropower development in Nepal, it seems necessary to address some target species to be focused on at every hydropower development site. This selection of target species is to secure biodiversity and important species for local utilization. If correct target species are selected, the conditions and mitigating measures developed to safeguard these species will also give benefit for the rest of the fish species in the river. Target species might be selected on the basis of three criteria:

i. IUCN red listed species

ii. Migratory species

iii. Locally valuable species

Red list species is obvious important species because these species are considered as weak when it comes to population size and current growth. The red list should be the official version and the purpose of a red list should be examined before use.

Migratory species are important in all hydropower projects because hydropower development in rivers normally affect the life cycles of migratory species. Locally valuable species have already a value pointed out by the local population and by the local fish experts. This selection of species is important to respect, and to take into account when it comes to mitigating strategies connected to hydropower development. Moreover, the target fish species for Kabeli are selected based on expert opinion, field surveys and consultation with local people.

Table 6.10: Selected target species of Kabeli

SN	Scientific Name	English Name	Local Name	Remarks
1	*Tor putitora*	Golden Mahseer	Sahar	Red list, registered
2	*Tor tor*	Dharke Mahseer	Sahar	Red list, registered
3	*Schizothorax richardsonii*	Snow trout	Butche Asala	Red list, registered
4	*Schizothorax progastus*	Snow trout	Chuche Asala	Locally valuable, registered
5	*Neolissocheilus hexagonolepis*	Copper Mahseer	Katle	Red list, registered
6	*Bagarius yarrelli*	Fresh water shark	Goonch	Red list, and if registered
7	*Anguilla bengalensis*	Eel	Rajbam	Long migratory, and If registered
8	*Clupisoma garua*	Catfish	Jalkapoor	Long migratory, and If registered
9	*Labeo dero*	River rohu	Gardi	Mid migratory, registered
10	*Pseudecheneis sulcatus*	Torrent catfish	Kabre	Locally valuable, registered

To maintain viable biotopes and to create access to spawning areas for the above mentioned species, the design and implementation of mitigating measures such as releasing minimum flow and the construction of fish ladder are crucial. For KAHEP, the minimum flow proposal is $0.86m^3/s$ or 10% of mean monthly flow in the driest month.

The 10% of mean monthly flow of April ($0.5m^3/s$) that is the minimum release in Khimti Khola seems to be working well as a mitigating measure. It is reasonable to extrapolate that release of the 10% of mean flow of February-April from the Kabeli dam is a good starting point to maintain the Kabeli River integrity. Khimti Khola data is reliable and shows acceptable results concerning the conservation of the fish population. Khimti khola is comparable to Kabeli, and it is reasonable to assume that the similar environmental condition as in Khimti is obtainable by release of 0.86 m3/s from the Kabeli-A dam site. One positive argument for Kabeli compared to Khimti is that the affected dewatered section is only half-length of the section in Khimti Khola (5.6 km versus 11 km) and that the gradient in Kabeli is not as steep as that of the Khimti. Steep gradient normally requires higher flow to give good upward migrating conditions for the fish species. The dewatered section in Kabeli will probably be easier stretch for migration than the dewatered section in Khimti. A shorter dewatered section than in Khimti, gives a suitable argument in justifying the release of 0.86 m^3/s for maintaining the ecological corridor further i.e. environmental release will meet needed time to migrate through the section.

At any case, a robust monitoring program during the implementation phase, will allow for improved understanding of the effects of this minimum downstream release to riparian connectivity and migration challenges of key fish species, and should therefore be addressed in the EMP.

If adjustments of minimum flow are addressed as a consequence of the monitoring results (EMP), it is likely that it will be a matter of only minor adjustments as changing flow during some few days or a week. This assumption is connected to the knowledge on upward migration of one or two fish species during dry season. Furthermore, the latest measurements of flows for 2011 and 2013 indicate that in comparison to the results obtained from statistical methods, the flows measured in Kabeli seem to be higher than estimated for the two-year period. It is understandable that two years is too short for making clear conclusions, so KEL continues the real time hydrological data measurements in Kabeli.

Proposed Downstream Environmental Flow

In conclusion, 10 percent of the minimum annual monthly flow, as required by the Hydropower Development Policy (2001) provisions of the GON is proposed for Kabeli-A. Based on international expert advice and experience from similar projects in Nepal, this downstream flow release will: (i) maintain the shallow water ecological requirement for the fish species of the Kabeli as pointed out by the IFIM methods elsewhere, thus maintaining shallow water ecological conditions for feeding and rearing of the juvenile fish species of the Kabeli River dewatered stretch; (ii) maintain the migration of fish upstream and downstream along dewatered section; (iii) optimize the power generation to make the project commercially viable, and (iv) meet the religious / ceremonial water flow and depth demands from the local communities. The ecological corridor will be kept open due to minimum flow passing through the proposed fish ladder. As part of the implementation phase EMP, it is expected that a detailed monitoring program of the EF will be carried out during the first years of operation.

The flow requirement for cremation is envisaged only downstream of the Kabeli Bazaar area. Upstream, two small tributaries join Kabeli with a combined minimum dry season flow of 0.18 m^3/s (refer Table 4.12). Further, in this stretch, the groundwater joining from either flank of Kabeli is expected to contribute, at least, additional 0.3m^3/s (personnel experience in Middle and Lower Marsyangdi HEP Measurements) in the river in the driest month (March/April). Considering all these releases and assuming that 10% of the minimum monthly flow of Kabeli is released from the Dam, total water available in the Kabeli river near Kabeli Bazaar will be sufficient to sustain the envisaged flow requirements of recreation/cremation as well as aquatic fauna and flora (Table 6.11).This will also be confirmed with a robust monitoring program as part of the project's EMP during implementation.

Table 6.11: Water Availability situation at Dewater Section with 10% of Minimum Mean Monthly Flow from the Dam

Months	Natural Flow at Intake site (m^3/s)	Flow proposed for Release m^3/s	Water added to Kabeli by tributaries in dewater section(m^3/s)	Minimum groundwater contribution in the dewater section in the driest month(m^3/s)	Water available at dewater section(m^3/s)
January	10.31	0.86	0.2763	0.3	1.4363
February	8.63	0.86	0.2361	0.3	1.3961
March	8.88	0.86	0.2015	0.3	1.3615
April	13.3	0.86	0.1795	0.3	1.3395
May	31.63	0.86	0.2109	0.3	1.3709
June	86.28	48.55	0.8095	0.3	49.6595
July	168.95	131.22	2.8001	0.3	134.3201
August	181.71	143.98	3.5041	0.3	147.7841
September	127.42	89.69	2.7426	0.3	92.7326
October	58.11	20.38	1.2095	0.3	21.8895
November	25.25	0.86	0.4904	0.3	1.6504
December	16.18	0.86	0.3266	0.3	1.4866

Source KEI 2011

The project will release 24 hours a day 10% of the minimum mean monthly flow from November to May as regulated environmental flow in the downstream section of the barrage to upkeep the existing aquatic life of the stretch to a minimum threshold of thriving. The project design will incorporate a system design to release the stipuated environmental flow for all times of project operation from November through May.

2. Additional Arrangements for Religious and Cremation Requirements

The proposed DownstreamFlow is assumed sufficient for the general sanitation of the river stretch where the general non-consumptive use is limited to a few numbers of people. But, in the river stretch where a large number of people will gather and perform religious and cremation as in the Kabeli temple and in the cremation grounds, the dispersed natural flow may not be able to maintain the sanitation conditions of the used river stretch. To maintain cleanliness of the river bed and to provide adequate water to the users the water flowing in the river will be canalised in the month of November every year for funeral rituals at the cremation sites of the river. Similarly suitable ponds of waist height will be established in the dry season at the Kabeli Temple site for religious baths. The project will built structures like check dams as necessary along its cremation area sites to create pools and will also carry out regular cleaning operations in order to make the river bed clean and healthy. In the religious festival day additional water than the environmental flow will be released to maintain the river bed sanitation. These measures will be included in the EMP.

3. Prohibition on Fishing and aggregate mining in the Dewatered Section in the Dry season

Low flow conditions will be limited only to environmental flow releases in the dry season (November through May) and could potentially trap adult fish in isolated pools. This low water conditions may be regarded as favourable for fishing. As the ecological areas for the available fish species in the dewatered section is greatly constrained due to reduction in flows, existing fish species of the dewatered stretch have little area to hide and run away and will be trapped easier by fisherman. Therefore, to protect the thriving fish species in the dewatered stretch in the dry months; fishing in dry month will be prohibited in the dewatered section. Such prohibition will be carried out in cooperation with the local people and fishermen through awareness programs and employing some of the fishermen to regulate prohibition provisions and report fishing activities to the project and to the local regulating authorities for timely actions.

b. Change in the composition of the fish species in the reservoir section

<u>Impact</u>

From November through May, a reservoir will be maintained at the upstream barrage of the KAHEP as per the operation plan of the project (refer section 2.9, Chapter II). While from June through October the river will be left open to flow in its natural conditions. The aquatic life of the Kabeli river is represented mostly by cold water fish adapted to free flowing conditions in a highly oxygeneated environment. Since the water above the barrage will be a big pool for a stretch of about 1.3 km, some of the fish speices are likely to be driven away from the reservoir stretch to upstream sections which will constrain the feeding, rearing, and spawning grounds of these species.Other species might find the reservoir as a more favourable habitat. As very little is known about the ecological status of the aquatic life of the Kabeli, it is difficult to predict the extent of the impact to the resident and migratory aquatic species to the changed flow regime and water qualityconditions. Considering the short water retention period with daily fluctuation of water level from minimum to maximum depth twice a day and reservoir being filled by highly oxygenated water in a shallow water environment for most part of the reservoir, it is envisaged that the impacts related to low dissolved oxygen will be considered to be low and insignificant to the majority of the aquatic life. Similarly, the intermitent shallow water reservoir conditions is not likely to drive away the shallow water loving fishery of the river as the reservoir also provide habitat of the pool like environment of the unregulated river.

Mitigation

This impact is expected to be insignificant as explained in the previous paragraph. Only option to avoid this potentially minor impact to aquatic life from the reservoir water condition is to design the project as run-off-the-river option and forego the benefit of peaking power from water regulation in the reservoir in the dry season. Since this option is not economically beneficial and the risk to fish/ aquatic life is low, no action will be taken to mitigate the impact. The impact resulting from the reservoir formation to aquatic life will remain as residual impact of the project throughout the project life. However, aditional fish mitigation and compensation measures are included in the EMP (fish hatchery, functional intact river strategy).

c. Reservoir eutrophication and associated impacts to aquatic life

Impacts

The catchment of the Kabeli river is composed of a number of rural settlments and agricultural fields that becomes the potential source of the phosphorous and nitrogeneous waste from sweage of man and animals and also release of agrochemicals from agriculture.Since KAHEP will have a small daily regulation reservoir, with a short retention time, any detectable sign of euthrophication is unlikely, however, water quality measurements will be part of the EMP. Even in the present conditions, algal blooming in the detached pool sections in the river have been observed in the Kabeli River. Such algal blooming in the reservoir section could not be completely ruled out. If such eutrophication occured due to increased concentration of phosphorous and nitrogen, it canhave effect onthe fresh water aquatic life with possiblefish diveristy implications. As stated above, the operation mode of the reservoir regulation, however, does not allow long period retention of the water hence limiting the chances of increase in the concentration of phosphorous and nitrogen and it is more likely that the eutrophication will be an issue of minor significance in the reservoir.

Mitigation

Water quality in the reservoirs and algal bloom and aquatic weeds will be monitored. If eutrophic conditions are detected and algal blooms are present, the following measures will be implemented as necessary.

1. One of the options of preventing eutrophication is minimizing the actions that lead to the increase in the concentration of nitrogen and phosphorous in the Kabeli River. This will demand improvement in the onsite sanitary facility in the Kabeli River catchment and to educate the Kabeli River catchment farmers on the judicious use of the agro-chemicals. The project will assist the local communties for the improvement of the onsite sanitation management and in the use of agrochemicals on regular basis, NRs1,50,000is estimated for the assistance for the aforementioned activities as annual reccuring cost.(NRs.45,00,000for 30 years)

II. Impact on fish migration and spawning areas of fish in the Kabeli River Upstream of the weir

The dam height of 14.30 m constructed across Kabeli River will potentially avert the upstream migration of migratory fishes namely *Tor Putitora* (Sahar), *Schizothorax richardsonii* (Blunt–nosed Asala), *Schizothoraichthys progastus* (Pointed nose - Asala), *Neolissocheilus hexagonolepis* (Katle) and *Labeo dero* (Gardi). These fishes migrate to upstream areas of Kabeli River for spawning and move downstream for feeding. Further *Tor Putitora* (Sahar) and *Schizothorax richardsonii* (Blunt–nosed Asala) are included as the endangered and vulnerable species in the IUCN red list of 2012 respectively. Refer 4.3.3.6 for description of fish of conservation significance in KAHEP.

Upstream migration of the fish in the Kabeli, and in the Tamor as well, is not well understood. The literature rivew of the cold water fish populations in the major Himalayan rivers and consultation with the local part time fishermen suggests that upstream migration of the fish start from June till September. The peak upstream migration is in June, July and August and downstream migration is in October through November. Some species might migrate upstream during low flow season.

Thus, if unmitigated, the construction of the dam will restrict the migration and reduce the population and diversity of Kabeli River in the long run. This is one of the potential significant impacts to the fish populations of the Kabeli River.Studies conducted elswhere have indicated that the diversion structures on a natural river, if unmitigated can cause a loss of nearly 60% of the fish habitat with a long term effect on the fish population.

Furthermore, the migration patterns of fish in the entire Tamor river watershed are also not fully known. Apart from Kabeli, other tributaries like Mewa Khola and Hewa Khola that have similar river characteristics are in the Tamor basin and the migrating fish have alternative migration routes. Fish monitoring efforts will be necessary to assess impacts and residual impacts on fish migration in the Tamor watershed. This monitoring effort will be included in the EMP.

Mitigation

To assess the reported diversity composition of the fish species an additional sampling study during early stages of construction and during operation will be carried out. The sampling will commence during monsoon 2013[13] and will be done at least four times in the first year to capture four seasons and then twice a year to cover dry and monsoon until the fifth year of operation. The potential sampling sites are:

1. Upstream of Kabeli-Tamor confluence at Tamor.
2. Upstream of Kabeli-Tamor confluence at Kabeli
3. Headwork area
4. At least 5 KM upstream of headwork
5. At least 10 KM upstream of headwork
6. About 2.5 KM downstream from dam
7. Downstream of the Kabeli-Tamor confluence half distance to powerhouse
8. Downstream of tailrace at Tamor

There are various options to mitigate the effects of restriction to fish migration due to diversion dam, however, the effectiveness of the applied measures may be quite different for the different measures depending upon the local field conditions, behavior of the existing aquatic fish species etc. Commonly used mitigation options are:

- Fish Trapping, Hauling and Release
- Fish Lock Alternative
- Fish Ladder Alternative
- Cold water Fish Hatchery annexed withy open water stocking of mid-range and long distance migrants

The **Fish Trapping, Hauling and Release alternative** is cost effective, labor intensive and provide direct benefit to the local economy as this will be based on the employment of the local fisherman community. For the trapping of fish, various fish traps can be used. The commonly used fish traps for upstream and downstream migrant fishes are bamboo weir fish traps, fish wheels, fyke or Hoop Nets and pot gears. The trapped fish then can be hauled using transportation vehicles. To transport the fish

[13]This has already started in July 2013: findings of which are summarized in Section 4.3.3.3 and in Table 4.26, and Table 4.28 of this EIA Report.

upstream and downstream, specially designed insulated water tanks with facilities for aeration and water circulation will be needed. Such tanks can be designed and manufactured in Nepal. The only drawback of this option is that the handling of the fish during trapping and hauling may result in high mortality of the fish.

The **Fish Lock** Alternative is the automated mechanical device designed and placed in the dam structure. A special fish lock structure below, above the dam attracts, and lock the fishes. The locked fishes are then hauled across the dam by a specially designed lift automatically. Such devices have been brought into operation at number of dams in other parts of the world. Owing to the fish release conflict, difficulties in attracting fish in the lock area and difficulty for fish to access the trap area in the turbulent water condition released from the spillway in monsoon, this alternative may not function effectively at times when it is required the most.

The **Fish Ladder** Alternative provides a natural migratory path to the migrating fish without human intervention in the migrating season. Since very little is known on the swimming speed of the targeted fish species and required flow condtions of water, it is difficult to design an effective fish ladder. As dam height is low, a fish ladder constructed with a few pools and sections designed as a small riverbed could be a better option in the case of Nepal.

On site cold water **fish hatchery** annexed with open water stocking of mid-range and long distance migrant species annually in the upper catchment of the Kabeli is the other alternative. But this alternative will require maintenanceof a on site fish hatchery of the targeted fish species for the production of the targeted numbers of fingerlings from hatchery and hauling of the fish fingerlings for open water stocking in the Kabeli River. Experience of cold water fish hatchery in Nepal (Kali Gandaki "A", Pokhara, Trishuli, and Godavari) reveals that the target[14] fish species including the IUCN red list species could be breed in the hatchery in captivity. This option though costly in terms of infrastructure and operation investments has advantages over the other options as it ensures the conservation of the IUCN red list species in the Kabeli River, and may even conserve the native species that have been recently caught in the Kabeli, such as the Kabre.

An analysis of the various options reveals that the Fish Trapping and Trucking and Fish Lock Alternativesare relatively cheap and do not require high investment costs compared to fish ladder and cold water fish hatchery alternatives but would require an effective and efficient management throughout the project operation period. The effective and efficient management in the context of Nepal is highly questionable. Therefore the fish ladder alternative in combination with the on- site cold water fish hatchery annexed with the open water fish stocking are the best alternatives in the case of the Kabeli River to minimise the barrier effect to fish migration vis-á-vis conservation of the IUCN red list speceis. Such a combination of fish ladder and fish hatchery is also expected to overcome the uncertainity of the effective functioning of the fish ladder, which itself is a subject of study and research in Nepal.Thefish ladder will facilitate upstream migration of the fish speceis in the Kabeli River. To find an optimal and functional design, modification in the latter stage of project operation will be made as a part of adaptive management strategy based on site monitoring results. Apart from this, the cold water fish hatchery will compensate for some of the impacts on fish diversity and population of the upstream Kabeli River. In the downstream section, the habitats provided by the Tamor River are anticipated to mitigate the impacts on fish diversity and population.

Therefore, as mitigation to the barrier effect, the project dam design will incorporate a suitable ladder after examining the effectiveness of the various ladders in use in Nepal or in the region. The

[14] See Table 6.10 for target fish species of Kabeli.

downstream flow will be released from the fish ladder for all times during project operation. Estimated cost for the fish ladder is NRs.56,99,914.00 which is included in the civil costs.

Summarizing, in addition to the fish ladder, the project will provide an onsite cold-water fish hatchery for a selection of the migratory fish species including the IUCN red list species and operate the fish hatchery for the production of fish fingerlings for open water fish stocking in the Kabeli River. A separate study, included in the EMP, for the establishment and operation of the cold water fish hatchery will be undertaken in the initial phase of project construction period based on the experience of the cold water fish hatchery in Kali Gandaki "A", Pokhara, and Trishuli. Estimated cost for the fish hatchery study and establishment is NRs10 million. The cost of operating hatchery will be borne by the developer.

III Impact of Fish Entrapment in Headrace Tunnel and Turbine

<u>Impact</u>

The fish assemblage of the Kabeli River comprises of resident and migratory fish species (Table 4.*30*, Chapter IV). The resident species as they are small sized fish with low sport value are not subjected of harvesting by locals. These species are distributed both upstream and downstream of the Kabeli diversion structures and considered resident or non-migratory in behavior, the effect of entrapment to the resident species in the headrace tunnel and turbine will have a limited localized impact for the fish population inhabiting the reservoir areas only. Therefore, the impact is considered as of low significance.

The migratory fish (Table 4.*30* Chapter IV), on the other hand, found in the Kabeli River are reported to have behavioral characteristics similar to that of anadromous species i.e. these fish migrate upstream from the downstream areas for spawning in the headwaters and return back to the downstream areas and remain in the downstream areas till the next spawning season. Entrapment of these species at the headrace and intake tunnel is likely in the process of downstream migration, and they may be sucked through the turbines while migrating downstream, with consequent potential mortality effects. The envisaged effects could have long term implications on fish population.

Literature review and consultation with local fishermen reveal normal downstream fish migration starting towards the end of September and continues through December, the peak downstream migration is in October. The available flow in October is larger than the KAHEP design discharge whereas in the months of November and December the available discharge is less. Therefore, the risk of fish entrapment in the turbine is considered higher for the migratory species in the months of November and December than in October. In these months, the only available discharge through the diversion structure is the environmental flow that will be released through the fish ladder structure.

<u>Mitigation</u>

Nearly thirty migration devices have been tested over the past 50 years (Therrien, J et al. 2000). These devices are grouped in four main categories: bypasses, physical barriers, behavioral barriers and trapping and transportation systems to avoid fish trapping into the headrace structures and to the turbine.

The KAHEP will incorporate a surface spill in its barrage design to release the EF through a fish ladder. The EF will be released throughout the project life and it is envisaged to also function as a bypass structure for the migrating fish downstream in the low flow season. During the high flow periods or periods when the design flow of the KAHEP is lower than the available Kabeli River flow (June, through

October), the opening of the radial gate of the barrage in addition to the fish ladder structure will provide pathways for the downstream migration.

The company is evaluating different options to avoid fish entrapment into the desanding basin and subsequently to the headrace tunnel and turbine in the KAHEP waterways. One option being considered is to build the fish ladder on the right bank of the dam where KAHEP is also considering to construct a fish friendly spillway. To construct the fish ladder at the right bank is expected to reduce the risk for up migrating fish to be trapped in the tunnel inlet as soon as they enter the reservoir. Alternatively, these structures may be built on the left banks but in addition to fish friendly spillways and physical barriers, the water velocity at the intake will be kept at less than 1 m/s to avoid entrapment of upstream migrating fish when they enter the reservoir.

Envisaged mitigation cost for this arrangement is about NRs 3.5 million.

IV. Impact of KAHEP on the Tamor River

Impact

The KAHEP operation will impact Tamor River hydrology in two ways. First, there will be overall reduction in the Tamor River hydrology in the stretch between Kabeli – Tamor confluence and Kabeli tailrace outlet, and second there will be hydrological fluctuation on Tamor River due to operation of the plant at peak demand/hours (2 hrs in the morning and 4 hrs in the evening) during low flow season (November through May). The Tamor River flow at the downstream of the tailrace outlet will be influenced significantly by the water release during the peaking operation (6-8 AM and 6-10 PM). The stretch of Tamor River between Kabeli – Tamor confluence and Kabeli tailrace outlet will experience reduction in the existing Tamor River hydrology due to water diversion by KAHEP. Table 6.12presents the expected average hydrological reduction in this affected stretch.

Table 6.12: Hydrological Change in the Tamor River (between Kabeli – Tamor confluence and Kabeli tailrace outlet) due to KAHEP

Months	Tamor at KAHEP Powerhouse Site (m^3/s)	Kabeli at KAHEP intake (m^3/s)	Available water from Kabeli after KAHEP (m^3/s)	Tamor After KAHEP (m^3/s)	Percentage Change
January	39.1	10.31	0.86	29.65	24.17
February	32.3	8.63	0.86	24.53	24.06
March	31.4	8.88	0.86	23.38	25.54
April	45.2	13.3	0.86	32.76	27.52
May	96.2	31.63	0.86	65.43	31.99
June	343.7	86.28	48.55	305.97	10.98
July	679.4	168.95	131.22	641.67	5.55
August	730.7	181.71	143.98	692.97	5.16

September	509.7	127.42	89.69	471.97	7.40
October	237.7	58.11	20.38	199.97	15.87
November	81.9	25.25	0.86	57.51	29.78
December	52.5	16.18	0.86	37.18	29.18

Source: KEL 2012

The hydrological reductions are significant in the non-monsoon months (November to May) with maximum in the month of May. In the monsoon months, the hydrological difference will be minimum and vary between 15 and 5 percent of the existing average monthly flows. Since sufficient water is available in the affected stretch of Tamor River, the impact of the hydrological reduction to the aquatic ecology and other goods and services of the stretch's Tamor River hydrology is envisaged to be insignificant.

Secondly, the KAHEP operation in the dry season (November through May) with daily peaking and non-peaking operations is expected to bring noticeable changes in the Tamor River hydrology with fluctuations on the river hydrology and water levels downstream the tailrace. Table 6.*13*presents the expected fluctuations in the Tamor River hydrology in the non-operation and peaking operations.

Table 6.13: Hydrological Fluctuations in Tamor River in Non-operation and Peaking Operation Periods

Months	Tamor River Hydrology Non -operation Periods (m^3/s)	Tamor River Hydrology Peaking Operation Periods (m^3/s)	Percentage Change
January	29.65	67.38	127.25
February	24.53	62.26	153.81
March	23.38	61.11	161.38
April	32.76	70.49	115.17
May	65.43	103.16	57.66
June	305.97	343.7	12.33
July	641.67	679.4	5.88
August	692.97	730.7	5.44
September	471.97	509.7	7.99
October	199.97	237.7	18.87
November	57.51	95.24	65.61
December	37.18	74.91	101.48

KEL, 2012

Daily water fluctuations above 100 percent of the non-operation periods hydrology in the Tamor River are expected, maximum being in the month of March with over 160%. Such a fluctuation in the river hydrology daily is of concern to the aquatic ecology as well as the river safety and goods and services of the downstream riverine communities of Tamor River which are analyzed in the paragraphs below.

Studies conducted in the flow regulated sites with pulsed water releases for peaking power generation, particularly in the low water periods, have indicated severe reduction on habitat persistency (Freeman et.al, 2001). The most marked effect of this kind of peaking activity is the phenomenon stranding which means that macro-invertebrates and fish can be trapped in the gravel when water flow undergo rapid decrease. The effects depend on the cross-section profile, the gravel bed composition, the fluctuation nature and the species of macro-invertebrates and fish present. If the shorelines are flat with low angle of inclination, the stranding effect is higher than if the angle of inclination is high. These stranding effects are normally seen as the most serious environmental consequence downstream of a peaking power station. In Nepal these effects are not studied and due to the fact that the effects are species specific, it will be of high value to do monitoring work and to design a study on these topics as part of the EMP.

The most critical situation is the decreasing flow. A fast decline in flow will give the small fish and macro-invertebrates small chances to escape. Normal reaction for small fish is to hide into the gravel when a frightening situation occurs. Corse gravel give good shelter and high mortality while fine sand gives bad shelter and low mortality. Bigger fish is normally able to escape.

One of the physical consequences of hydro-peaking is erosion which depend on gravel properties, angel of shore line inclination and how rapid the rise and fall in water levels occur. This erosion effects will normally be of high grade the first years after start of the hydro-peaking and then the effects will be reduced as a consequence of riverbed stabilization.

Knowledge of effects from hydro-peaking on fish is mainly developed on salmonids and detail effects and mitigating measures are probably impossible to transfer to Himalayan rivers. For salmonids, results of experiments show that reduction of the rate of water level to less than 13 cm per hour will give significantly reduced risk for stranding. But, as already expressed, this guideline might be misleading in Himalayan rivers, where fish may be better adapted to natural torrential rivers and drastic daily flow fluctuations from both snowmelt and monsoon season.

Hydro-peaking daily fluctuations may also affect local habitats in the discharge fluctuation zone. It has been reported that hydro-peaking may affect shallow water spawning habitats, especially if the fish assemblage spawns during such high hydrological fluctuation periods. A hydro-peaking zone in a regulated river will also normally give unstable hydraulic conditions that will affect the ecosystem and probably normally cause reduction in productivity.

The KAHEP induced changes in the Tamor river hydrology during the dry season is likely to have the similar impacts for at least 2 to 3 km downstream from the KAHEP tailrace. Further downstream pulse effect of the water release is expected to decrease and the river will naturally neutralize the pulse effect as it moves downstream.

The other impact of the hydrological fluctuation envisaged is the safety and goods and services issues of the downstream riverine communities. Like Kabeli, Tamor River downstream to the KAHEP tailrace is not used for consumptive uses. The religious and recreation uses, including fishing, is the only goods and services provided by the river to the riverine communities. The expected change in the water levels in the Tamor River in the operation and non-operation period is less than 0.42m in the dry season and less than 0.2m in the monsoon season (Table 6.14). Expected rise in the water level will have a time lag of nearly 20 to 30 minutes, and there will be sufficient time for the communities using the Tamor River to move to safety in areas immediate to the tailrace outlet. However, warning devices are warranted. Further downstream, as additional tributaries add to the Tamor hydrology, these impacts of safety are expected to gradually decline.

Table 6.14: Water Levels in the non-operating and peak Operating periods in Tamor River

Months	Water Level None Operation (m amsl)	Water Level Peak Operation ((m amsl)	Water Level Difference (m)
Jan	457.32	457.7	0.38
Feb.	457.29	457.68	0.39
Mar.	457.25	457.67	0.42
April.	457.4	457.76	0.36
May	457.72	458.02	0.3
June	459.16	459.28	0.12
July	460.36	460.47	0.11
Aug	460.48	460.56	0.08
Sept.	459.78	459.91	0.13
Oct.	458.59	458.8	0.21
Nov	457.6	457.94	0.34
Dec	457.44	457.8	0.36

KEL 2012

Mitigation

The anticipated hydrological change in the Tamor river stretch between Kabeli-Tamor confluence and the Tailrace outlet will be a residual impact of the project, though significant impacts of the hydrological changes is not anticipated in the stretch.

Impact of hydrological fluctuation downstream of the tailrace on the aquatic ecology of the Tamor River particularly to the fish juveniles at this level of project planning is not clearly understood but might be considerable. However, monitoring of the downstream river stretch for the envisaged impact is needed for the formulation of future adaptive management strategy in order to identify additional mitigation and management measures.

To mitigate the potential impact of the hydrological fluctuations in the dry season to the riverine communities following measures will be implemented.

- If findings during the monitoring program indicate that reduced rate of change in water level at the end of each peaking period can give reduced fish mortality, this measure will be considered. The slowdown of hydropower production will be tested by time-span of 1 hour, 2 hours and 3 hours from full production to zero production: gradual closing down of hydropower production may be an option for reducing the stranding effects.

- Establishment of siren warning system for at least 5 km downstream of the Tailrace outlet in the Tamor River. Siren will be blown twice at least 15 minutes and 5 minutes before the evening peaking operation. Community consultation on the siren blowing times will be undertaken during the construction period. Estimated cost for the siren is NRs 2.5 million

- Community awareness programs to the riverine communities of the Tamor river downstream tailrace will be organized on the river safety issues and bill boards will be placed along the routes leading to the Tamor River prior to the operation phase and the bill boards will be maintained by the project throughout the project operation periods. Estimated cost for the downstream community awareness program is NRs 250,000.

- The local FM radios will be utilized for the daily broadcasting of the peaking operation period to inform local communities on the timings of the water release and expected duration of the high hydrology in the Tamor River downstream. Special talk programs will be organized regularly from the local FM station on the safety issues related to hydrological fluctuations. Estimated annual cost of the provision is NRs 50,000.

Summary of the predicted impacts for primary environmental issues are presented in Table 6.15below.

Table 6.15: Summary of the Primary Environmental Issues - Impact Prediction

SN		Primary Issues	Direct / Indirect Impact	Extent	Duration	Magnitude
A	**Construction Phase**					
1	Impacts on vegetation due to the site clearance for the project activities and offsite activities of construction works and associated workforce		D/ID	L/S	LT/ST	M
	a	*Loss of Forest and Site Clearance for Project Structures and Facilities*	D	S	LT	M
	b	*Loss of vegetation due to the offsite activities of construction works and associated workforce*	ID	L	ST	M
	c	*Impacts on protected species of flora and fauna*	D	S	ST	M
	d	*Impact on community and leasehold forests due to construction of dam, access road and powerhouse structures*	D	S	ST	M
B		**Operation Phase**				
1	Disturbance to fish and aquatic species and its habitat due to the obstruction created by the proposed weir		D	L/S	LT	H/Lo
	a	*Dewatered Section*	D	L	LT	H
	b	*Change in the composition of the fish species in the reservoir section:*	D	S	LT	Lo
	c	*Reservoir eutophication and associated impacts to aquatic life*	D	L	LT	H
2	Impact on fish migration and spawning areas of fish in the Kabeli River Upstream of the weir		D	R	LT	H
3	Impact of Fish Entrapment in Headrace Tunnel and Turbine		D	R	LT	M
4	Impact of KAHEP on the Tamor River		D	R	LT	M

Note: D = Direct, ID = Indirect, S= Site specific, L= Local, R= Regional, ST=Short Term, LT= Long Term, H = High, M=Moderate, LO= Low

6.1.2 Secondary Issues

6.1.2.1 Construction Phase

I. Impact due to land acquisition for project facilities and access road

A total of 47.718ha of land will be required for the project. Of the total, 22.508ha is permanent land while temporary land is 25.21ha (Table 2.2). In terms of land use, 61.10% is the riverine area including river beds, river flood plains and elevated banks. Agricultural land required is 35.60% followed by 3.30% of the forest land including community forests, communal forests and leasehold forest.

Of the land use types acquired permanently, only 7.678ha is agricultural land, 1.57 ha is forest land, and the rest 13.26 ha is the riverine area. A major part of the riverine land required lies in the reservoir area (9.51 ha) of Kabeli river. The barrage structure and the powerhouse occupy remaining 3.57 ha of the riverine area.

Major part of the temporary land required also lies in the riverine area, occupied by the project facilities such as quarry, muck disposal etc. The agricultural land required temporarily consists g of construction camps and storage facilities sites totaling 8.30 ha. The proposal does not envisage usage of the forest area for temporary use.

a. Impacts of Permanent Land Acquisition

Permanent land acquisition is of concern in terms of land utility and services rendered in long term to the land owners (individual or communities). The key impacts to the individual owner relates to loss of agricultural land, the primary source of livelihood in the rural society depending on the subsistence agriculture. Taking into consideration the land and property to be acquired permanently and the households or individual owners of the land, a physical displacement of the people from the area is not envisaged. Details of the effects of agricultural land acquisition to the owners of the land are evaluated in the Social Assessment Report and will not discussed any further in this report. The envisaged impacts are direct, long term and of high magnitude to the agricultural land owners.

Permanent acquisition of the forest land area has a long term impact on the communities dependent on the forest resources for various purposes. Clearance of forest land will reduce the tangible resource base used by the local communities such as fodder, timber, firewood, litter, animal grazing etc. Non tangible loss in terms of environmental services such as water holding, stocking of greenhouse gas, oxygen generation, shade are the direct and indirect losses to the communities which will increase competition on the resource use and provisioning etc. Since these resources are also available in the nearby areas, the imparted impacts of the loss are of low to moderate magnitude only to the communities.

The proposed permanent land to be taken from the riverine area is entirely for the project structures such as barrage, operating platform, intake, and reservoir, sensor building at the headwork and powerhouse and switchyard at the powerhouse.

The construction of barrage structure will obstruct the river flow regime both during construction and operation period. Construction of the dam is proposed in the dry months (low river flow periods) by diverting the river by coffer dams to withstand the projected dry season floods and passing the water across the construction site by a diversion tunnel (refer section 2.6.1). In the wet period when the river flow regime is high and there is possibility of occurrence of high floods, water will be allowed to flow directly through the river. The river width is sufficient to cater the projected floods to pass through the river without imparting any damage. The construction planning of the barrage and the design and operation schemes of the barrage has an inbuilt mitigation proposition to minimize the impacts of changes in the river flow and flood regime for construction and operation periods.

The riverine area designated for the reservoir will not be affected by the river flow and flood regime because the reservoir operation is proposed only during the dry season when the river flow is lower than the design discharge of the project. In the wet season when the river flow is high and is often associated with floods, the barrage gates will be opened to allow the floods to pass uninterruptedly ensuring that no damage occurs.

The powerhouse site and switch yard located at the active alluvial fan of Piple Khola (refer section 4.2.1) has a risk of floods and associated land degradation. The project design has taken this issue into consideration and has incorporated measures to protect the powerhouse area from the floods of Piple Khola (refer UFSR 2011).

The permanent acquisition of the riverine area, however, will certainly restrict the community activities of animal grazing, collection of construction materials and restriction in mobility. It also has the potential of increased recreational activities particularly in the reservoir areas. Fishery may be developed in the reservoir pool for large fishes in seasons when normally large size fish migrate downstream for feeding. As the reservoir provides good nutrition augmentation area with large volume of water, many of the large fish will be attracted in the reservoir from the upstream section for feeding. The envisaged impacts of the riverine area acquisition on permanent basis are of low order magnitude only.

Mitigation

1. To minimize the impacts of the loss of land and property of the individual landowners, Resettlement Compensation and Livelihood Assistance Plan (RCLAP)for affected households has been prepared based on the census survey of the affected households. The underlying principle of the RCLAP is to at least maintain the existing livelihood of the affected households. As far as possible, land to land compensation should be given priority to minimize the risk in the same area. If this is not possible, then land and property will be compensated at the market price without depreciation, to enable the household to purchase similar quality land and property in the same area. Additionally, the affected households and individuals will be given adequate rehabilitation packages in order to reestablish their livelihood.

2. Strictly adhere to the construction planning of the headwork and powerhouse area during construction phase;

3. Strictly adhere to the operation scheme of the barrage as per the design

4. Adhere to the Piple Retaining structures and Tamor Guide Bund as proposed in the feasibility report for the powerhouse site

5. Mitigation measures listed in section 6.1.1.1, I, a and b and section 6.1.1.1, III will be implemented to minimize the impacts to communities for the loss of forest area and forest resources.

6. A separate free access to communities will be provided, if the construction area fencing obstructs the access to the land and property or the agricultural and grazing activities of individuals and communities. The contractor will be made responsible for the above through contractual clauses.

b. Impact of Temporary Land Acquisition

Temporary land acquisition of the land for a construction period only will have impacts to the local communities' agricultural production and in the mobility due to restriction posed by the construction area fencing. Though the impact for the construction period is of high magnitude in livelihood of the land owners and communities using the open riverine areas, these impacts are localized and short term in nature and will be recuperated once the construction work is over.

Mitigation

1. The construction contractor will give all rent of the temporary acquired land. The rental will be based on the land productivity and shall not be less than the total annual land productivity. The rental will be paid every six months.

    - For agricultural land under individual or household ownership, the contractor will make an agreement with the owners of the land on the land rentals through bilateral negotiation. A copy of the agreement of the bilateral agreement signed by both the parties will be presented to the Project Management to monitor the compliance of the agreement in the later periods. The contractor is obliged to rehabilitate the land occupied to "as is condition" prior to occupation after the end of the construction period before handing over the land to the owner. The key parameters for the rehabilitation unless specified in the agreement will be i) top soil maintenance, ii) demolition of all structures, fences and drainages, iii) establishment of land boundaries pre-project conditions, iv) area should be free from construction or camp solid wastes. The contractor should submit the handover of the land signed by the affected party to the Project Management. In case the contractor fails to submit the handover letter signed by the affected party, the contractor's money will be retained from its account and the project management will make all the required payments to the affected parties.

    - In case of the riverine and other community land occupied temporarily, the contractor will pay the land rentals as to the direction of the VDC representative as per the government norms. The contractor will also rehabilitate these lands once the construction work is over. The project environment officer will foresee the rehabilitation works and provide a clearance certificate to the contractors. In case of failure to present the clearance letter, the contractor money will be retained from its account and the project management will rehabilitate the area.

II. Impact on land use pattern, topography, geology, slope stability

As elaborated above, the project is going to require nearly 47.718 ha of land for the project development on permanent and temporary basis. The acquired lands will be utilized for various project purposes with obvious effects on the land use pattern, topography, geology, and slope stability.

a. Impacts on Land Use Pattern

The agricultural and forest land areas occupied permanently (9.248 ha) will have a permanent land use change. These areas will be converted into structural sites. In the riverine area, nearly 4.15 ha will be converted in to structural sites (barrage, operating platform, intake, sensor building, powerhouse and switchyard) while the rest will remain as riverine area only, but with some changes in morphological characteristics.

There will be no change in the land use pattern of the temporary land acquisition sites except in the muck disposal sites (9.1ha). The muck disposal sites will be developed into elevated areas above the river flood plain and could be utilized for various public use such as school grounds, afforestation area etc. in agreement with the local communities. This is a beneficial impact on the land use pattern; the unused riverine area will be converted into usable elevated areas.

Mitigation

The change in land use pattern of nearly 22.580 ha of the land area occupied permanently by the project is the residual impact of the project in the land use and will remain as such for the project life. The change in land use of about 9.1 ha of the riverine area in the muck/spoil disposal site, if developed to usable land is a positive impact to the project. To develop this area into a usable land, the contractor will develop a plan of land development in these sites. The top soil of the other structural location will be saved by the contractor and will be used as top cover over the muck and the land will be developed into land for other purposes. The land development plan will be approved and monitored by the project environmental officer to comply with the development plans.

b. Impact on Topography and Geology

Minor topographical changes are expected in the following areas:

- Barrage area and intake site
- Powerhouse site
- Quarry sites
- Muck disposal site
- Reservoir area and
- Downstream barrage

The topographical change in barrage/intake site, powerhouse site, reservoir area and muck disposal site will remain as the permanent change throughout the project life. As the changes will be minor compared to the relief distribution in the area will not have a negative effect in the land relief pattern. However, it will impart an aesthetic impact to the nature lover.

The change in topographic forms in the quarry site will be a temporary feature. The flood plain areas will be filled with the river materials as the rivers have high sediment transportation capacity in this area in one to two flood events.

The lowering of the river bed is expected in the downstream section of barrage because of the churning effect of the rather clean water released from the reservoir. The low sediment water has high erosive power. Lowering of river bed by about a meter is expected immediately downstream of the barrage structure. The envisaged impact of the change is to the barrage structure itself. The barrage structure design has incorporated measures against the erosion to protect the barrage structures.

Geological changes are not expected by the project construction. Construction of underground structures using high intensity blasting materials might bring change in the geological properties of the surrounding rocks. Since, geological stability is required for the stability of built structures; projects do take measures against such changes, if required during construction.

Mitigation

1. To minimize the effects of land use changes, the design engineers will be instructed to design the superstructures visible at the ground surface complementing to the surrounding topographic forms such that the general aesthetics of the area are similar to the existing ones.

2. The downstream section of the barrage is protected by a mat of big boulders for a length of at least 50m (or as long as necessary) to avoid downstream erosion of the river bed by sediment free water released from the barrage

3. Controlled blasting will be practiced at all times while excavating the surface or underground area to have a minimum impact to the physical properties of the surrounding rocks.

c. Impact to Land Stability

Surface and subsurface excavation works upgrading and rehabilitation of the access roads might encounter the problem of land stability during the construction period.

The barrage area, as it is located at the toe of the moderately sloping land unit with sound rock underneath, is not envisaged to cause major land stability problems during excavation. The quarry site located in the flood plain requires only surface stripping operations and does not involve land stability problems. The surge shaft portal, penstock pipe location, and power house require excavation in a rather steep section and involving weak bed rock and regolith materials may give rise to the land stability related issues during construction of these structures. But the impacts of such land instability, if any, will be site specific only and may impinge upon the construction schedules in the event of failure.

The headrace tunnel excavation works, as it lies more than 100m below the ground level of the hills which do not show active landslide, is not expected to invite surface land instability during construction.

The access roads to headwork and powerhouse require upgrading and widening of the road in the initial phase of construction periods. Road upgrading is in itself a mitigation measure for the road transport safety and road corridor safety. However, proper actions of road upgrading are pre-requisites for the safety of the road corridor and road transport. In the absence of such actions land stability of the corridor declines with implications on the transport mobility as well stability of the entire landscape.

Mitigation

1. All surface excavation above 3m vertical height will be excavated through benching such that 3m high slope will rest over a bench of nearly 3m wide before a next slope is excavated from the edge of the bench. The inner edge of the bench will be facilitated with a horizontal lined drainage to collect and divert the water from the vertical face. The standing slope will be at 45 degree angle in case the material is soil or gravel and could be up to 60 degree if it is a bed rock. The slope material will be protected by suitable grass species, if it is soil or gravel material.

2. The excavated surface will be protected against the water erosion by adequate vertical and horizontal drainages and the water collected from the excavation area will be discharged into safe area

3. Controlled blasting will be practiced at all times while excavating the surface or underground area to have a minimum vibration impact in the surrounding areas. Road upgrading works requiring road widening will avoid further cutting of slopes by maximizing back filling operation taking benefit of the micro-topography and retention walls wherever required.

4. Road side drains will be constructed to collect the water from the cut slopes and discharged to the suitable natural drainages through a cross drainage structure at regular intervals.

5. Cut slopes will be protected against erosion and slides by the construction of breast walls and grass plantation depending upon the height and slope of the cut slope and the geological composition of the cut slopes.

d. Impact on structures due to blasting vibration and use of heavy construction machinery

The vibrations of blasting might damage some of the supra structure located close to the tunnel alignment, such as mud mortar houses of the local area. Cracks might develop in these houses. Such incidents have been reported in other HEP (e.g. Kali Gandaki "A" and MMHEP) close to the tunnel alignment. The envisaged impacts are of low magnitude.

Heavy construction machinery will be used in the construction site only. As the construction site lies far from the settlement area, damages to the existing structures are not envisaged.

Mitigation

1. Controlled blasting will be practiced at all times while excavating the underground area to have a minimum vibration impact on the house structures located close to the tunnel alignment.

2. The damaged house structures will be compensated for the damages caused by the blasting in the tunnel. All houses located about 500m on either side of the tunnel alignment will be surveyed prior to the start of construction works and the structural conditions of the houses and the cracks developed will be documented. This will form the basis for compensation if such damage is reported. A third party auditor will approve all estimates. Estimated initial amount for prior survey of house structures and compensation is NRs 3,500,000. Additional resources will be made available if warranted.

6.1.2.2 Operation Phase

I. Impact on micro-climate in reduced flow zone

Temperature modeling in West Seti Hydropower Project (West Seti EIA, 2001) and Karnali Chisapani Multipurpose Project (HPC, 1987) have projected increase in day time temperatures by 0.5 to about 1 degree celsius with corresponding decline in night time temperatures by same proportions in the summer season as the flowing water acting as temperature buffer is greatly reduced in the dewatered riverine areas. Similar impacts in the reverse order might be observed in the reservoir due to presence of large volume of water in the reservoir section of riverine area. The impacts of such change in micro-climate could be of significance to the temperature non-resilient faunal and floral species. Since temperature resilience of the existing flora and fauna is not well understood, the significance of the impact is difficult to qualify and quantify. Since human beings are less sensitive to such changes in temperatures, health effects to the public health is not expected.

Mitigation

The microclimatic effect of the project in the dewatered and reservoir section could not be mitigated with the selected project design. No mitigation measures will be implemented to minimise the impacts of micro-climatic change and will remain as the residual impact throughout the project life.

II. Upstream Impacts due to impoundment created by the weir

a. Impact of river bed level rise due to upstream reservoir

The water impoundment in the reservoir by the barrage structure does not impart significant impact to the upstream areas except for the erosion of the river bed in the immediate vicinity of the reservoir as upstream will be slightly elevated. Due to the change in the longitudinal profile of the river bed, sedimentation will be observed immediately upstream of the reservoir. The river might migrate laterally and could erode the river bank for about 200 to 300 m upstream of the reservoir which in long term might affect the agricultural land (about a ha) located close to the river in lower alluvial tars. Potential land areas, which might be affected, have been already acquired, however, the river hydrological actions are not always predictable and hence some additional areas have a remote chance of such impacts. The envisaged impact is direct, localized, long term and of low magnitude only.

Mitigation:

1. The river bank erosion due to bed level rise and damage to the agricultural fields will be minimized by river bank protection measures in the critical areas susceptible to erosion potentials as noted or reported by the neighboring farmers. Upstream erosion will be monitored and bank protection measures will be implemented by the project operator, as needed.

b. Reservoir bank failure impact

The impoundment of water in the reservoir and fluctuation of the water level daily in the months from November through May might trigger small scale slumps from the reservoir banks into the reservoir. Large debris slides due to water level fluctuations in the reservoir rim are not expected. Since the land use around the reservoir rim is mostly forest land of barren nature, the envisaged impact is of very low magnitude only.

Mitigation

Small scale slumps in the reservoir rim by the water fluctuation will remain as the residual impact of the project and will not be totally avoided nor mitigated.

III. Impact on spring along the tunnel alignment

Experience in the Kali Gandaki "A" and Middle Marsyangdi HEP with headrace tunnel structures was found to dewater the landmass above the level of tunnel within an influence area of up to 200 m of the tunnel alignment. Dewatering or draining of the groundwater above the level of tunnel is high in the initial phase of construction and again re-established after 10 to 15 years of construction. The springs along the tunnel alignment are enumerated in Table 4.11 (Chapter IV).

These water sources are likely to beimpacted by the tunnel excavation works. Provided these spring water sources are drained to the tunnel, the population depending upon these sources will have to travel long distance for the drinking water purpose and the agricultural products based on the irrigation water from these sources will not be available to the local communities with implication on livlihood. The envisaged impacts will be high on the communities dependent on these water sources.

Mitigation

1. Prior to the start of the construction work, the water spring within 200m strip above the tunnel alignment will be surveyed in the peak dry season and the available spring discharge is measured and documented. The survey will be done in the presence of the village elites and leaders. Estimated cost for the survey of spring location and discharge measurement is NRs215,000.

2. On the report of the water discharge reduction, the water sources will be resurveyed and if found affected, provisonal arrangements of water requirement to the affected villages or communties will be made immidiately available as a short term measure. Estimated cost of such short term arrangement is NRs 600,000.

3. Piped water supply from the near by available perennial sources will be arranged to the affected village/communties as a long term measure. Estimated cost for the new piped water supply system to the potentially affected villages is NRs3,500,000.

Summary of the predicted impacts for the secondaryenvironmental issues are presented in Table 6.16below.

Table 6.16: Summary of the Secondary Environmental Issues - Impact Prediction

S.N.		Secondary Issues	Direct / Indirect Impact	Extent	Duration	Magnitude
A	**Construction Phase**					
1	Impact due to land acquisition for project facilities and access		D	S	LT/ST	H
	a	*Impacts of Permanent Land Acquisition*	D	S	LT	H
	b	*Impact of Temporary Land Acquisition*	D	S	ST	H
2	Impact on land use pattern, topography, geology, slope stability		D	S	LT/ST	LO/M
	a	*Impacts on Land Use Pattern*	D	S	LT	M
	b	*Impact on Topography and Geology*	D	S	LT	LO
3	*Impact on Land Stability*		D	S	ST	LO
B	**Operation Phase**					
1	Impact on micro-climate in reduced flow zone		D	L	LT	LO
2	Upstream impacts due to impoundment created by the weir		D	S	LT	LO
	a	*Impact of river bed level rise upstream reservoir*	D	L	LT	LO
	b	*Reservoir bank failure impact*	D	S	LT	LO
3	Impact on spring along the tunnel alignment		D	L	LT	LO

Note: D = Direct, ID = Indirect, S= Site specific, L= Local, R= Regional, ST=Short Term, LT= Long Term, H = High, M=Moderate, LO= Low

6.1.3 Other Issues

6.1.3.1 Construction Phase

I. Potential for local air quality deterioration due to construction activities

The significant volume of fugitive emissions will be generated from various excavations, crushing and mixing activities during construction in and around the project site. The movement of vehicles on the earthen road surface is also expected to generate large volumes of fugitive emissions. Different factors that determine the amount of dust blown in the atmosphere include type of activity & operation modality of the construction works & vehicles and climatic conditions (dry & wet). The fugitive emission generally consists of large size particulate fractions over 10 micrometers, which settle down quickly within a few hundred meters of the source of generation. However, 10 to 15 % of the particulate of size fraction less than 10 micrometer can remain in the air and are predicted to degrade the ambient air quality of surrounding areas. As the construction sites are located at a distance from the settlments, effects of air pollution is projected to be minimum. The vehicles plying from the main road to the construction sites, however could impart high impacts of suspension dusts to the households located close to the road corridor. In the construction sites, the high suspension dust particle will have high impact on the health of the occupational workers.

The cooking activities in construction and labor camps and combustion from vehicles/machineries will generate gaseous emissions. However, the amounts of emissions generated from such activities are nominal and are not likely to degrade the ambient air quality of the local surrounding areas significantly.

The construction activities inside the tunnel such as drilling, blasting, and mucking generates high amount of dust as well as high concentration of CO, NOx, and SOx. The concentration values of emissions in the tunnel will depend upon the construction activities and modality of mucking operation besides efficiency of ventilators. High concentration of dusts and gaseous pollutants in the tunnel is of concern related to occupational health and safety of the workers.

Mitigation

1. The earthern and gravelled road corridors will be sprinkled regularly to minimise the fugitive dusts from the plying of the construction and project vehicles particularly in the winter and dry summer season. The contractor will be made reponsible to sprinkle water regularly on the road corridors linking the Kabeli Bazaar market settlment to the headworks, and close to the powerhouse site.

2. The aggregate crushing sites and active construction sites will also be sprinkled regularly by water as required. The contactor will be made reposnsible contractually for water sprinkling.

3. The occupational workers at the construction sites, engineers and supervisors will be provided with air masks, helmets, and safety goggles. The contractors will be made responsible to provide the above mentioned PPE contractually. Further, it will be mandated that all the workers and engineers will have to wear these gears inside the construction sites to minimise the health impacts of the fugitive dusts and head safety.

4. Powerful ventilators will be installed for ventilating the tunnel area for which the contractor will be made responsible contractually. The ventilators will be operated 24 hours a day during excavationand lining periods of the tunnel. Visitors and other workers not related to muck work will be prohibited to enter the tunnel after blasting operation and during mucking operations.

II. Potential of noise pollution in the suronding areas

The construction activity particularly blasting operations, machinery operations and vehicular traffic will accentuate the background noise level during the construction period close to the construction sites (quarry sites, batching plants, aggregate crushing plants, powerhouse, headworks, mechanical and equipment yards) and along the vehicular corridors. At the construction site and immediate vicinity the background noise level is expected to be between 65 to 70dBA (experience in the Middle Marsyangdi HEP), whereas background noise level is expected to be close to 50 to 55 dBA for the nearest community which is 200 m away from the activity point. Accentuated short lived peak noise during blasting could be as high as 90 dBA for the nearest community, while the noise level contributed by the vehicular movement along the road corridor could be as high as 80dBA.

The impacts of the noise level is expected on be high to the occuational worker which can have implication on their health both by the increased background noise level and the shortlived high pitch noise of blasting and vehicular movements. The communties located at distance will not feel the impact of the increased background noise, but high pitch short-lived noise may impact the health of the communities particularly the old aged and children in the morning, evening and night. The persistent noise is anticipated to cause communication disturbances between the teachers and pupils in the educational institutions.

Apart from the above, the noise impact will be felt by the thriving wildlife of the area. The high pitch short lived noise will drive most of the terrestrial wildlife from the area only to return to the area after the construction period, provided that the wildlife will not migrate permanently away from these locations.

Mitigation

1. Operation of noise generating construction actvities in the day time as far as possible.
2. Confining blasting operations during the day time only. Prior information should be given by blowing siren 10minutes beforeblasting operation and 10 minutes after blasting operation to indicate the commencement and conclusion of the operation.
3. Regular maintenance of the vehicles to reduce the mechnical and body noise while driving.
4. Prohibition on the blowing of horns in critical stretches close to villages and near the school area along the road
5. Installing noise reducing equipment in the ventilators, compressors and diesel generator sets

III. Impacts due to stockpiling of construction material and muck disposal

The project has designated separate areas for the stockpiling of construction materials such as sand, aggregates, iron rods, steel frames, cement for the project construction period. However, open and haphazard stockpiling has potential to degrade the aesthetic beauty of the stockpiling areas. Similarly, the haphazard disposal of muck in the designated area and elswhere is of concern related to air pollution, water quality issues, and erosion and sedimentation. As the muck disposal site is located in the flood plain area, improper disposal might increase the sediment load in the river and there is a possiblity of muck washout during high monsoon floods which could cause the downstream sedimentation and disturbance to the aquatic life. The envisaged impacts are direct, short term and of moderate magnitude.

Mitigation

1. Stockpiling and storage of the construction materials in designated sites only. Prohibition on the stockpiling of construction materials in other areas.
2. While preparing the site for construction for the access road, powerhouse and headworks, the top soil will be managed separately and saved in a separate area for later rehabilitation works.
3. Prior to the start of muck disposal, the contractor will make a plan for muck diposal and get approval from the project environmental officer. Apart from this, a plan will be in place for toe and slope protection of the muck disposal areas from the monsoon washout.

4. The muck deposited will be properly compacted and will be facilitated by surface runoff drainge facilities to avoid air pollution and run off erosion.

5. The muck disposal sitewill be rehabilitated by covering the muck surface by the top soil saved from the access roads, headworks and power house site preparation.

IV. Impacts on drainage pattern

Surface drainage changes are expected along the access roads and at the headwork site and powerhouse site. Storage yards, equipment yards, camps and muck disposal site also will alter the natural surface drainages. The change in the natural drainages (micro to macro) has the potential for surface erosion, and water logging within and outside the limit of the project occupied area. The consequences are degradation on land quality and sites for the breeding of mosquitos with health implications of the construction workers.

The internal access roads are the other project facilities that alter the natural drainage substantially. As it passes through the agricultural land, it might also obstruct the water flow from the upslope terrace to the downslope terrace hindering the free flow of water required for irrigation with implications on agricultural productivity. This could be a reason of conflict with the local farmers. Envisaged impacts of the change in the natural drainage is of low magnitude, but along the access road, the magnitude of the impact is much higher.

<u>Mitigation</u>

1. All project construction sites (headworks and powerhouse) will have runoff drainages during the construction period and later wil be remodified to suit to the local conditions in the operation period as permanent network. The run off water collected will be safely discharged to the natural water bodies.

2. All project facility sites (camps, mechanical yards, storage facilities, muck diosal sites etc.) will be provided with temporary drainage facilities to collect and discharge the run off water safely to the natural water bodies. After the completion of the muck disposal, the muck disposal sites will have permanent drainage networks to collect and discharge the run off water safely to the water bodies.

3. The access roads will have facilities such as permanent side drain structures to collect water from the slope area. The collected water of the side drains will be discharged to suitable natural waterways to avoid upstream and downstream erosion.

4. In the agricultural fields, provisions will be made upon the prior consultation and arrangement with farmers to drain the slope water to the downslope agricultural land such that the water required for irrigation is not blocked.

5. Cleaning of the road side drains and other drainage structures regularly once before the onset of monsoon, twice during monsoon and once after the monsoon such that the drains are maintained to operate as designed and are not filled with the sediments collected from the side slopes.

V. Impacts due to operation of Quarry

The quarry site is located in the flood plain area of the Kabeli and Tamor River. Haphazard quarrying from the flood plain might change the river morphology and river water pathways significantly involving changes in river bank erosion and sedimentation pattern than the exiting ones with both positive and adverse implications on the river banks. Quarrying at the river wet channel might involve changes in river water quality particularly in the increase in the sediment load. Though land stability and erosion related impacts are not envisaged because of the site location, impacts on aquatic life habitat and change in river erosion and deposition sites could be of significance. Envisaged impacts are site specific to local, short term and of moderate signficance.

<u>Mitigation</u>

1. Quarrying operations in the flood plain will be stripping operation rather than forming a big borrowpit at one location.
2. The quarry operation will not be carried below the flowing water level of the river
3. Excavation of aggregates from the river wet channel will be prohibited.
4. River flood plain quarrying will be carried out only in the dry season i.e from November through May only.

VI. Impact on water resource and water quality

a. Impact of Headwork Construction

The barrage and the intake foundations lie on the river bed. Hence, any construction on the river bed is going to impinge upon the river water quality and habitat of aquatic life. For the construction of barrage foundation, the project has a plan of river water diversion at the construction site, such that the construction works directly don't impinge the flowing river. However, river diversion works will have serious implication on the existing water quality during the diversion period and existing aquatic ecology permanently. The envisaged impacts on water quality is short term, while on the aquatic ecology is long term and of high magnitude.

<u>Mitigation</u>

Since the project has to construct the barrage sructucture, the perceived impacts could not be avoided and will remain as the residual impact. However to minimise the impact on water quality during barrage foundation construction, discharge of construction waste such as cement, and concrete slurry will not be discharged to the river water. Arrangement will be made to collect the unused waste materials for disposal in the designated muck/spoil disposal sites.

b. *Impact* of tunnel drainge discharge

Tunnel excavation is invariably associated with seepage water which is drained from the tunnel through the adit portals. In the KAHEP, discharge of tunnel seepage water is envisaged from the surge tank adit portal, headrace tunnel adit portal and from the settling tank areas. The consultant's monitoring experience in the Middle Marsyangdi reveals that these tunnel discharges have high concentration of suspended solids as well as ammonia and some heavy metals such as iron, arsenic etc. Though the envisaged tunnel discharge is small in quantity, it has the potential of water quality degradation of the receiving water bodies. Direct discharge of the tunnel seepage water to the water bodies will make the water unusable for the downstream users as well as impart high impact to aquatic life.

<u>Mitigation</u>

The tunnel seepage water discharges will be collected in settling tanks/ponds outside the portal areas in a suitable location for sedimentation and treatment (e.g. pH, flocculation, etc). The contractor will be made responsible for periodic cleaning and treatment operation through contractual clauses. The water after treatment will be released to the nearest water bodies.

c. Impacts of aggregate washing

The aggregates require washing during crushing to remove the deleterious materials such as clay and silt to maintain the physical properties of the aggregates for concrete preparation. The washing of the aggregates generates high amount of suspended sediment load in the water. If this washing water is released directly to the water bodies, the envisaged impacts are similar to those of the tunnel seepage water discharges.

Mitigation

The water discharged from aggregate washing plant will be collected in settling tanks/ponds at a suitable location for sedimentation and treatment.The water will then be released to the nearest water bodies. The contractor will be made responsible for the required treatment arrangements through contractual clauses.

d. Impacts of the batching plant wastewater

To ensure the quality of the concrete, the concrete batching plant needs to be thoroughly washed after each day's operation or every batch operation. The water released from such washing operations is charged highly with cement. Discharge of such wastewater into the receiving water body has impacts more adverse than the tunnel seepage discharge and the aggregate washing plant discharge as cement consists of non-settling fine materials. Direct discharge of unused concrete slurry into the water bodies is hazardous to water as well as the river banks as it solidifies quickly over the river bed materials and degrades the habitat of aquatic life.

Mitigation

1. The water discharged from aggregate washing plant will be collected in settling tanks/ponds at a suitable location for sedimentation and treatment.The water will then be released to the nearest water bodies. The contractor will be made responsible for the required treatment arrangements through contractual clauses.

2. The unused concrete and cement slurry in the construction works will be placed in the designated muck/spoil disposal sites.

e. Impacts of the disposal of used lubricants, grease, and toxic chemicals and seepage of petroleum products from the bunkers and mechanical yards

The construction machinery and vehicles use large quantities of grease and other lubricants. Similarly, a number of toxic chemicals are used for enhancing the property of concrete admixtures and water proofing works. Disposal of these materials after use or expiry of the usable date into the water bodies has a long lasting impact on the water quality of the receiving water bodies with implications on the aquatic life ecology on both local to regional scale.

The seepage of the petroleum products from the storage yards/bunkers of the construction site and the release of these products as mechanical yard wastewater into the water bodies also has the potential of water quality degradation rendering the water unsuitable for consumption and aquatic life. Envisaged impacts of such disposal or seepage of the contaminated water is of high magnitude.

Mitigation

1. All spent grease and unused or expired toxic chemicals will be collected separately in plastic drums and stored in a safe place under the shade. The contractor will be made responsible for this.

2. All empty containers of grease and toxic chemicals will be punctured and stored in a safe place under the shade. The contractor will be made responsible for this.

3. The unused chemicals, spent grease will be discharged only with the approval of the project environmental officer. As of the date, the project area does not have a sanitary landfill in the nearby locality. The environmental officer in coordination with the contractor will identify some secured sites or will arrange disposal in sanitary landfill elsewhere depending upon the volume and toxicity of the waste. The contractor will be made responsible for this through contractual clauses.

4. The petroleum bunkers are placed in a separate area in a concrete bunded area with a facility of oil and grease separator. The contractor will be made responsible for this.

5. The wastewater from the mechanical yards is collected in a separate area. The water is treated for the oil and grease and then released into the water bodies. The contractor will be made responsible for the required treament arrangements.

f. Impacts of wastewater from camps (kitchen wastewater and toilet wastewater)

Construction camps for engineers, contractors and labor force generate a high volume of waste water charged with high biological oxygen demand (BOD), total suspended solids (TSS), and ammonia concentration. Estimated wastewater volume assuming 125lt/person/day and ground abstraction and loss of 30 percent is $70m^3$/day. The total BOD load of the wastewater is about 32 kg/day. Direct release of this waste into the receiving water bodies will make the water unsuitable for consumption and also hazardous for aquatic life. In camps and construction sites, due to insufficiency of toilet facilities or due to behavioral nature of the workers (used to open defecation); open defecation along the river bank may be frequent. This will not only reduce aesthetic and land pollution but will also cause source of water pollution and spread of vector borne disease in the local area. The envisaged impacts of such discharge and activities though short term is of high magnitude.

Mitigation

1. Provisioning of adequate toilet facilities will be made in the camps and active construction sites. The toilet waste of the camps will be drained to a single treatment facility in each camp. The treated water will only be released to the nearby area. In the active construction site, toilets will be facilitated with collection pit and soaking area. The contractor will be made responsible for this measure.

2. Open defecation will be prohibited in and around the construction sites, camp sites and in the river bank area. Hoarding sign boards will be placed in the construction camps, and active construction sites. The contractor will be made responsible for the measure.

VII. Impact due to solid waste generated in camps and construction sites and its disposal

The solid waste generated in construction camps which include a range of solid waste from normal household kitchen waste to garden waste, packaging wastes comprising plastics, paper cardboards to other common wastes such as clothes, rubber, leather, glass bottles, broken glass and porcelain, ruptured plastic bottles, buckets. Estimated potential solid waste generation the construction camps is 8 ton/day. This could be disposed haphazardly, which could be a major concern of land pollution and aesthetics in and around the areas of construction camps.

Similarly in the construction sites, cement bags, packaging materials and containers of the equipment, and other materials, small iron pieces, wires, worn out ropes, wood pieces, worn out timbers, used and worn out vehicle tires, damaged plywood planks are generated as solid waste from construction. Haphazard disposal of these construction wastes will degrade the aesthetics of the surrounding area and cause pollution of river banks and bed.

Mitigation

1. A solid waste collection and storage system will be established in all the construction related camps and construction sites. The collected waste will be segregated depending upon the property of the waste such as degradable, glass, metals, plastics, cloths, leather etc. and will be stored in separate bunded areas. These materials will be disposed as per the recommendations and approval of the project environmental officer. As of the date, there is no sanitary landfill site in the project nearby areas. The environmental officer in coordination with the contractor will identify a secure site or arrange for disposal depending upon the nature and volume of the waste generated. The contractor will be made responsible for the measure.

2. Garbage containers of adequate size will be placed at critical places in the construction related camps and construction sites. The collected garbage will be collected daily for segregation and storage as outlined above. The contractor will be made responsible for the measure.

VIII. Encroachment in the surrounding forest

The project, as far as possible, has minimized land acquisition of the forest areas and has plans and measures to ensure that there is no encroachment of the forest area by the construction workforce employed by the project.

Since the construction site is a place of high economic activity, a large number of locals as well as outsiders will come to the construction area in the construction phase for economic gains. These people, who are not directly related to the project, however, could encroach the forest area located close to the construction site for various purposes. The envisaged impact is high in such incidents affecting local forest areas and its resources.

Mitigation

Controlling outsiders that are not related to the project is beyond the scope of the project. However, the project will assist the local authorities on the following activities:

1. The project environmental officers will inform the local authorities, VDC representative, Community forest user groups, Leasehold forest user groups and the Forest range post office well ahead of time, if it finds the forest area close to the construction site being encroached.

2. The project will assist the local authorities in the protection works of the forest areas close to the construction sites. Estimated costs of NRs1,536,000 is allocated for this purpose.

3. The project environmental officers will prohibit the construction workforce to enter into the local forest areas for recreation as well as illegal harvesting of forest resources. If found guilty, the construction workforce will be penalized.

IX. Impact due to illegal hunting, poaching and trade of fisheries

The construction workforce might be involved in illegal wildlife hunting and poaching of wild animals and fish, the envisaged impact will be of concern.

Mitigation

Section 6.1.1.1, I, b of this chapter has addressed this issue in detail. The mitigation measures listed in the section will be implemented to minimize the impacts.

X. Possible fire hazard on forest resources

The grass species and Sal trees (*Shorea robusta*) present in project construction sites are vulnerable to fire, especially during the dry season. The forest area in the project site does not have fire lines. Even a small fire in the form of cigarettes butts and match stick used by the construction crew could be a crucial factor for fire hazard. Likewise, the leakage of fuel from vehicles could also be the cause of fire. The forest fire could create a big fire hazard affecting the whole region.

Mitigation

1. Hoarding boards will be placed at critical location of the access road on the preventive actions to control the forest fire. Estimated cost of NRs100,000 is allocated for this measure.

2. Public awareness programs with limited firefighting training will be launched to prevent the forest fires in the local area. Estimated cost of NRs300,000 is allocated for this measure.

3. Project workers will be regularly informed not to throw lighted cigarette tips in the forest areas and not to use forest area as picnic spots. Besides, firefighting training will be provided to the construction work force.

XI. Impacts on wildlife and its habitat due to construction activities

The increased mobility of people and construction vehicles will drive away the terrestrial wildlife from the vicinity of construction sites. The terrestrial wildlife is very noise sensitive. Thus, increased noise levels not only drive them away from the area but also leave impact on their feeding behaviors. The increase in noise level in general and high pitch noise during blasting is envisaged most likely to drive away the terrestrial wildlife of the valley even at considerable distance from the construction site.

Mitigation

As elaborated above (section 6.1.3.1, II) efforts will be made to minimize the noise level during the night, when most of the wildlife are agile. However, the impacts of noise on wildlife will remain as the residual impact of the project throughout the construction phase.

XII. Disturbance on movement of wildlife due to construction activities

Some of the wild animals such as the Himalayan black bear, porcupine, jackal, and civet and monkey species are seasonal crop raiders of agricultural fields and orchard farm. The construction activity will disturb the movement of these wild animals and birds as these are noise sensitive. The envisaged impact is adverse to the feeding habitat of the wildlife, but beneficial to the local communities.

Mitigation

The above impact will be residual impact of the project throughout the construction phase.

XIII. Impacts of Internal Access Road Upgrading and Operation

Impact

The internal access roads up to the powerhouse and headworks have been opened by the local communities as community dry season roads. These roads are earthen roads with poor gradient and curves. As these roads lack road side drains and cross drains, they could not be operated during the monsoon season. At number of locations, cut batter slopes of the roads are steep and unstable.

For the uninterrupted operation of these roads during construction and later during operation, these roads need upgrading which include improvement and upgrading of road formation width, gradient improvements, stabilization of unstable cut batter slope, construction of side drains and cross drains etc. All of these works, in fact, are the mitigation measures for the newly opened road corridor against land degradation and ensuring land stability of the road corridor *vis a vis* minimizing the anticipated erosion. However, haphazard management of the upgrading works could lead to unwarranted enhancement of erosion particularly related to side casting of the earthen materials while road grading and construction of side drains and cross drains.

Mitigation

To minimize the anticipated impacts following measures will be implemented.

1. Side casting of the spoil material will be prohibited and the spoil materials shall be placed at the designated spoil disposal sites
2. The spoil material generated in one section of the road will be used to filling at the other section of the road while grading the road surface to achieve the desired road gradient.
3. The cross drainage structure to bypass the runoff water of the side drain will be placed to natural drainage which has sufficient capacity to drain the accumulated run off.
4. In the agricultural fields, provisions will be made upon the prior consultation and arrangement with farmers to drain the slope water to the downslope agricultural land such that the water required for irrigation is not blocked.
5. Cleaning of the road side drains and other drainage structures regularly once before the onset of monsoon, twice during monsoon and once after the monsoon such that the drains are maintained to operate as designed and are not filled with the sediments collected from the side slopes.

The cost for the above mitigation measures is already included in the upgrading cost of the internal access road in the civil cost.

6.1.3.2 Operation Phase

I. Impact on the forest resources and wildlife due to increased accessibility including possibility of illicit hunting and poaching

There will be frequent movement of project vehicles, and public vehicles due to availability of the access road. In addition, there will be frequent gathering of people from distant as well as nearby regions to view the hydropower plant. As the establishment of permanent structures such as headworks, powerhouse penstock, camp sites and many portions of the access road will be on forest land, it is likely that the forest resources of the area could be exploited commercially. The illegal hunting and poaching of wildlife will also be a matter of concern. This impact will be indirect but significant.

Mitigation

1. Hoarding boards at critical locations will be placed and maintained to generate awareness to the visitors on the significance of forests and wildlife of the area and how an individual contributes in their protection and conservation. Estimated NRs100,000 is allocated for the measure as annual recurring cost.

2. Leasehold forest user groups and community forest user groups will be assisted for the protection and conservation of the forested areas. Estimated NRs.20,000 is allocated for the measure as annual recurring cost. (NRs.600,000 for 30 years)

II. Impact on wildlife due to possible fragmentation of habitat

As already stated, the project development site is not the prime habitat of the conservational or economical important mammals or any other animal life, and is used by wildlife for seasonal migratory route, occasional feeding purpose, or temporary habitat for social driven animals, etc. Given small footprint of the project on the forest areas, the impacts on fragmentation of habitats are considered insignificant.

Mitigation

Loss of forest land is permanent albeit of low magnitude. Compensatory measures have been included and agreed with community forest groups.

Summary of the predicted impacts for Otherenvironmental issues are presented in Table 6**..17**below.

Table 6.17: Summary of the Other Environmental Issues - Impact Prediction

SN	Other Issues		Direct / Indirect Impact	Extent	Duration	Magnitude
A	**Construction Phase**					
1	Potential for local air quality deterioration due to construction		D	L	ST	LO
2	Potential noise pollution in the surounding areas		D	L	ST	LO
3	Impacts due to stockpiling of construction material and muck		D	S	ST	M
4	Impacts on drainage pattern		D	S	LT	LO
5	Impacts due to operation of Quarry site and Borrow areas		D	S	ST	M
6	Impact on water resource and water quality		D	L	ST	H
	a	*Impact of Headwork Construction*	D	L	ST	H
	b	Impact of tunnel drainge discharge	D	L	ST	H
	c	*Impacts of aggregate washing*	D	L	ST	H
	d	*Impacts of the batching plant wastewater*	D	S	ST	LO
	e	Impacts of the disposal of used lubricants, grease, mobils, and toxic chemicals and seepage of petroleum products from the bunkers and mechanical yards	D	L	ST	H
	f	Impacts of wastewater from camps (kitchen wastewater and	D	L	ST	H
7	Impact due to solid waste generated in camps and construction		D	L	ST	M
8	Impact on structures due to blasting vibration and use of heavy equipment		D	L	ST	LO

SN	Other Issues	Direct / Indirect Impact	Extent	Duration	Magnitude
9	Encroachment in the surrounding forest	ID	L	ST	H
10	Impact due to illegal hunting, poaching and trade of fisheries	ID	L	ST	LO
11	Possible fire hazard on forest resources	ID	R	ST	LO
12	Impacts on wildlife and its habitat due to construction activities	D	R	ST	M
13	Disturbance on movement of wildlife due to construction activities	D	L	ST	M
14	Impacts of Internal Access Road Upgrading and Operation	D	L	ST	LO
B	**Operation Phase**				
1	Impact on the forest resource and wildlife due to increased accessibility including possibility of illicit hunting and poaching	ID	L	LT	H
2	Impact on wildlife due to possible fragmentation of habitat	D	L	LT	LO

Note: D = Direct, ID = Indirect, S= Site specific, L= Local, R= Regional, ST=Short Term, LT= Long Term, H = High, M=Moderate, LO= Low

6.1.4 Impacts not Covered by EIA Terms of Reference

The impacts covered by descriptions and discussions above (section 6.1.1, 6.1.2. 6.1.3) were as per the EIA Terms of Reference. There are a number of impacts related to the project but not covered by the EIA Terms of reference. These impacts and the required mitigation measures are presented in the sections below. In addition, impacts on community health and safety, occupational health and safety, and law and order that are described in section 6.1.4.3, 6.1.4.4, and 6.1.4.5 are also explicitly incorporated in SA and SAP reports.

6.1.4.1 Explosive Risks

A requirement of explosives for the tunnel construction could not be avoided. There is not only a need to export explosive materials from third country but also to provide adequate security to the explosive while transportation and during the storage. Explosives transport, delivery, and handling is totally regulated and controlled by the Government of Nepal under the Explosive Act. The security during transport and even in the storage yard and in the active construction site is provided by the Government of Nepal, however, arrangements for transport vehicle, permanent storage yard and temporary storage yard is the responsibility of the developer and the contractor. It is therefore the risk of the explosives to community while transportation and during storage is adequately handled by the government authorities and the envisaged impacts are insignificant.

However, the handling of the explosive in the construction sites is managed by the contractor workforce. Improper management of the explosives, particularly the leftover of the explosives, and unfired detonators and fuse wires can have a disastrous effect. Handling of the leftover detonators and fuse wires in the Middle Marsyangdi Project as ordinary solid waste caused big blast in the solid waste separation yard. No human loss occurred but houses close to the solid waste separation wards suffer heavy damages.

Mitigation

1. Contractor in co-ordination with the concerned government agency will arrange safe import of the explosives from the third country as per the Explosive Act provisions
2. Contractor in co-ordination with the government agency will arrange safe transportation vehicles equipped with emergency response measures for in road transportation of the explosives to the project sites.
3. Project proponent will allocate a safe area in consultation with the concerned government agency, away from the settlement area, for the safe storage of the explosives in bunkers.
4. The contractor will construct the safe bunkers as per the specification of the concerned security agency of the government in the area as provided by the project.
5. The contractor will arrange an explosive depot in the active construction site as per the specification of the concerned security agency of the government.
6. The contractor shall train the staff using explosive on the safety and security aspects of handling of the explosive including the leftover of unfired detonators, fuse wires etc.
7. The unfired detonators, explosives, and fuse wires will be collected separately as per the specification and handed over to the concerned security personnel of the government on site on a daily basis.

6.1.4.2 Traffic related Accidental Risks

Two types of vehicular traffics are expected in the area. One that brings construction materials from the south confined to the Mechi highway; and the other that facilitates day to day construction works confined to the construction site vicinity. The former traffic comprising heavy vehicles with high pay loads are slow moving. Expected vehicular traffic of this type will be a maximum of 30 to 35 in a day during the construction period in the Mechi highway corridor. The later traffic confined to the active construction sites comprises both light and heavy vehicles. Expected vehicle number in the construction site is more than 100. This traffic is also expected to frequently pass through the Mechi highway.

Since the Mechi highway corridor is not heavily congested with the traffic, the envisaged increment in the daily traffic numbers related to the project is not expected to cause congestions. The road being narrow is expected to slow down the vehicular movement particularly when the high payload trucks pass through the corridor in some sections. The speed of vehicle, particularly light vehicles related to the project and rash driving related to project construction works in the construction site, has potential of fatal accidents. Similarly, parking of the project vehicles by the side of the Mechi highway has potential to obstruct the other vehicles and sometimes lead to fatal accidents. The other effects of the fast moving project vehicles in the earthen roads is the fugitive dusts polluting the ambient air of the corridor to a distance of up to 100m from the corridor which is already discussed in section 6.1.3.1, I above.

Mitigation

1. Placing of hoarding boards along the Mechi highway indicating that the project construction is ongoing and the heavy payload vehicles related to construction works are on the move for precautionary driving to the other road users

2. Placing traffic signs at the critical locations of the Mechi highway and the project internal access roads
3. Placing signs for speed limits of the vehicles in the Mechi highway and the project internal access roads
4. Restriction on speed limits for all the project related vehicles in the Mechi highway and the project internal access roads
5. Restriction on the parking of the project vehicles by the side of Mechi highway and the project internal access roads
6. Arrangement for project vehicle parking at the construction sites and construction camps
7. Regular training and instruction to the project vehicle drivers on the safe driving
8. Project environmental officer will monitor the performance of the safe driving instructions, parking, and speed limit and report to the project management and contractor for immediate actions for non-compliance and the concerned will oblige to take the recommended action for compliance

6.1.4.3 Community Health and Safety

The project is expected to impinge upon the community health and safety due to four main reasons:

1. Project construction activity related pollution of air, water, and land
2. Project camps related pollution of air, water and land
3. Project traffic related accidents and
4. Transmission of disease from the influx of construction workforce from outside and influx of economic opportunity seekers from the project but not employed directly by the project.

Of the four, first three have been discussed from the pollution perspective in sections 6.1.3.1; I, II, III, V, VI, VII, and X. The pollution of the air, water, noise and land has a direct inter-relationship with the community health, for the people of the project areas are not exposed to levels of pollution that is expected during the project construction period.

Transmission of communicable disease such as STD, viral infections, malaria, from the outside workforce is of serious concern. The project areas during the construction phase is opportune areas for illegal prostitution activities because of the availability of disposable money and eager biological needs for persons living alone away from family. Possibility of transmission of HIV/AIDS is one of the critical silent issues related to health of the local communities as well. Apart from this epidemic outbreaks of communicable and water borne diseases is highly potential due to pollution of the water resources which might also affect the local communities. Congregation of a large number of people for various economic opportunities related to the project has potential to degrade the overall sanitation status of the area, particularly in the new market centers developed locally to cater to the services of the project workers. Uncared solid waste, use of polluted water sources in such areas is of a concern to the health and safety of the local communities.

Mitigation

1. Carryout pollution prevention of air, water, noise, an land as elaborated in sections 6.1.3.1; I, II, III, V, VI, VII, and X ;

2. Protection of water supply sources of local communities from pollution activities of the project
3. Barricading the project active construction sites by fences and guards at the entrance and exit to restrict local people without official permission to enter in the active construction sites to prevent construction work related accidents;
4. Minimize pedestrian interaction with construction vehicles through parking facilities, traffic signs, and posting traffic guards at critical locations;
5. Collaborate with local communities and responsible authorities to improve signage, visibility and overall safety of roads, particularly along stretches located near schools and market centers other locations where children may be present;
6. Collaborate with local communities on education about traffic and pedestrian safety (e.g. school education campaigns and community awareness programs);
7. Provision of first aid to stabilize the accident injured people;
8. Transport container of hazardous materials are labeled with the type of material and quantity along with shipment documents and chain of custody;
9. Elimination of water impoundment caused by construction works and in the local market areas;
10. Maintain sanitation conditions of the market areas servicing the construction workers in coordination with the market area communities;
11. Public awareness programs on STD, HIV and AIDS in collaboration with the local health posts;
12. Distribution of free condoms to the construction workforce in the construction camps on request;
13. Emergency plan for the control of diseases in the event of epidemic outbreak to ensure information disseminations on preventive actions, curative actions and medication services in coordination with local health posts;
14. Project environmental officer will monitor and prepare updated information on the community health issues related to project actions

6.1.4.4 Occupational Health and Safety

Hydropower projects involve wide ranging construction activities that have potential implications on the occupational health and safety. Occupation health hazards could emanate from the general conditions of the living environment and working area environment. Sometimes the ignorance of the workforce also leads to occupational hazards. Additionally, there are physical hazards, chemical hazards, fire hazards, electrical hazards etc. related to occupational health and safety. Failure to address the hazards and their potentials to impinge on the occupation heath could have a significant impact on the project construction schedules apart from the health of the construction workforce.

Mitigation:

The mitigation actions will include five basic elements i) elimination of hazard, ii) controlling of hazard, iii) minimization of hazard, iv) providing appropriate personal protective equipment (PPE) and v) treatment of patients. As the workforce management is largely controlled by the contractors, it will be the responsibility of the contractors to prepare an Occupational Health and Safety Management Plan based on the above elements, which among other shall include:

1. OHS training to the construction workforce on regular basis depending on the nature of job he /she is performing,

2. Firefighting training to groups of construction workforce working in areas potential of fire hazards

3. Hazardous chemical containment training to groups of construction workforce working in areas of hazardous chemical storage

4. Emergency preparedness training and drill operations on regular basis for firefighting, chemical containment, or evacuation to response the untoward emergency

5. Regular monitoring on the use of PPE by the construction workforce as required by the nature of a job;

6. Design and maintenance of living conditions of camps, and working environment related to ventilations, noise, indoor air pollutions, light, sanitation facilities, first aid medications etc.;

7. Provisioning of a health care facility with equipment, medication and health professional to stabilize the injured in the event of accidents and to respond to the epidemic outbreak in the camp or out in the community;

8. Provision of stand by ambulance in the active construction site to evacuate the injured and stabilize the health in the health care facility before he/she is transferred to the nearest hospital;

9. Establishment of a helipad close to construction site for emergency evacuation of the injured if so required.

6.1.4.5 Security related Law and Order Erosion

The project development site is a rural area, where everyone in the community knows each other by face and name. This in itself is an asset which automatically maintains the law and order in the local community. Once the construction work starts, a large number of people come into the area which may be project employee or outsider visiting project site for economic opportunities. Obviously, these will outnumber the people residing in the construction sites and its vicinity, which might psychologically or physically threaten the local law and order situation. Incidents of quarrels, burglary, gambling, teasing the local girls etc. are likely and potentially of a serious concern to the local communities. Apart from this, stealing of construction goods from the construction sites and storage area have occurred in the past at the ongoing projects and could be likely in this project area as well. The limited security personnel of the government may not be able to cope with the changed situation to maintain the law and order.

Mitigation

1. Prepare a code of conduct for the construction workforce and the project staff on how to behave with the local people of the project area, which besides others will include:

    - Respect to the local people their culture, traditions and women
    - Not indulge in any conflict with the local people
    - Not to gamble with the local community people
    - Not to drink alcohol outside the construction camps and roam local markets after consuming alcohol

2. Co-ordinate with local security agency to increase the security force in and around the construction sites to watch the security situation and take needed action to the defaulters.

3. The contractor will employ its own security personnel to protect the construction goods at the camps, active construction sites and in the storage area. Preferably local retired military and police personnel will be employed in such security posts in co-ordination with project VDCs authorities.

Summary of the predicted impacts for environmental issuesnot covered in the EIA TOR are presented in Table 6.18below.

Table 6.18: Summary of the Impact Prediction onEnvironmental Issues not covered in the EIA TOR

SN	Other Issues	Direct / Indirect Impact	Extent	Duration	Magnitude
A	**Construction Phase**				
1	Explosive Risk	D	S	ST	L
2	Traffic related accidental risks	D	L	ST	L
3	Community health and safety	ID	L	ST	M
4	Occupational health and safety	D	S	ST	H
5	Security related law and order erosion	ID	L	ST	M

Note: D = Direct, ID = Indirect, S= Site specific, L= Local, R= Regional, ST=Short Term, LT= Long Term, H = High, M=Moderate, LO= Low

6.1.5 Kabeli Corridor 132 kV Transmission Line Project (KCTLP) Impacts

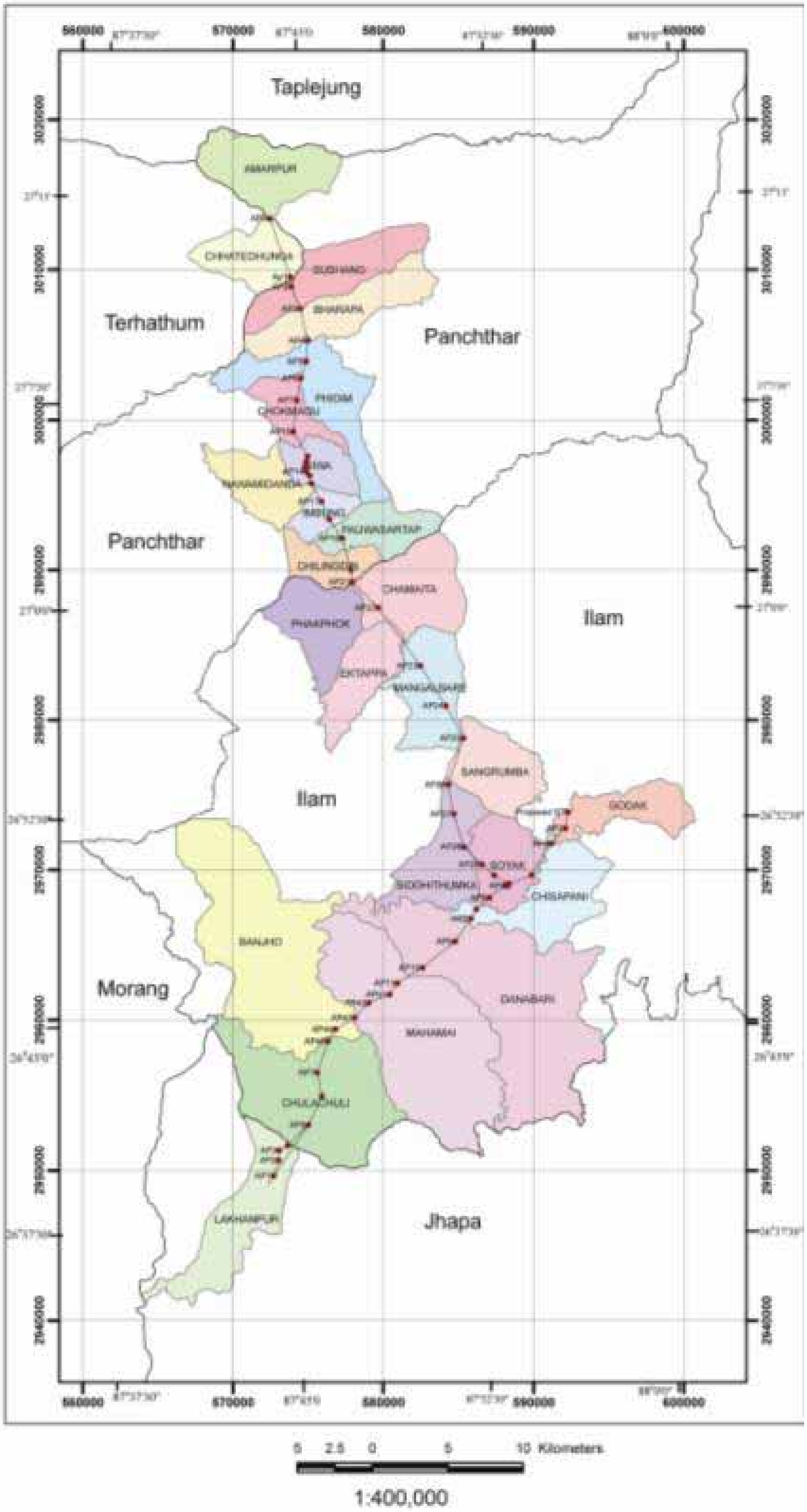
The proposed Kabeli Corridor transmission line project funded by the World Bank is envisaged to provide transmission line facility to the licensed hydropower projects of the eastern region including the KAHEP to be developed in the immediate future. A separate IEE/EIA study for this transmission line project was conducted by NEA in compliance with the government of Nepal statuary environmental legislation and the World Bank policy and operational directives. This project has been given environmental clearance from the government of Nepal and the World Bank and is under construction planning in the near future. The key environmental impacts of the transmission line project are briefly summarized hereunder in the context of the KAHEP development.

The proposed transmission line is a 132 kV double circuit line with a line length of 83.74 Km. It consists of a bear conductor of size 326.1 mm^2. Total tower estimated for the transmission line is 287 with 55 angle towers. Right of Way (ROW) of the transmission line is 18m. There are 4 associated sub-stations for the transmission line located at Damak, Illam, Phidim and Kabeli.

The transmission line passes through 25 VDCs of 4 districts namely Terhathum (*Chattedhunga),* Panchthar (*Amarpur, Shuvang, Bharapa, Phidim, Chokmagu, Siwa, Nawamidanda, Imbung, Pauwasartap & Chilingden),* Ilam *(Phakphok, Chamaita, Ektappa, Mangalbare, Sangarumba, Siddhithumka, Soyak, Godak, Chisapani, Danabari, Mahamai, Bajho & Chulachuli) and* & Jhapa

(Lakhanpur). It starts from 132/33 kV sub-station at Sabitra Chowk of Lakhanpur VDC in the Terai and extend north east through Chaju Khola at the foot hills of Chure and across Chure mountains into the valley of Mai Khola in the Mahabharat and Midlands. From Soyak, it bifurcates into two branches: the short one extending north east from Soyak up to Godak 132/33 kV substation (Setuwabesi, Godak VDC-3) and the longer one extending north-north-west from Soyak up to Amarpur 132/33 kV substation (Pinasighat, Amarpur VDC-9) in the northern part of midland zone (Figure 6.7).

Figure 6.7: Districts and VDCs across KCTLP



The key environmental impacts identified for the projects are:

- Land use change and restriction in approximately 155.057 ha of land
- Impacts of electromagnetic fields
- Forest land fragmentation

- Loss of 59.26ha of forest area including 19.472 government forest, 23.801 ha community forest and 15.981 ha private forest
- Loss of 18877 seedlings, 7191 saplings, 10494 poles and 3317 trees worth NRs. 1,03,58,250.00 @ NRs. 30 / plant for 3,45,275 trees
- Bird Hits particularly across the waterways
- Weeds encroachment in the transmission ROW
- Loss of 96.415 ha of private land permanently belonging to 914 households
- Loss of 6.98 ha of private land temporarily during construction belonging to 55 households
- Loss of 23 built structures worth NRs 80,50,000 including 18 permanent structures and 5 temporary structures
- Loss of standing crops in the permanently occupied areas and in the land use worth NRs.86,32,387
- Impacts on occupational health
- Impacts on community health and hygiene

To minimize the envisaged impacts and to maximize the beneficial impacts, the project has augmented following **mitigation measures** as under:

- Cleared area will be replanted and ground clearance activities will be limited to trimmings of the tall standing trees prarticularly in the steep slopes.
- The spoil materail generated will be managed properly and sidecasting on the side slopes will be controlled.
- Tower foundations sites will be further re-examined from the stability point and excavations along tower foundations will be minimized to the required depth only.
- The loss of forest land use due to clearance of tall trees along ROW wil be compensated by the compensatory afforestation programs.
- Standing trees and vegetation along ROW particularly in the hilly terrian will not be cleared untill and unless the clearance is necessary and the clearance area will be planted by NTFP species of lower heights.
- Agricultural land use will be allowed for agricultural purpose.
- Except in the sub-station heavy machinery will not be used for construction and noise producing construction activities will be carried out in the day time zone only.
- Liquid and solid waste will be collected in safe area and disposed safely . Spent oils, mobils, and other chemicals generated will also be safely collected in drums and disposed as per the advice of the engineers.
- Toilets in the camps and active construction sites will be constructed as per the requirement to prohibit haphazard defecation.

- Regular sprinkling of water will be done at the consatruction sites to minimise the fugitive dust emissions.
- Fuel wood will be replaced by the subsidised kerosine or LPG at the camp sites.
- Good earthing in all the pylon structures, regular trimming of the trees will be provisioned to reduce the impact and effects of electromagnetic fields.
- Additionally, an awareness program will be also launched to further avoid and minimize the impacts on the safety issues to the communities along the ROI of transmission corridor..
- Control the workforce on the damage on the vegetation structure and punish those who indulge on such activities.
- Use of bird flight diverters across to increase the visibility of the conductors to avoid the bird hits particularly across the waterways.
- Erection of barricade around the tower foundations and substation sites and uses of thorny protuberances around pylon to divert wild animals and to restrict climbing along the pylon.
- The loss of land and property, price of the standing crops, fodder tress, fruits trees will be compensated at the market price.
- The household will be provided with salvation of the demolished material and transportation cost will be provided to transport salvaged material.
- Extra Discomfort allowances for 6 month rental and livelihood subsistence will also be provided to those whose house is demolished.
- NTFP enhancement training will be given to the forest community user groups and NTFP plantation will be encouraged in RoW.
- The lost community resources due to the project will be compensated as per the forest guideline 2006.
- Telephone and electricity users will be given prior information regarding the disruption of the services and services will be re-established once the cable stringing is completed.
- The affected households will be given priority in the project job. The job gender discrimination will be avoided. Priority will also be given to the female members and members of the indiginous, tribal and vulnerable groups in the job, enhancement and training program.
- The construction workforce will be regularly instructed to respect female member of the community, local people and their traditions and culture.They will be instructed to remain within the camps and not to enter into the private premises without informing or without the permission.
- The local law and order authorities will be regularly informed about the construction planning and sites of construction works and ativities In case of construction related work force impacts, the project will support the schools of the project affected VDCs,
- Health and safety plans will be prepared and operationalised for the entire period of construction to safeguard the health and safety of the construction workforce.

- The construciton workforce will be instructed about the risk of the constrction works regualrly and will be provided with protective equipments.
- First aid kits will be provisioned in all working sites.

Environmental Management Plan (EMP) has been prepared for the KCTLP to set out environmental management requirements and to develop procedures to ensure that all mitigation measures and monitoring requirements will be carried out in subsequent stages of project development. To ensure that the recommended mitigation and monitoring actions are duly implemented, monitored, assessed, evaluated and disseminated to the stakeholders for feedback and improvement, the KCTLP, PMO will establish a separate Environmental and Social Unit (ESU) of its own The ESU will comprise of two sub-units, namely Environmental and Social Implementation Sub-unit (ESISU) and Environmental and Social Monitoring Sub-unit (ESMSU).

6.2 BENEFICIAL ISSUES

This section highlights the beneficial impacts due to implementation of the project. Beneficial impacts are also discussed in SA and SAP reports in detail.

6.2.1 Construction Phase

I. Employment opportunity for skilled, semi-skilled and unskilled local population

The project requires about 600 to 800 numbers of skilled, semi-skilled and unskilled workforces on a daily basis for 4 years during the construction period. The policy of the project is to provide maximum job opportunities to the local area people in the construction related jobs. As most of the competent population of the area is in search of jobs and there is a strong demand for job opportunities on the proposed project, the local people will benefit. While allocating job opportunities to the locals, the following preferential order will be followed:

- Directly project affected people (whose land and property are affected by the project)
- Indirectly project affected people (with houses close to the project site)
- Project VDC people – *Dalit* and *Adivasi Janajati* are preferred than high caste groups
- Project District people - *Dalit* and *Adivasi Janajati* are preferred than high caste groups
- Citizen of Nepal - *Dalit* and *Adivasi Janajati* are preferred than high caste groups

II. Improvement of local economy/potential of micro-enterprises and small industries

KAHEP is a large construction project and involves a huge number of construction workforces (600 to 800 on a daily basis) for a period of about 4 years. The construction work force will require a variety of service facilities and consumer goods produced locally as well as from outside of the project area. Fresh vegetables, fresh fruits, milk and milk products produced locally will be in high demand. The local farmers of the project area producing these products will, thus, benefit. Tea shops, grocery shops, restaurants, fast food will be the major source of income to the local people. Besides, other micro and small industries such as dairy, poultry & livestock farming, furniture, tailoring, etc. could be established by the local people themselves to meet the requirements of the construction workforce. The project will incorporate programs to assist local farmers in the commercial production of local agricultural produces by training, distribution of improved seeds, or technology transfer etc. The cost estimates are included in a separate Social Action Plan (SAP) report.

III. Potential Improvement of public facilities and infrastructures

The project has a plan for environmental enhancement for the project affected VDCs, which includes support to water supply facilities, educational institutions, health care institutions, road network developments, and community forests right from the start of the project construction. The above programs are envisaged to help develop local infrastructures and social services in the project impacted VDCs helping the local people to improve their quality of life. The cost estimates are included in a separate SAP report.

IV. Potential exposure of the local population to new technologies and technology transfer

The Project has a plan of launching training programs for local people through environmental enhancement measures in specialized area such as house wiring and maintenance, slope stabilization, bio-engineering, spoil handling, masonry, gabion wires weaving, construction of dry walls & gabion walls, carpentry, welding etc. These trainings will confer technical skills and know-how to local construction workers that will help them to obtain employment opportunities in other construction projects especially hydroelectric as many hydroelectric projects are going to be constructed in the region. The cost is included in a separate SAP report.

6.2.2 Operation Phase

I. Positive impact on the rural economy due to electricity royalty

As per the provisions in the government regulations, 50 % of the total royalty obtained from the sale of hydroelectric produced will be allocated to the affected Development Region, out of which 12 % will be allocated to the affected District Development Committee (DDCs) for local development. As per the hydropower policy (2001), the project affected VDCs are part of rural electrification that will envisage the increase of the rural economy and are entitled to 1% of the royalties received by the affected DDCs.

II. Decrease in load shedding due to implementation of the project

Despite its high potential for hydropower, Nepal has not been able to harness its water resources for the overall development of the country. Though Nepal initiated its water resource development for hydropower since 1911, it has been able to harness only about 600 MW in the last 99 years, while its proven hydropower potential is estimated to be around 42,000 MW. Currently, the country is facing an acute shortage of electrical energy due to the increasing demand of around 8 to 10% per annum, while the annual hydropower energy input in the national grid falls short of the demand due to unexpectedly slow pace of the hydropower development. As a result, the country may expect a load shedding of 12 hours a day in the winter season. The implementation of the proposed KAHEP will generate 201.0 GWh of hydroelectricity per year and feed into the national grid and simultaneously, will help to decrease the present load shedding.

III. Opportunities for Hydroelectric Development

The implementation of the proposed KAHEP will add up 201.0 GWh of hydroelectricity into the national grid per year. As the rivers of the project site have high potential of hydroelectricity development, many investors will be motivated to invest in hydropower projects in the region. The construction of the transmission line and access roads of the proposed project could be utilized by other hydropower developers to develop new hydropower projects nearby the project site.

IV. Changes in local economic activities

The royalty provided to the project affected VDCs will increase the implementation of the development activities in the project area, which in turn, will improve the economic activities of the project area. Furthermore, many enterprises and industries could be opened in the area due to the availability of electricity thus enhancing the local economic activities.

V. Changes in micro and macro economy

With the increase in the economic activities, the local area micro economy will be drastically changed. Currently people are practicing subsistence agriculture for livelihood. There will be a shift in the agriculture practice from subsistence to commercial farming. Many people will establish cottage industries based on local resources as electrical energy will be available for the industries. This will bring a substantial change in the macro-economy of the entire district. Dependency on agricultural activities will be minimized by the introduction of industrial and service oriented enterprises in the local area.

VI. Development of new infrastructures

With the implementation of KAHEP, as the wheel of local economy moves forward, many new infrastructures in the form of access roads, transmission lines, communication networks will be developed from the locally generated economic resources by the people.

VII. Basis for rural electrification

As per the Hydropower Policy (2001), the project affected VDCs are entitled for 1% of the royalties out of the total allocated royalties for the affected DDCs received from the project by the government for local development. That includes rural electrification as well, which will increase the rural economy of the affected VDCs.

Chapter VII: RAPID CUMULATIVE IMPACTS ASSESMENT AND PROPOSED MANAGEMENT MEASURES

7.1 BACKGROUND

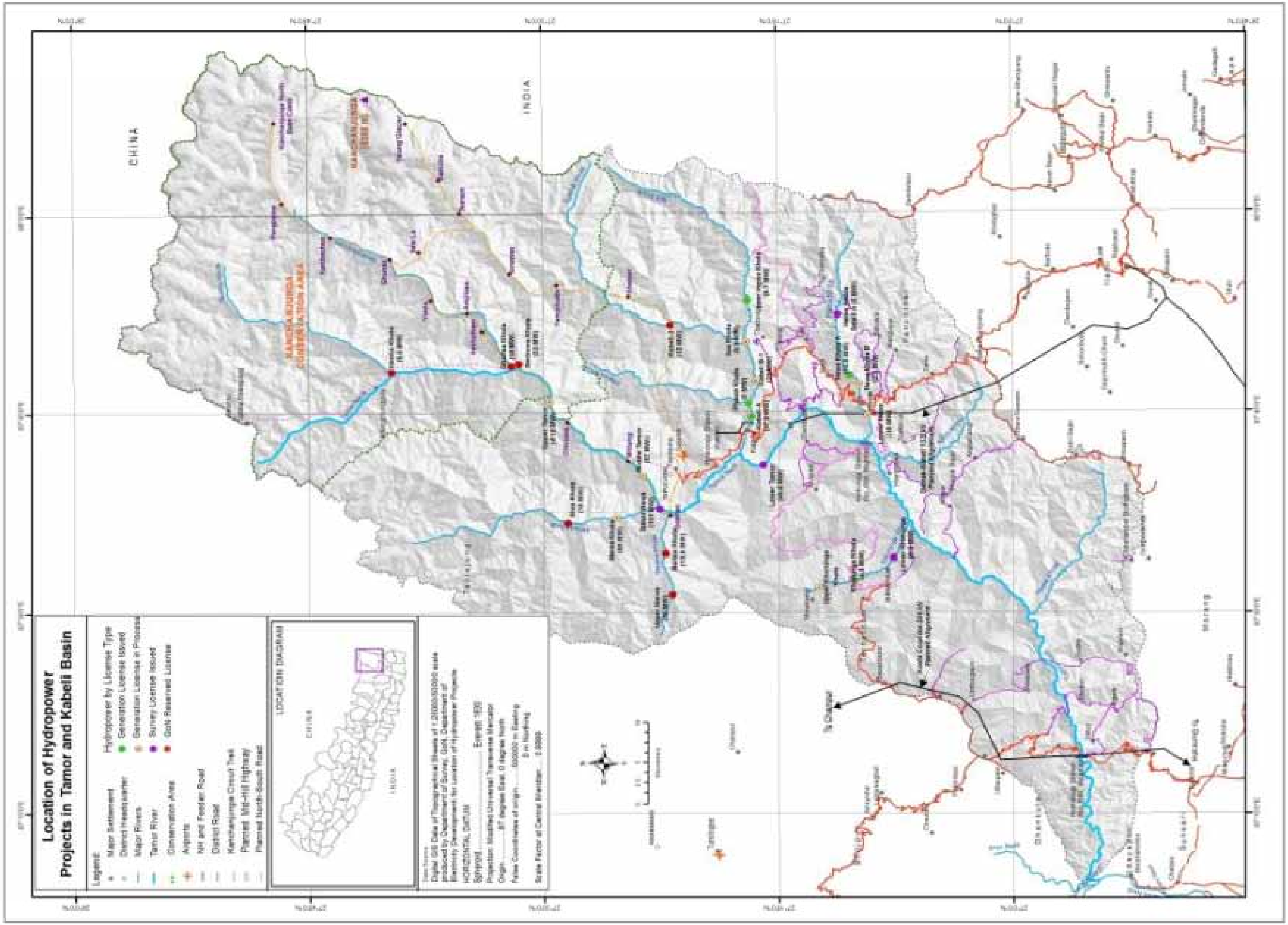
Over 1996-1997 the Government of Nepal (GoN) carried out a comprehensive screening and ranking process of 138 potential hydroelectric projects. In the late 1990s the sector formally opened to private sector developers, resulting in a rush from individuals and companies applying for a hydropower development license in Nepal. Annex 7.1 describes the licensing process currently followed by the Ministry of Energy (MoE).

As illustrated in Figure 7.1, there are nine major basins where the theoretical hydropower potential of 83,000 MW is concentrated.

Figure 7.1 – Location of the Kabeli-A HPP as it relates to all major watersheds of Nepal

As of June 21, 2013, the DOED had issued 24 licenses for hydropower development in the Tamor-Kabeli basin. While the likelihood of all of these projects materializing in the near future is still uncertain, if they were all to be constructed and operated, the potential cumulative impacts in the Tamor-Kabeli watershed would be unprecedented for Nepal (Figure 7.2).

Figure 7.2 – Layout of hydropower projects with government, survey and construction licenses
(This figure also includes projects that the GoN has reserved for development in the future as well as the transmission lines)



7.2 OBJECTIVES

The concept of Cumulative Impact Assessment and Management (CIA) is new to Nepal. The GoN and the related concerned Ministries and Departments (Ministry of Energy, Ministry of Science Technology and Environment, Water and Energy Commission Secretariat, Department of Electricity Development, etc.) do not legally require CIA as part of the EIA process.

However, in response to the requirements from a potential financier, the World Bank Group (the IDA and IFC), KEL has undertaken Rapid Cumulative Impact Assessment (RCIA) to assess potential cumulative impacts related to the KAHEP. This RCIA has an ultimate goal of identifying: (i) issues that KAHEP, when placed in the context of existing, planned, and reasonable predictable developments in the future, may generate; or (ii) cumulative effects initiated by KAHEP that could jeopardize the overall long term environmental, social and economic sustainability of the watershed. Preparation of this RCIA involved consultation with local experts, government officials, and international CIA practitioners; advice from an independent international freshwater fish ecology expert who has worked in Nepal for several years; collection of additional fish and water quality data; and an extensive literature review.

KAHEP is committed to manage the significant potential cumulative impacts identified by the RCIA by:

- Including in its Environmental Management Plans (EMP) the mitigation measures to appropriately manage its contribution to any potentially significant cumulative impacts (please refer to section 7.10 and Chapter 8, on proposed mitigation measures included in KAHEP's EMP); and
- Work with the WBG, GoN and other stakeholders to design a governance mechanism that would allow for the appropriate development, implementation, enforcement, supervision and monitoring of a basin-wide approach to the environmental and social management of the cumulative impacts (please refer to sections 7.10 on Proposed Management Strategy and 7.11 on Complementary Studies).

To implement the second part, the proposed project includes a separate US$2 million Technical Assistance component for the Ministry of Energy (MoE). This Technical Assistance is to increase GoN's capacity to manage the potential cumulative impacts and risks, and carry out any additional basin-wide studies that are necessary to design additional measures to manage potential cumulative impacts at the Tamor-Kabeli watershed level. The main components of this Technical Assistance are summarized in Box 7.1.

Box 7.1: Components of the IDA Technical Assistance to the DOED

Component	Budget (USD)
1. TA for supervision of KAHEP to ensure compliance with PDA.	300,000
2. Capacity Building of GoN agencies and financial institutions in hydropower development	200,000
3. Capacity Building on Social Aspects • Development of implementing guidelines for resettlement, community benefit-sharing mechanisms, monitoring and evaluation etc. • Strengthen capacity of regulators, project developers and consultants by offering short and medium term training	500,000

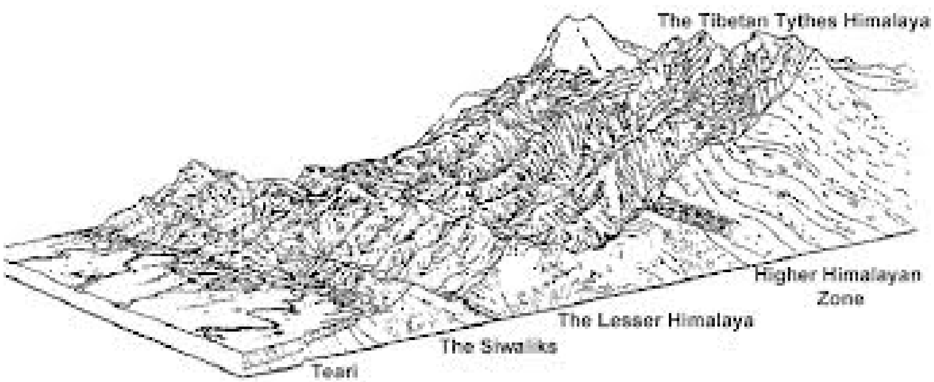
4. International Workshop on "Integrated River Basin Management For Sustainable Hydropower Development"	Trust Fund (TBD)
5. Additional Basin-wide Studies to Manage Cumulative Impacts in Kabeli-Tamor Watershed	600,000
6. Capacity Building on Environmental Aspects • Review of existing guidelines for hydropower sector • Develop supplementary guidelines on specific topics such as Minimum Ecological Flows; Watershed Management; Sediment Management etc. • Strengthen capacity of regulators, project developers and consultants by offering short and medium term training	400,000

7.3 TAMOR-KABELI WATERSHED GENERAL CONTEXT

The KAHEP is located in the Kabeli River about 5.6 kilometers upstream from its confluence with the Tamor River. The Tamor is a major river in eastern Nepal and forms part of the Koshi River system. It has a total length of 198 km and has a drop of nearly 5,850 m from its head to the confluence with Arun at Tribeni. The average river gradient is 0.0295 (Shrestha H.M. 1983). The Tamor is a snow fed river and its hydrology is influenced both by monsoon rains and snowmelt. It originates from the Kanchenjunga area, home to Mount Kanchenjunga, the third tallest mountain in the world (8,586 meters). The Tamor and the Arun Rivers join the Sun Koshi at Tribeni to form the larger Sapta Koshi[15] River network which flows through the Mahabharat Range and finally on to the Gangetic plain in India.

The Tamor River basin covers four out of five physiographic regions of Nepal within a 200 km north to south direction and with elevation differences from 66 to 8,586 m above sea level. These physiographic regions are shown in Figure 7.3 and described below:

Figure 7.3 – Physiographic regions of Nepal



High Himalayan region: This region is always covered by snow with altitudes ranging from 3,000 to 8,586 meters (Mt. Kanchenjunga). The mountains are very steep with active glacier systems. The Tamor River catchment has a number of glacial lakes with a history of glacial lake outburst floods (GLOF). The GLOF of 1980 originating from Lake Nagma Pokhari had a flood surge reaching 20 m above the riverbed of Yangma Khola. It is estimated that the peak flow at Yangma Khola was about 8,500 m^3/s decreasing to about 3,300 m^3/s at the gauging station 690 at Mulghat. The geology consists of gneiss, schist, limestone and shale of different ages. Physical weathering predominates and soils are very stony. This region falls largely within the alpine and arctic climate regimes, so there are active

[15] The Sapta Koshi River is a network of seven major rivers flowing through the Koshi River basin. All the seven rivers, namely, the Tamor River, the Arun River, the Dudh Koshi River, the Likhu River, the Tama Koshi River, the Sun Koshi River, and the Indrawati River, from east to west, originate from the High Himalaya. Among the tributaries, the Sun Koshi-Bhote Koshi, the Tama Koshi, and the Arun River originate in Tibet.

glacier systems where there is enough precipitation in high catchments. The climate is dependent on elevation and location in the mountain massifs. Characteristic landforms are glaciers, cirque basins, moraines, U-shaped valleys and avalanche slopes. Bedrock in most of the areas is exposed at or near the surface including gneiss, schist and the Tethys sediments. Less than 1% of the region has soil and climate suited to crop production, only where irrigation is available.

High Hills (or Mountain) region: The altitude of this region ranges from 2,000 to 2,500 m and it lies below the permanent snow line. It has a cool climate and receives heavy to moderate snow in winter. Mountain slopes are very steep but there are some flat valleys as well. Phyllite, schist, gneiss, and quartzite of different ages characterize the geology. Soil formation on the slopes is slow and they are rocky. This region borders the Middle Hills to the south and the high Himal to the north. Gneiss and garnetiferous mica schist are common. High river gradients and enhanced river down-cutting resulted in the formation of deep canyons since glaciation. Agriculturally this region is of lesser importance. After the snow melts, the mountains are covered with thick grasses and livestock like sheep, yak, and other mountain animals graze in this region. In the valleys, one crop a year (in summer) is harvested. The Kanchenjunga Conservation Area (KCA) is located within this region, and it is described under the *Protected areas, biological hotspots and forest* section below.

Middle Hills (or Mountain) region: This region includes a wide range of physiography. Mountain peaks range up to 2,000 m with narrow river valleys. The mountains are the Mahabharat range. The geology consists of a complex of phyllite, schist, quartzite of Cambrian to Precambrian ages and granite and limestone of different ages. The climate ranges from warm subtropical to warm temperate. The higher peaks receive occasional snow whereas some lower parts receive occasional frost in winter, which causes damage to crops. Soils are extremely variable because of the differences in bedrock, geomorphology and microclimate. The southern margin mostly consists of a prominent belt of uplifted mountains known as Mahabharat Lekh. This belt is made up of deeply weathered granite, limestone, dolomite, shale, sandstone, slate and quartzite; it is intensively cultivated and is home for more than 60% of the population. Subtropical dense forest occupies the non-agricultural land. The dam and the powerhouse of the Kabeli-A hydropower project is located in this region. Tamor river fisheries are dependent upon the habitats (spawning and rearing) provided by rivers like Kabeli flowing through this region. The mean annual precipitationover the Project area is estimated to be 2,135 mm.

Siwalik region: This region lies at the foot of the Mahabharat range. Altitudes range from 300 m to 1,800 m. The geology mainly consists of tertiary mudstone, sandstone, siltstone and conglomerate. Soils vary depending on the materials from which they are developed. There are several inner valleys or duns, which are densely populated. Because of alluvial deposition, these valleys are very fertile. The landscape is very rugged and unstable, consisting of weakly consolidated Tertiary sediments with gentle to strongly sloping dip slope. Siwalik soils are unable to retain high precipitation, which frequently occurs, resulting in flash floods. The Tamor River emerges from the Middle Hills into the Siwalik region.

The Terai region: Altitudes range from 66 m to 300 m in the lowest physiographic region of Nepal, the Terai. Although the Tamor basin does not include the Terai, the Tamor river does flow into the Sapta Koshi, which ends up in the Terai. The Tamor River introduces huge amounts of sediments into the Sapta Koshi River, supplying important nutrients for the fertile lands of the Terai region.

Protected areas, biological hotspots and forests

There are two important biological hotspots in the Tamor-Kabeli watershed: the Kanchenjunga Conservation Area (KCA), and Tinjure Milke Jaljale/Guranse Danda (TMJ) Forest, which provide biological diversity such as unique rhododendron forests, rare and endangered wildlife and bird species, medicinal and aromatic plants as well as spectacular panoramic views of the Himalaya range:

Kanchenjunga, Makalu, and Kumbhakarna. Both KCA (25 km aerial distance from KAHEP) and TMJ (10 km aerial distance from KAHEP) are in a remote mountainous region and are accessible only by trekking over steep mountainous terrain from the KAHEP site: at least two days to KCA and one and half days to TMJ.

The Kanchenjunga Conservation Area: The KCA is the main protected area in the watershed and is located in the Taplejung district, in the high hills region, at an altitude of 2000-2500 m. The landscape of the KCA comprises cultivated lands, forests, pastures, rivers, high altitude lakes and glaciers. It has an area of 2035 km^2 representing high mountain physiographic regions, as follows: rocks and ice (65%); forests (14.1%); shrubs (10.1%); grassland (9.2%) and agricultural land (1.6%). The KCA comprises some of the most stunning scenery in all of Nepal and is a global hotspot for plant biodiversity, with twenty-three species of rhododendrons growing in the area. Rich forests support more than 250 species of birds and endangered wildlife. KCA is well known for its three river valleys (Simbua Khola, Ghunsa, and Tamor valleys) and has a lot of ethnic diversity and cultures. Approximately 5,000 people of about 11 ethnic communities live in the area.

In 1998, the Department of National Parks and Wildlife Conservation (DNPWC) joined WWF Nepal to launch the Kanchenjunga Conservation Area Project (KCAP) in an effort to help ensure sustainable management of the region's pristine ecosystem. KCA Management Council (KCAMC) was formed with the support of WWF Nepal in April 2003. In August 2006, the cabinet of the GoN passed a resolution to hand over management of KCA to the KCAMC.

Tinjure Milke Jaljale/Guranse Danda (TMJ) Forest: The GoN is in the process of declaring the TMJ Guranse Danda Forest a protected forest that lies within the Tamor watershed. The TMJ ridge borders Taplejung, Terhathum and Sankhuwasabha districts. This is an area well known for its biodiversity, and is one of the largest natural rhododendron forests with the highest number of rhododendron species in the world. The TMJ represents middle and high mountain landscapes between two successfully protected areas of Nepal, KCA and Makalu-Barun National Park (MBNP) and is a popular tourist destination for mountaineering, trekking and rafting. It represents important global eco-regions including Eastern Himalayan Alpine Grasslands and Shrubs and Broadleaf Forest. It harbors more than 250 plant species including 17 endemic, nine endangered and 14 threatened species. Faunal diversity of the area includes rare, endangered and threatened species of mammals like snow leopard (*Unciauncia*), leopard cat (*Felis bengalensis*), clouded leopard (*Neofelis nebulosa*), musk deer (*Moschus chrysogaster*), pangolin (*Manis species*), etc. The TMJ landscape maintains contiguity/ connectivity and a wildlife corridor between the MBNP and the KCA.

Other areas of ecological importance: Besides the protected areas described above, the main forest areas in the basin are located in the more remote parts, at higher altitudes/ridges/upper mountain slopes, and steep valley slopes, particularly along/near riverbanks. Based on the altitude, the types of forests in the basin include subtropical, temperate, sub-alpine and alpine forests. Subtropical forests below 2,000 m are: *Shorea robusta* – the dominant forest in the lower altitudes along the river valleys, and *Schima-Castanopsis* – the dominant forest in the upper subtropical range. The temperate forest is between 1,900 and 3,000 m, and may include East Himalayan Oak-Laurel forests at 1,900 – 2,600 m, and rhododendron and mixed rhododendron–maple forests at 2,600 – 3,000 m. The sub-alpine forest is between 3,000 and 4,000 m, and is rich in medicinal and aromatic herbs, and non-timber forest products (NTFPs), some of which have a very high market value. The NTFPs also have food and medicinal values. The alpine forest lies between 4,000 and 5,000 m and comprises dwarf rhododendron scrub and alpine meadows.

Furthermore, even though it is not yet widely exploited, the Tamor River is a fair river for white-water rafting. With the river's steep canyon walls in the upstream reaches and powerful and continuous rapids along the river stretch, rafting activities would have amazing views of Mt. Everest, Mt. Kanchenjunga and Mt. Makalu.

7.3.1 Current Developmental Status of the Tamor-Kabeli Watershed

As the watershed develops, linear infrastructure such as highways, roads and transmission lines have already started landscape fragmentation. As of today, development activities in the Tamor-Kabeli basin have been ad-hoc and mostly guided by individual efforts of interested groups and developers. Hydroelectric power is the only sector where some level of government regulation is currently in place, but even this level has been limited to providing hydropower development licenses.

The Sapta Koshi basin, which includes the Tamor-Kabeli watershed, has a theoretical hydropower potential close to 22,350 MW[16]. There are only two projects under operation, the Sunkoshi (10 MW) and the Khimti (60 MW); the Upper Tamakoshi (456 MW) is under construction. These are the only major hydropower plants in the Sapta Koshi basin, but there are also some mini-hydroelectric power plants. Among numerous water resource projects in the basin, perhaps the best known is the Koshi Barrage, a bi-national multipurpose irrigation, flood control and hydropower generation sluice project across the Koshi River in Nepal, near the Nepal–Indian border, some 170 km south of the Kabeli project site. It was built between 1958 and 1962 and has 52 gates controlled by Indian officials as per the Koshi treaty. As of today, the Tamor basin has no major hydropower plants or dams in operation. However, the Koshi barrage, as the first structure constructed on the Koshi River, has probably already created a barrier to long distance fish migration in the larger Koshi basin, including the Tamor-Kabeli river systems.

Other sectors have no known development plans for the near future. Planning initiatives of the local bodies (including District and Village Development Committees – VDCs) are limited to resolving immediate needs of the communities (related to water supply, trail development, extension of rural motorable roads, small irrigation, etc.) and lack medium to long term strategic objectives.

Knowledge of the current environmental and social conditions at the basin level is limited, but there seems to be wide and unregulated natural resource extraction by local communities, including a recent increase in illegal fishing using electric shock and poison. Most of the secondary information available covers the district administrative boundaries, which do not coincide with the natural basin boundaries.

Modern development and infrastructure works, so far, have been limited and therefore have generated only limited impacts on the natural environment. Rural roads supported/constructed by the districts and the earthen roads opened on community initiatives of the basin VDCs, have in recent years added to erosion, downstream sedimentation and changes in land use, including some isolated cases of economic displacement of affected people. Mechi Highway, passing approximately north-south through the Tamor basin and through the southern border of the Kabeli basin, has also had limited impact on land use, forest resources and soil erosion. The planned Mid-Hill Highway[17] corridor passes approximately east-west through the Tamor and Kabeli basins. The increased access due to highways, if unmanaged, is expected to further increase resource extraction for livelihood. As of today, opening of new highways in the region has created unplanned market centers that provide access to much needed commodities to local people, but at the same time has resulted in new settlement and population encroachment along the highway. These encroachments not only generate additional

[16] Source: South Asia Trade and Energy Security, The Role of India, Narottam Banskota.

[17] The Mid-Hill Highway is a recent announcement of the central government; its full length does not exist at present. There are some existing east-west road sections in the mid-hills. The plan is to upgrade the existing road sections and construct new sections, hence connecting existing and new road sections to make an east-west Mid-Hill Highway of Nepal. An initial road corridor has been identified. Some of the east-west existing sections of the proposed road are within the Tamor basin. The remaining sections to complete the future Mid-Hill Highway still need to be defined and constructed. Currently, there is no firm plan for completing the sections.

sources of domestic pollution (e.g., garbage, waste water) but increase pressure on the existing natural resource base (e.g., water supply, land, forests, fish, etc).

A coherent integration of the highway projects with other agricultural/horticultural based cottage industries along with the new hydropower development projects may help local communities reduce their reliance on unregulated and unsustainable exploitation of natural resources, diversify sources of livelihoods, and slow down or reverse the current environmental degradation trend of the basin. This will also reduce pressure on the Kanchenjunga Conservation Area, which as stated above, is located within the Tamor-Kabeli watershed.

7.3.2 Future Development Projections for the Tamor-Kabeli Watershed

Future development in the Tamor-Kabeli watershed can be broadly divided into three groups:

1. Hydropower Development
2. Transmission Lines
3. Other Development Sectors

7.3.2.1 Hydropower Development

Considering the license status and difficulties with financial arrangements, the KAHEP will probably be the first hydropower plant to be developed in the Kabeli River and likely to be one of the few, if not the only new project to be constructed in the Tamor Watershed in the next 5 to 7 years.

As of June 21, 2013, DOED had issued 24 licenses to hydropower developers in the Tamor basin, which are in various stages of development. These projects range from 2 to 415 MW, totaling 918 MW. These licenses are grouped into the following three categories:

- Projects that have obtained a generation or construction license: The Government has awarded 13 licenses totaling 648 MW in the Tamor basin. Four of these are in the Kabeli River, including the KAHEP (Table 7.1 and Figure 7.4).
- Developers who have obtained survey licenses and are working towards getting a generation license: Currently there are four projects, totaling 165 MW (Table 7.2).
- Projects that the Government has reserved for future development: When a license is cancelled, the project automatically goes into a basket that is reserved by the Government. In this category, there are seven hydropower projects, totaling 105 MW. It is unclear whether the Government will develop these projects or offer them to potential private developers (Table 7.3).

Table 7.1- Projects with a generation (construction) license (as of June 21, 2013)

	Project	Capacity (MW)	River	Status of license	Developer
1	HewaKhola – B	2.3	Hewa	license in process	Panchathar Power Company P Ltd.
2	IwaKhola	9.9	Iwa	license in process	Rairang Hydro Development Co Pvt. Ltd
3	Kabeli B-1	25	Kabeli	license in process	Arun Kabeli Power Limited
4	Lower Hewa	10	Hewa	license in process	Mountain Hydro Nepal (P.) Ltd
5	MewaKhola	50	Mewa	license in process	United MewaKhola Hydropower Pvt. Ltd
6	Middle Tamor	57*	Tamor	license in process	Tamor Sanima Energy Pvt. Ltd
7	Upper Tamor	415**	Tamor	license in process	Tamor Sanima Energy Pvt. Ltd
8	Upper Khoranga	6.8	Khoranga	license in process	
9	HewaKhola A	14.9	Hewa	license obtained	Panchthar Power Company Pvt. Ltd.
10	Kabeli-A	37.6	Kabeli	license obtained	Kabeli Energy Limited
11	KhorungaKhola	4.8	Khoranga	license obtained	Reliable Hydropower Company. P. Ltd
12	PhawaKhola	5	Phawa	license obtained	Shiwani Hydropower Company
13	Upper IngwaKhola	9.7	Ingwa	license obtained	Ingwa Hydopower Pvt. Ltd.

Source DOED 2013

* Developer has applied for a downgrade from 57 to 54 MW

** Developer has applied for a downgrade from 415 to 280 MW

Table 7.2 -Projects with survey license issued (as of June 21, 2013)

	Project	Capacity (MW)	River	Status of license	Developer
1	Lower Khorunga	5.5	Khorunga	license obtained	IDS Energy Pvt. Ltd
2	Lower Tamor	49.5	Tamor	license obtained	Shiva Gauri Hydropower Pvt. Ltd
3	TamorMewa	101	Tamor	license obtained	Spark Hydroelectric Company Limited
4	Upper Hewa	8.5	Hewa	license obtained	Upper Hewa Khola Hydropower Company

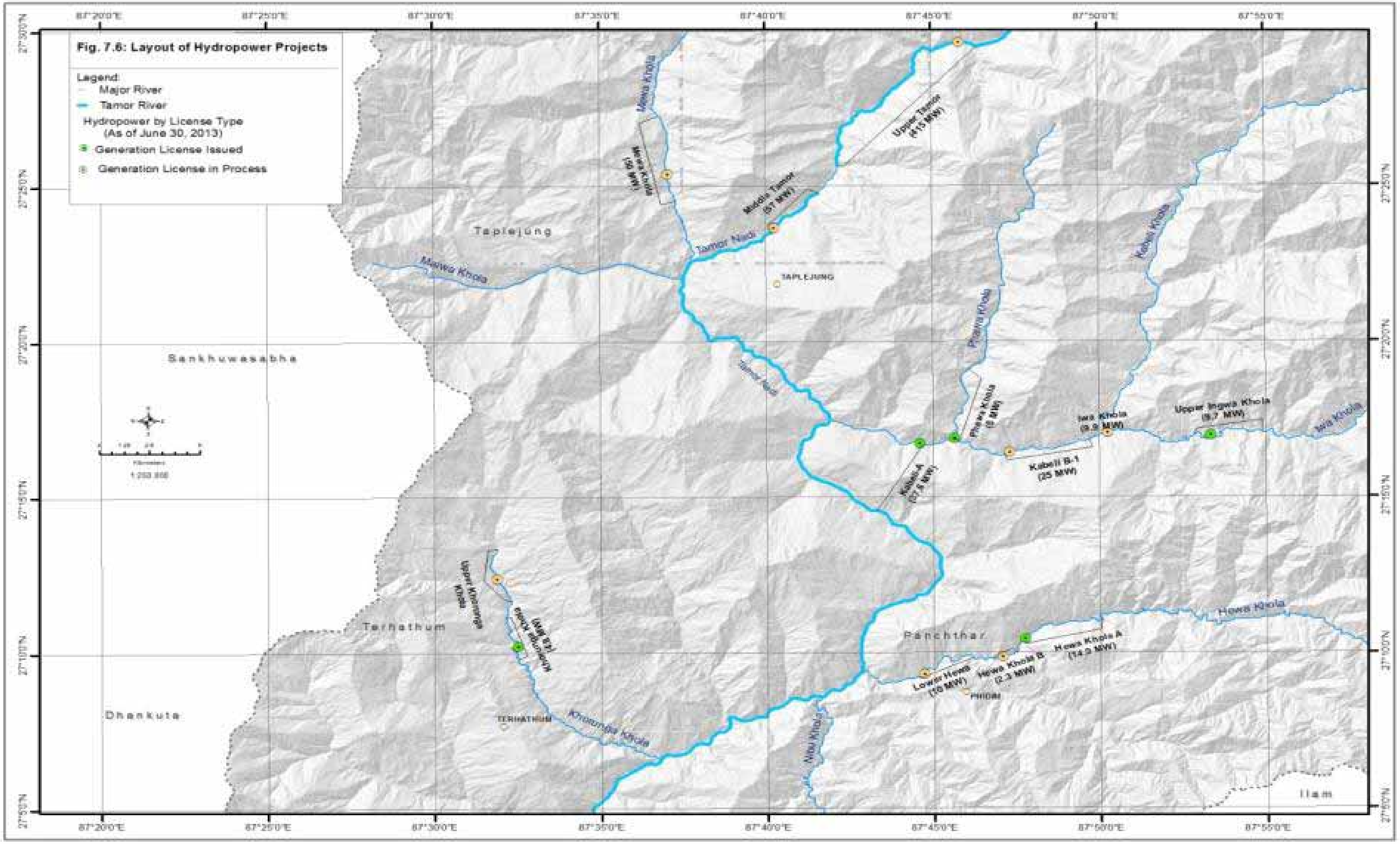
Source DOED 2013

Table 7.3 -Projects reserved by the Government of Nepal (as of June 21, 2013)

	Project	Capacity (MW)	River
1	GhunsaKhola	10	Ghunsa
2	Kabeli-3	12	Kabeli
3	MaiwaKhola	13.5	Maiwa
4	SimbuwaKhola	35	Simbuwa
5	SiwaKhola	15	Siwa
6	Upper Maiwa	10	Maiwa
7	YanmaKhola	9.5	Yanma

Source DOED 2013

Figure 7.4 – Layout of hydropower projects under Scenario 1, showing the expected dewatered sections



7.3.2.2 Transmission Lines

One of the bottlenecks for hydropower development in the Tamor basin has been the lack of transmission lines to connect the immense generation potential of the basin with major power consumption centers. Since there are no major electricity consumers in the direct area of influence, potential developers of hydropower in the Tamor basin would need to build transmission lines to evacuate power. Separate transmission lines would not only be financially unviable but also could potentially create significant cumulative landscape and soil erosion impacts. To avoid potential cumulative impacts of multiple transmission lines, and break the current hydropower development gridlock, the IDA is financing the Kabeli Transmission Line, which is under construction. This 132 kV double-circuit transmission line will connect Kabeli with the Lakhanpur VDC of Jhapa district in Terai, and thereafter the hydropower development activities in the Tamor basin should gain momentum, namely in the districts of Ilam, Panchthar, and Taplejung, including Kabeli basin.

The two transmission lines in the Tamor basin are the above 132 kV Kabeli Transmission Line, and the Koshi Corridor Transmission Line, with 220 kV capacity, which is still at a planning stage (Figure 7.2). The 132 kV Kabeli Transmission Line is designed for evacuation of electric power generated by potential hydroelectric power plants to be constructed by Independent Power Producers (IPPs) in the Kabeli, Hewa and Mai river basins. As noted earlier, this Project is funded by IDA. In addition to evacuating power from KAHEP, this line will also improve reliability and quality of power supply to the eastern region of the country, and provide ample transmission capacity to meet future needs from further generation in the KAHEP vicinity. This project also aims to improve the distribution grid, by constructing facilities to electrify 2.5 km on either side of the transmission line. The proposed transmission line alignment passes through 25 VDCs. The transmission line is 90 km long and will be connected with 4 substations. The 220 kV Koshi Corridor Transmission Line has been recommended by the Transmission System Master Plan to evacuate power from Arun HEP and other potential hydroelectric projects foreseen for the region. Approximately half of the proposed linear stretches traverse the ridge of the Tamor basin, crossing Tamor River at Mulghat and deviating from Basantapur towards Sankhuwasabha. It is unclear when this transmission line will be built.

It is important to keep in mind that as the above pipeline of hydropower projects consolidates, developers will need to build substations and transmission lines to connect with the two main transmission lines mentioned above. Therefore, even though these two main transmission lines will significantly reduce major negative cumulative impacts, the GoN still will need to assure strategic planning of the interconnecting local transmission line network, to maximize efficiencies and avoid unacceptable cumulative landscape visual impacts and habitat fragmentation.

7.3.2.3 Other Development Sectors

The road network has gradually expanded over the last decade. Currently there are three main roads planned by the GoN which are expanding into the basin (Figure 7.2): Mechi Highway, Koshi Highway and Mid-Hill Highway. Mechi Highway, beyond Ranke, is located within the Tamor basin, and is already constructed up to Taplejung district headquarters. The Mechi Highway is expected to be constructed up to the Tibetan border. The Koshi Highway, between Bhedetar and Basantpur, is located in the Tamor basin and a Bhedetar-Basantpur section of this highway has already been completed. Koshi Highway is also planned to be extended to the Tibetan border. A section of the Mid-Hill Highway, which was recently given priority by the GoN, passes through the Tamor basin between Basantpur-Myanglung-Kabeli-Ganesh Chowk-Chiyobhanjyang. A feeder road (F058) along the southern ridge (Bhedetar-Raja Pokhari-Kopche-Daregauda-Rabi) is also being gradually constructed. In addition to the GoN centrally-funded roads, there are also a number of local/ rural roads being built by the respective District Development Committees (DDCs) and Department of Local Infrastructure Development and Agriculture

Roads (DoLIDAR), which are generally guided by the District Transport Master Plans. Furthermore, there are numerous village/ community roads that are built by VDCs. All over Nepal, these village roads are often constructed with inadequate planning, design, and supervision.

Other developments include small-scale irrigation systems, water supply, industry, agriculture/horticulture, tourism, urban/market centers, and forestry. As of July 2013, there was no specific regional strategic development plan covering all the above areas in the basin. The GoN does not currently regulate existing or planning of developments in the above sectors. Therefore, it is difficult to predict any likely trends of potential cumulative impacts of the developments and their subsequent potential implications on future environmental and social conditions, such as land use, land stability, soil, water and air quality, and terrestrial and aquatic ecosystems, or on livelihoods of local communities.

7.4 LIMITATIONS

With the exception of the primary data collected as part of this EIA for KAHEP, this RCIA is based on secondary information and consultations with the GoN, local authorities, other developers, and primary researchers, as well as with the watershed management, fish and aquatic ecology international experts and knowledgeable individuals of the Kabeli and Tamor basins. Identification of valued environmental and social components (VECs), their status in the past, present and likely trends in the future, was based on existing scientific and local knowledge and in good faith.

Within the above constraints, the RCIA has flagged potential for significant cumulative impacts related to multiple cascading hydropower developments in the Tamor Watershed, including the Kabeli sub-basin. Therefore, the proposed management strategies are indicative and need further verification and refinement once the detailed complementary studies, proposed under section 7.11 below have been completed.

In addition, most of the selected VECs are concentrated in aquatic habitats. This RCIA has intentionally not covered potential cumulative impacts on the terrestrial and land use impacts for the KCA, the TMJ/Guranse Danda and forest resources. Any impact on these conservation areas will be mostly due to the induced linear infrastructure and the overall urban development of the area. The assessment of potential pressures on the KCA and TMJ go beyond the capacity of a single project developer as KEL, and any mitigation measures will need to be designed and implemented as part of a GoN led protected area planning and development effort. Any impact assessment of multiple hydropower development on the KCA and TMJ would be highly speculative; thus this RCIA provides only limited insight of potential cumulative impacts on the KCA and TMJ, and is mostly focused on aquatic and riparian aspects.

7.5 SCOPING: BOUNDARIES DEFINITION

7.5.1 Geographical Boundary

In December 2011, KEL commissioned a stand-alone Cumulative Impact Assessment, which tried to anticipate those environmental and social cumulative impacts that KAHEP, in combination with the other existing, planned and reasonably predicted activities, could potentially cause in the Kabeli River basin. As a result and in consultation with the WBG and other international CIA practitioners, watershed resource management and fish experts, in March 2013 KEL decided to expand the geographical boundary of the analysis, to cover the whole Tamor-Kabeli watershed. Therefore, this updated RCIA covers the latest information on various licenses issued (both survey and generation) for hydropower projects for the whole Tamor-Kabeli catchment area and available information on the status of highways, roads, transmission lines, trekking routes, irrigation, protected areas, and national forests.

7.5.2 Temporal Boundary

As noted above in section 7.3.2.1, as of June 2013 there was a total of 24 hydropower projects at different stages of development in the Tamor-Kabeli watershed. Given the difficulty of predicting if and when some or all of these developments will indeed materialize or be dropped, this RCIA has considered three potential scenarios:

- Scenario 1 – assumes that all projects in Table 7.1 will materialize. Thirteen projects with a construction license reach financial closure, are constructed and are commissioned within the next 15 years. This scenario includes the 37.6 MW KAHEP, which will be the first project, with construction to start in late 2013 and operations in 2018.
- Scenario 2 – assumes that in addition to the 13 projects in Scenario 1, all projects that currently hold generation licenses will be constructed and commissioned by 2030.
- Scenario 3 – assumes that all 24 projects (including those with government-reserved licenses) will be constructed within the next 50 years.

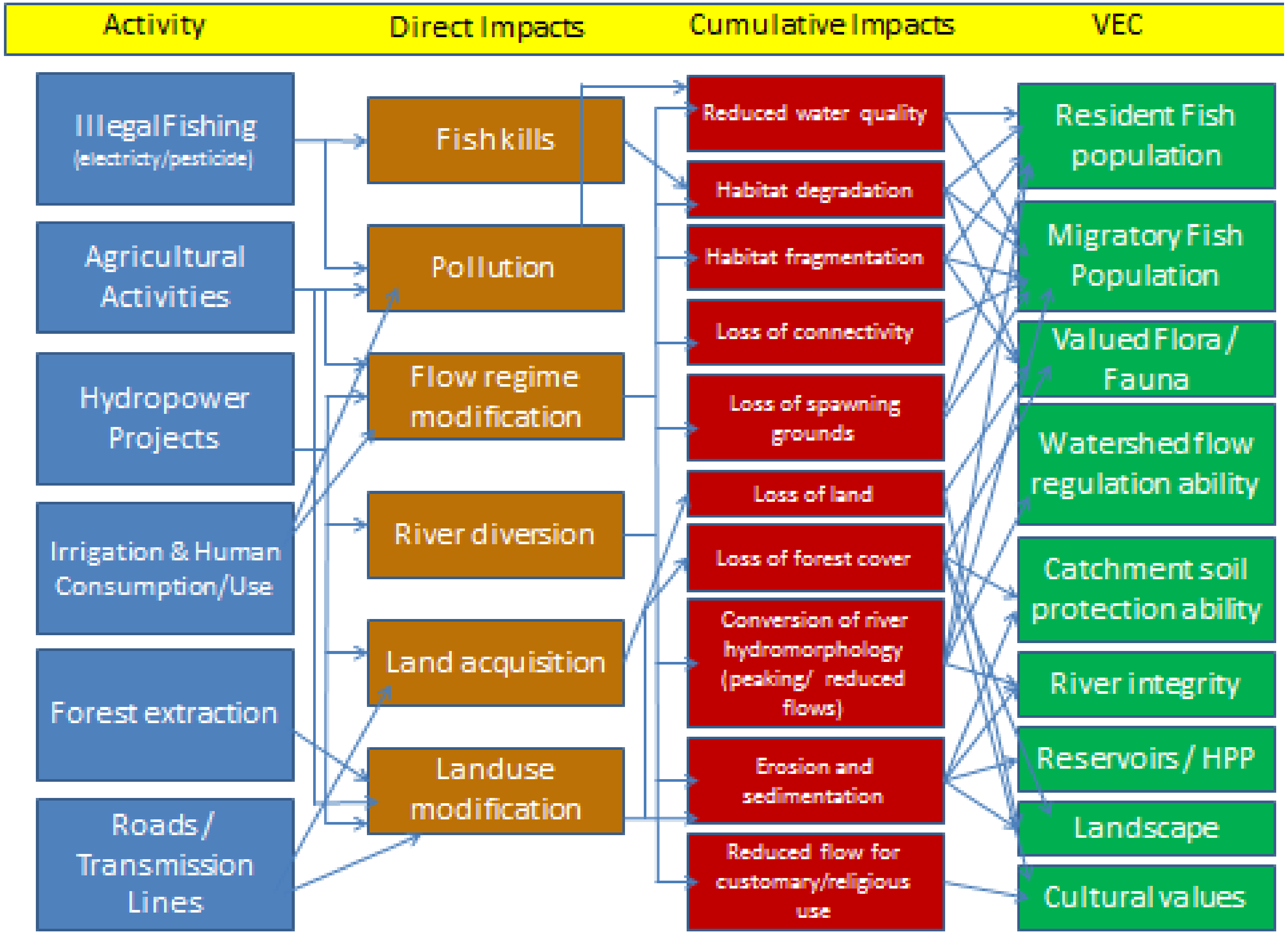
Since Scenarios 2 and 3 are still uncertain and any cumulative impact assessment at this stage would be highly speculative, this RCIA will concentrate on Scenario 1, and define a temporal boundary limited to the next fifteen years. It is expected that any cumulative impacts associated with projects considered under Scenarios 2 and 3, will essentially be incremental to those of the Scenario 1. Therefore, it would be expected that the GoN will require that any project developed under Scenarios 2 and 3 follow those mitigation measures designed under Scenario 1 to manage cumulative impacts at the watershed level.

7.6 DEFINITION OF VALUED ENVIRONMENTAL AND SOCIAL COMPONENTS

As part of the original CIA performed in December 2011, KEL undertook a rigorous and extensive consultation process to define, together with relevant stakeholders, which VECs were likely to be significantly affected or be the most sensitive receptors to the potential cumulative impacts under Scenario 1. Even though this initial effort concentrated on the Kabeli sub-basin, there is no evidence that the affected VECs would be any different for the whole Tamor watershed. However, a second consultation process involving stakeholders for this expanded geographical boundry – Tamor-Kabeli watershed – will be conducted during implementation of the Technical Assistance component of the IDA operation.

Figure 7.5provides a schematic representation of the cumulative impacts expected from multiple cascading hydropower developments in the Tamor basin, when placed in the context of existing and reasonable foreseen future activities.

Figure 7.5 – Tamor Watershed: General schematic illustration of expected cumulative impacts resulting from cascading hydropower development and other present and foreseen activities



To identify and agree on the VECs for the Kabeli basin, in December 2011 KEL organized a one day scoping workshop where key knowledgeable individuals were invited. Focus group discussions took place, consultants guided a discussion on different VECs present in the basin, and participants commented on and rated them relative to their degree of importance. Table 7.4 lists all the different VECs identified by this multistakeholder group for the Kabeli basin. Participants in this VEC selection scoping session are presented in Annex 7.2.

Table 7.4: Valued Environmental and Social Components of Tamor-Kabeli Basin

Feature	VEC	Concern
Physical Environment	Air quality	Community health, visibility
	Noise	Community health, disturbance to wildlife
	Surface water quality and quantity	Shortage of water for water supply, water mills, irrigation; aquatic life/fish; community health; religious, sprital and other cultural uses
	Groundwater	Community health, shortage of water supply
	Landslide/erosion and sedimentation	Damage to agriculture, infrastructure, housing structures, etc.
	Land Use	Land use change resulting in loss of productive agricultural land, forest land, pasture/grass land, etc.
Biological Environment	Fish and fish habitats	Decline in the fish population, further decline of the following target species: • *Schizothoraichthys progastus* (Chuche Asala) • *Schizothorax richardsoni* (Buche Asala) • *Neolissocheilus hexagonolepis* (Katle) *Pseudecheneis sulcatus* (Kabre) • *Tor putitora* (Sahar) • *Tor tor* (Sahar) • *Bagarius yarrelli* (Goonch) • *Clupiosoma garua(Jalkapoor)* • *Labeodero* (Gardi) • *Anguilla bengalensis* (Rajabam)
	Amphibians	Paha (small – lower river section, and larger – in the upper river section) valued highly
	Terrestrial Ecosystem/Vegetation	Loss of forested ecosystem which is already dwindling; loss of medicinal plants (limited knowledge/study, traditional knowledge-base eroding, over harvesting and illegal harvesting on rise); Khair, Simal, Sal, Salla, Chattiwan (all medicinal plants) rapidly declining
	Wildlife and Wildlife Habitats	Habitats already fragmented and wildlife declining: Leopards (Chituwa) common in the past are rare now; various types of wild bees common in the past rapidly declining; Aringal ko Chaba very rare now; Chiple Kira in the upper catchment declining; Mayur (Lower valley sections) rapidly declining due to habitat loss

Feature	VEC	Concern
Socio-economic and Cultural Environment	Socio-economic	Agriculture land of the Tamor-Kabeli basin is highly productive and is the food bowl of the area. Loss of land to development in the valley may have serious implications for local food security apart from rehabilitation and resettlement of the affected people. Other concerns are: ▪ Community growth – in-migration and change in demography; ▪ Constraints in local supply and demand; ▪ Implication for service facilities – water supply, health, education, etc.; ▪ Implication for law and order; ▪ Implication for community health – occurrence of unknown new diseases; ▪ Employment opportunities – local/outsiders; ▪ Business opportunities – local/outsiders; ▪ Employment income ▪ Education and training; ▪ Substance abuse; ▪ Wilderness – loss of wilderness; ▪ Traffic and noise – increase in traffic and noise; ▪ Tourism enhancement; and ▪ Industrial developments
	Local Food and delicacies	▪ Kabre fish and Asala fish are local delicacies and are already declining; ▪ Chyang (a kind of locally brewed beer) is an alcoholic breverage used in the festivals – might be replaced by foreign alcohols – loss of local beverage production; ▪ Fish fingerlings of Tamor are the special delicacy taken together with chyang – possiblity of over exploitation by development workers and other outsiders
	Culture and aesthetics	▪ Kabeli is a river of spritual significance– interference and dewatering in some stretches might impinge on its spritual importance; ▪ People of the region take a holy bath in the river before visiting the Pathibhara shrine of the region – interference and dewatering in some stretches might impinge on this; ▪ There is a belief that the meat of the sacrificied animal should not be taken across Kabeli, so people consume all meat before crossing Kabeli – interference and dewatering in some stretches might impinge on this; ▪ Temples and shrines at the banks of Kabeli and Tamor are considered to be of high spritual significance – interference and dewatering in some stretches might impinge on this; ▪ There is a belief that cremation of a dead body in Kabeli will raise the dead person to heaven –

Feature	VEC	Concern
		dewatering and diversion of water might impinge on this; ▪ Modification of dominance dynamics of people from different cultures. The Lepchas were the people living in the Kabeli valley in the past, who have now been replaced by Rai and Limbu cultural groups; ▪ Traditional activities – people might abandon their traditional activites (agriculture/festivals such as the rice harvest dance - Dhan Natch - and others) to work on hydropower projects; and ▪ Cross-cultural sensitivities – tensions and conflicts related to culture and traditions

Among residents of the Tamor-Kabeli basin, the most valued VECs were those related to maintaing fishing resources in the rivers. As mentioned in previous chapters there are 10 target species of importance. Kabre is a fish species connected to the folklore tradition of the region, and there is a belief that the name of the Kabeli River has its origins in the Kabre fish, thus reflecting a long lasting connection between the river and this fish. However, the fish populaion in the Kabeli is rapidly declining in recent years due to poisioning, electric shocks, overfishing, and pollution. It must be noted that during the field sampling performed as part of the baseline generation for this EIA, only a single Kabre fish was captured in the 2013 sampling.

Secondly, another important concern associated with the Kabeli River is its cultural and spritual value to local communities. Culturally and spritually Kabeli has its own significance to the local communities and is regarded as the most holy river by the people of the region. In that context, the water quantity and quality of the Kabeli River are extremely important to local people, as it is a source of spiritual cleansing in religious rituals, including burial ceremonies.

As a result of the scoping exercise, in consultation with stakeholders, international experts and WBG advisors, this RCIA will concentrate on the VECs listed in Table 7.5.

Table 7.5: Selected Valued Environmental and Social Components

Feature	VEC	Valued feature to focus management strategies
Physical Environment	Surface Water Quality and Quantity	• Ecosystem and environmental services integrity: long term temperature (T^oC), Dissolved Oxygen (DO), Total Suspended Solids (TSS), microbiology, natural patterns should remain within acceptable limits; • Enough quantity/quality of water to satisfy present and future consumptive human uses (e.g., domestic, irrigation, others)
	Landslide/Erosion and Sedimentation	• Erosion control: watershed sediment load retention/ regulation capacity should not be degraded;

		and ideally, it should be improved
Biological Environment	Resident and Migratory Fish Population	• Basin-wide aquatic connectivity: fish upstream and downstream migration should not be impaired; • Suitable habitat availability: foraging, spawning and cover habitat for indicator fish species should be maintained
Socio-economic and Cultural Environment	Spiritual and Religious	• Riparian flow regime: adequate quantity, quality, depth and velocity of river flow should be maintained to avoid disruption of existing cultural, spiritual and/or religious practices by local people
	Landscape	• Landscape/ habitat fragmentation due to multiple and overlapping access roads and transmission lines should be avoided

All other identified VECs were ranked as of lesser imporance to the consulted stakeholders. However most of them have an intricate relationship with the riparian ecosystem integrity and preservation of local livelihoods. As noted above, these VECs are not expected to be significantly different once the geographical boundry for the analysis has been expanded to the Tamor watershed.

7.7 SELECTED VEC BASELINE STATUS

7.7.1 Surface Water Quality and Quantity

The water quality of the Tamor River is good as the river is still fairly pristine. As the area is still devoid of industrial activities, there is no discharge of industrial effluent into the river. However, water quality tests for the Tamor River have not been conducted as part of this assessment. Rural activities, including agriculture wastes, animal and human defecation, and surface run-off from the catchment area, are non-point sources of water pollution. Secondary sources of information indicate the following water quality parameters for Tamor river[18]: water temperature ranges between 16.0-19.0^{o}C, DO ranges between 9.7-10 ppm, pH ranges between 7.3-7.5, total hardness between 28.5-34.2 mg/l, and conductivity between 37.7-56.7 µs/cm. But, as open defecation was seen along the river banks, some level of microbiological contamination of the water is highly probable.

As noted in Chapter 4, three samples of Kabeli River water at the project site (upstream of the dam, downstream of the dam and the dewatered section) were analyzed to assess river water quality. The overall chemical water quality of the Kabeli River is good. There are no industries discharging effluents in the river directly. However, activities like open defecation and use of water for different domestic purposes like bathing and washing utensils are common among the settlements along the riverbank and the river water is likely affected by microbial contamination. The river water in the dry post- and pre-monsoon season (October through May) is clear with low or negligible suspended sediment load. The sediment load significantly increases during the monsoon season from June to October.

[18] These tests were conducted in May-July 2009 - cited in the *Nepal Journal of Science and Technology 10* (2009): 219-223.

As also noted in Chapter 4, Kabeli River is one of the tributaries of Tamor River, which is one of the major rivers of the Sapta Koshi Basin. The contribution of the Kabeli River to Tamor River hydrology at the powerhouse site is about 25% of the average annual flow, but its contribution in the dry season flow (March to April) is nearly 30%. Dry month mean monthly flow of the Kabeli (refer Figure 4.3, Chapter 4) is estimated as follows: November (25.25 m3/s), December (16.18 m3/s), January (10.31 m3/s), February (8.63 m3/s), March (8.88 m3/s), April (13.30 m3/s) and May (31.63 m3/s). Similarly, dry month mean monthly flows of the Tamor River at powerhouse site are estimated as follows: November (81.9 m3/s) December (52.5m3/s), January (39.1m3/s), February (32.3m3/s), March (31.4m3/s), April (45.2 m3/s) and May (96.2 m3/s).

7.7.2 Landslides/erosion and sedimentation

The Himalayas are young, rapidly uplifting, and eroding at one of the highest rates in the world. Combined with steep slopes, present and past glaciation, high rainfall intensities due to the monsoon, and sparse vegetative cover, the Himalayas have high erosion rates and the rivers witness high sediment transport rates in all five physiographic regions (see Table 7.6) of Nepal. The Greater Himalayas are sparsely populated and human impacts there affect erosion rates to a lesser extent. These regions are still covered extensively by glaciers that supply downstream regions with large inputs of sediments. Human activity often exacerbates and accelerates natural processes of erosion, and its potential impacts have been the central tenet of the Theory of Himalayan degradation. While the deleterious impacts of road building, vegetation removal, and soil compaction through agriculture may be self-evident, there have been few studies to quantify the hypothesized increase in erosion due to such activities. Despite documentation of road construction increasing erosion rates, there is no quantitative estimate of how much more sediment is contributed to the catchment from the increased landslides caused by road building (Heimsath 2005).

Table 7.6: Physiographic Regions of Nepal and their general characteristics

Physiographic regions	Propor-tion of Nepal	Number of land system units	General elevation (m.a.s.l.)	Description
Terai	14	3	60-330	recent post Pleistocene alluvial deposits forming a piedmont plain
Siwaliks	13	5	<1000	semi-consolidated Tertiary sandstone siltstone, shale and conglomerate
Middle mountains	30	4	<2500	dominantly Precambrian phyllite, quartzite, schist, granite and limestone
High mountains	20	3	<4000	Precambrian metamorphosed gneisses and micaschist
High Himalaya	23	2	>3500	dominatly glaciated bedrock surfaces of gneiss, schist, limestone and shale.

The Tamor basin is located primarily in the four regions – High Himalaya, High and Middle Mountains, and the Siwaliks. Given the typical characteristics of Himalayan terrain, there is natural risk of landslide and erosion in the Tamor basin because of the steepness of the slopes, the ruggedness of the terrain and the fragile and complex geology of fault lines, combined with heavy rainfall during monsoon.

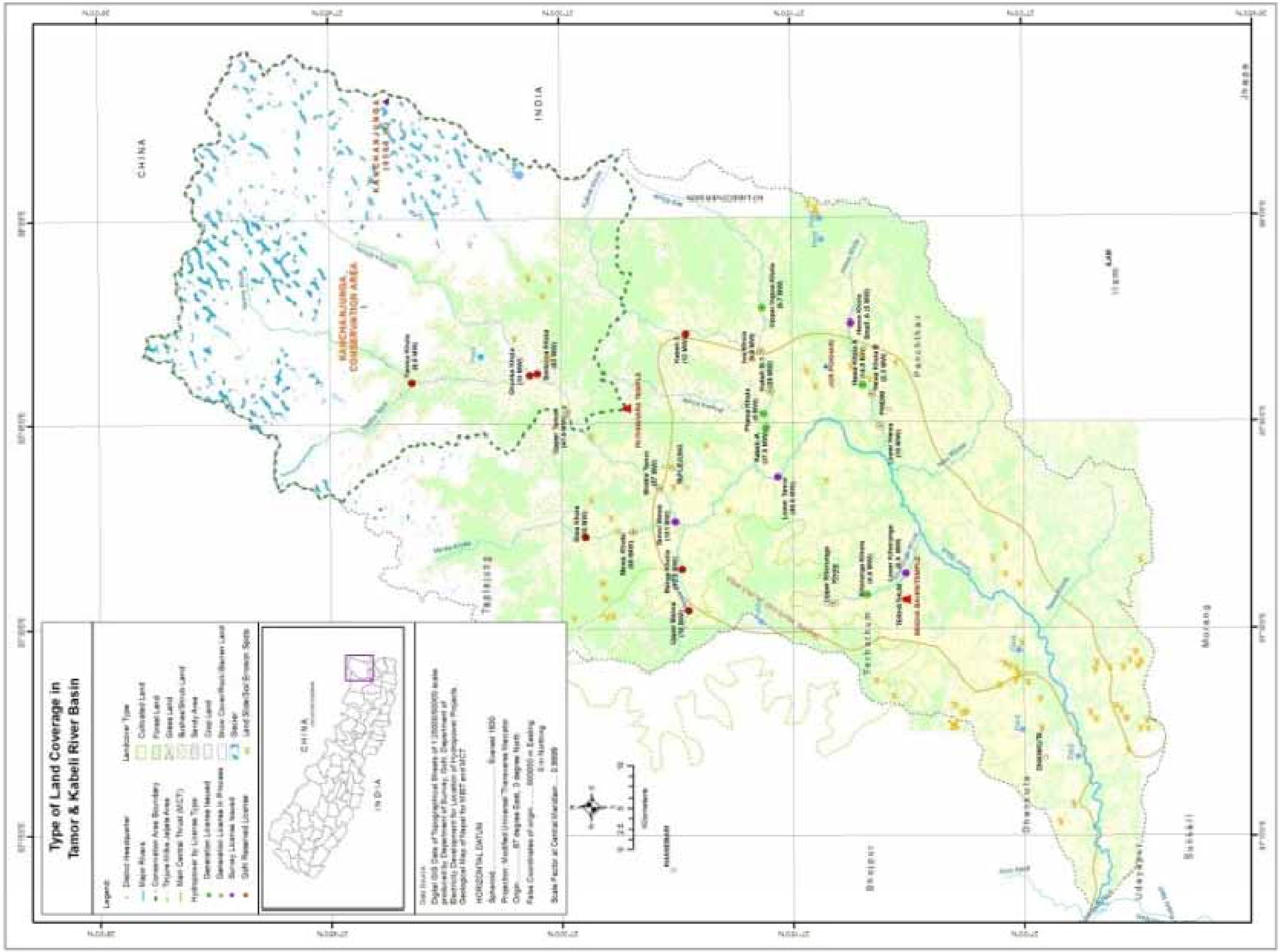
Geomorphologically, the Tamor basin is still in the formative process. The steep mountain slopes, particularly the valley slopes and the upper middle hillslopes, reflect the geomorphic dynamism of the area related to the mountain building tectonic activities. The general topographic forms reveal periods of active tectonism and tectonic quiescence. The two and three level terraces in the Tamor valley and one or two level terraces towards the mouth of the tributary valleys reveal periods of tectonic quiescense and a high degree of sediment deposition whereas the steep mountain valley slopes, particularly the vertical topographic breaks between the alluvial terraces (Tars) are the product of high degrees of active tectonism related to the Himalayan uplift and active riverine erosion. The gentler lower Middle, and upper Middle Mountain slopes reflect stabilisation of the landforms and mostly represent stabillised pre-historic landslide areas. The unstable features like landslides, debris flows, gully erosions and rill erosions are the key erosional features within the Tamor basin. The monsoon rains and their intensity are the main factors influencing erosion in the mountaineous slopes as well as along the riverine areas. Areas of instabilities and landslides are more visible and pronounced along the Main Central Thrust (MCT). Existing landslides are concentrated in the vicinity of the MCT, in the southwestern and northwestern parts of the basin (Figure 7.6).

As indicated in Chapter 4, the general landuse in the project area is dictated by the geomorphic forms of the area. The alluvial tars of the valley, and the lower and Middle Mountain slopes are extenssively used for agriculture and human settlement. The steep valley slopes and High mountain slopes are either under forest cover or are very steep, represented by bare rocks with thin soil development. Natural risks of landslides and erosion have been further aggravated by human interventions such as slope disturbance due to deforestation, land use and cover modifications and construction of linear infrastructure (Figures 7.4 and 7.5). Several rural roads are being constructed across the basin with GoN grants allocated to each VDC. These village roads, which were initially supposed to be labor-based, are now being constructed with bulldozers and excavators without any engineering design or supervision, nor any basic erosion or pollution prevention and control measures. The indiscriminate construction of these rural roads has contributed to land destabilization and has further triggered landslides. The roads, which stretch all over the basin, will contribute to an increased sediment load in the Tamor River watershed.

Himalayan rivers are known for their high sediment loads resulting from a high degree of catchment erosion. The monsoon is a period of high sediment load in the river. The Tamor River is one of the rivers in Nepal with the highest sediment load, with reported concentrations as high as 10,000 ppm in extreme events. Historical data on sediment concentrations are often not representative of the true picture as the sediment samples are collected during daylight and do not represent the peak concentrations which often occur during landslides in the middle of the night.

Riverbed morphological change during the monsoon season is a common feature of the Tamor and its tributaries: sand, gravel and boulder deposition in one place and scouring in other places are common. Debris flows are also seen quite frequently on weak and vulnerable slopes along rivers/streams. Change in the riverbed and flood plain morphology of the Tamor and its tributaries brings corresponding change in wet channel characteristics: the pool sections of the wet channels change into rapids, and rapids convert into pool sections on an annual basis. Consequently, aquatic habitat changes are also dynamic.

Figure 7.6 Land use in the Tamor-Kabeli Watershed



7.7.3 Resident and Migratory Fish Population

The Tamor River has a total length of 198 km and a drop of nearly 5,850 m from its head to the confluence with the Arun at Tribeni. The Kabeli River joins the Tamor halfway between its head and the Arun confluence. There are fragmented reports on the fish diversity of the Koshi and Tamor Rivers. Shrestha, T.K. (1990) has recorded 108 fish species in the Koshi River. Rajbansi (2002) reports about 54 cold-water fish species in the Koshi River of which about 31 species are also reported in the Tamor River. Shrestha, J. (2009) reports 37 species of fish in the Tamor River.

The Tamor and its tributaries together have a rich diversity, with over 50 cold-water fish species reported. This EIA has found 31 species in the Kabeli River just upstream of the Tamor-Kabeli confluence. The EIA for the Tamor Hydropower Project in 1998 enumerated 19 fish species at the project site located upstream of the Tamor-Kabeli confluence. Recently, an EIA for the Upper Tamor Hydropower project reported only 8 fish species at the project site. The headworks of that project are located in the KCA. Table 7.7 presents the list of fish species reported at various periods in the Tamor River basin from both downstream and upstream areas.

A literature review of fishery studies in other Nepalese river basins (Gandaki, Karnali, Mahakali, etc.) and their respective tributaries (Petr, T., 2002; Shrestha, J., 1978, 1994, 1995, 1999, 2002; Shrestha, T.K., 1990, 1995, 1996, 1998, 2002; Rajbansi, J.K, 1982, 1996, 2002, etc.), reveals that the fish species reported for the Tamor River are almost identical to those in other basins. Therefore, the fish species present in the Tamor-Kabeli watershed seem to have a wide distribution range in Nepal.

The decline in fish diversity from downstream to upstream in the Tamor River is quite characteristic of the Himalayan rivers. For this reason the Himalayan rivers are classified into three distinct zones (Shrestha, J., 2002; Petr, T., 2002) based on habitat types. These zones are: (i) *Snow trout zone* (1,875 – 3,125 m) characterized by fast flowing cold snow-fed water dominated by *Schizothorax plagiostomus* and other *Schizothorax* species; (ii) *Stone carp zone* (1,250 – 1,875 m) characterized by fast flowing waters and dominated by Stone carp (*Psilorhynchus pseudecheneis*), stone roller (*Garragotyla*), loach (*Noemacheilus* spp) and sucker catfish (*Glyptothorax* spp); and (iii) *Hill barbel zone* (625 – 1,250 m) characterized by fairly slow water current and dominated by mahseer (*Tor tor*, *T. putitora*) and katle (*Neolissocheilus hexagonolepis*). Normally, the dominant fish species of the Hill barbel zone are not reported in the Snow trout zone, whereas the Stone carp zone is overlapped by species from both the Snow trout and Hill barbel zones. The dominant fish species of the Snow trout and Hill barbell zones migrate upstream and downstream with the changes in discharge volume and temperature.

The species composition and quantity of fish is reported to be rapidly decreasing for the last few years in both the Tamor and Kabeli Rivers. As noted above, this decline is due to unregulated overfishing using poison and electric shock. It is also highly likely that this decline may be partially due to the barrier effect that the large Koshi barrage downstream has had over the past decades on the survival of long-distance migratory fish populations.

Table 7.7 Fish Composition of the Tamor-Kabeli river system

[Please note that a + indicates that the fish species has been reported in the river noted at the heading of each column. The number in parenthesis included next to the name of each river in the heading of the column indicates the study and location referenced as follows: (1) Rajbansi, J.K., 2002; (2) Rajbansi, J,K., 2002; (3) Shrestha, J., 2009; (4) KAHEP project EIA; (5) Tamor/Mewa Hydropower Project site, upstream KAHEP on Tamor River; (6) Upper Tamor Hydroelectric Project site, upstream Tamor/Mewa Hydropower Project site on Tamor River

		Kosi (1)	Tamor (2)	Kabeli (3)	Kabeli (4)	Tamor (5)	Tamor (6)
1	*Acanthophthalmus pangia* (Hamilton-Buchanan)[20]	+	+				
2	*Amblyceps mangois* (Hamilton-Buchanan)	+					
3	*Anguilla bengalensis*			+	+		
4	*B. barna* (Hamilton-Buchanan)	+	+	+			
5	*B. guttatus* (Day)	+					
6	*B. lohachata* (Chaudhuri)	+	+	+	+		
7	*B. shacra* (Hamilton- Buchanan)	+		+	+		
8	*B. tileo* (Hamilton-Buchanan)	+					
9	*B. vagra vagra* (Hamilton-Buchanan)	+	+	+	+	+	
10	*Bagarius bagarius* (Hamilton-Buchanan)	+	+	+	+		
11	*Balitora brucei* (Gray)	+	+				
12	*Barilius barila* (Hamilton-Buchanan)	+	+	+	+	+	
13	*Barilius bendelisis* (Hamilton-Buchanan)	+	+	+	+	+	
14	*Botiaal morhae* (Gray)	+		+	+		+
15	*Botia Dario*			+			
16	*Botia histrionic Blyth*			+			
17	*Brachydaniorerio* (Hamilton-Buchanan)[8]						
18	*Chagunius chagunio* (Hamilton-Buchanan) [1]	+	+			+	
19	*Chela* (*Chela*) *laubuca* (Hamilton-Buchanan)[9]	+	+				
20	*Clupiso magarua* (Hamilton-Buchanan)	+			+		
21	*Crossocheilus latius latius* (Hamilton-Buchanan)	+		+	+		
22	*D. devario* (Hamilton-Buchanan)	+					
23	*D.dangila* (Hamilton-Buchanan)	+					
24	*Danio acquipinnatus* (McClelland)	+	+				
25	*Esomus danricus* (Hamilton-Buchanan)	+					
26	*G. annandalei* Hora	+	+	+	+	+	
27	*G. gotylagotyla* (Gray)	+	+	+	+	+	
28	*G. indicus* Talwar[22]	+	+				
29	*G. lamta* (Hamilton-Buchanan)	+	+				
30	*G. Nasuta (*McClelland*)*			+			
31	*G. rupecola* (McClelland)	+					
32	*G. telchitatelchita* (Hora)	+	+	+	+		
33	*Gagatacenia* (Hamilton-Buchanan)	+	+				
34	*Glyptosterrum blythi*				+		
35	*Glyptothorax cavia* (Hamilton-Buchanan)	+	+		+	+	+
36	*Glyptothorax indicus (*Talwar and Jhingran)			+			
37	*Glyptothorax pectinopterus*		+		+	+	
38	*Heteropneustes fossilis*				+		
39	*L. dero* (Hamilton-Buchanan)[2]	+	+	+	+	+	
40	*L. dyocheilus* (McClelland)[3]	+					
41	*L.gonius* (Hamilton-Buchanan)	+					
42	*Labeoangra* (Hamilton-Buchanan)	+	+	+	+	+	
43	*Lepidocephalus guntea* (Hamilton-Buchanan)[21]	+	+				
44	*Mastacembalus armatus*			+	+		
45	*Myersglanis blythi (Day)*			+			
46	*Naziritor chilynoides* (McClelland)	+		+		+	
47	Nemacheilus elongates			+			
48	Nemacheilus rupicola*					+	
49	*Neolissocheilus hexagonolepis* (McClelland)[4]	+	+	+	+	+	
50	*Noemacheilus beavani*				+	+	
51	*Noemacheilus botia*				+		
52	*Noemacheilus elongates*						+
53	*P. homaloptera* (Hora& Mukherjee)	+					
54	*P. sucatio* (Hamilton-Buchanan)	+					
55	*Pseudecheneis crassicaudea*			+			
56	*Pseudecheneis sulcatus* (McClelland)	+	+		+		+
57	*Pseudeutropius atherinoides* (Bloch)	+					
58	*Psilorhynchoides pseudecheneis* (Menon&Dutta)	+	+	+	+	+	+
59	*Puntius conchonius* (Hamilton-Buchanan)	+	+		+	+	
60	*Puntius Sarana*			+			
61	*Puntius ticto*			+	+		
62	*S. bacaila* (Hamilton-Buchanan)	+					
63	*S. curvoforns* (Heckel)						
64	*S. esocinus* (Heckel)	+	+				
65	*S. labiatus* (McClelland)	+					
66	*S. niger* (Heckel)	+					
67	*S. progastus* (McClelland)[15]	+	+		+		+
	Schistura multifasciatus			+			
68	*Schisturaru peculainglisi*			+			
69	*Salmostoma acinaces* (Hamilton-Buchanan)	+					
70	*Schistura scaturigina* (McClelland)						
71	*Schizothora ichthyscurvifrons*			+			
72	*Schizothora ichthyslabiatus*			+			
73	*Schizothora ichthysprogastus*			+			
74	*Schizothorax plagiostomus*						+
75	*Schizothora xrichardsonii* (Gray)	+	+	+	+	+	+
76	*Schizothorax siuatus*			+			
77	*Securicula gora* (Hamilton-Buchanan)	+					
78	*Semiplotus semiplotus* (McClelland)	+					
79	*T. mosal* (Hamilton-Buchanan)	+					
80	*T. putitora* (Hamilton-Buchanan)	+	+	+	+	+	
81	*Tor tor* (Hamilton-Buchanan) [5]	+	+	+	+	+	
	Total Species reported	54	31	37	31	19	8

Fish Species of Conservation Significance:

The IUCN Red list of 2012 has listed five species within the Tamor-Kabeli watershed. The list includes three reported long distance migrants, namely *Bagarius yarrelli*, *Tor putitora* and *Tor tor*. Among the mid-distant migrants, *Schizothorax richardsoni* and *Neolissochilus hexagonolepis,* observed during the sampling period of this EIA, are also listed in the IUCN red list. IUCN Red List species that are listed as Critically Endangered are the species of greatest concern whereas the concern decreases for species listed as Endangered and Vulnerable. Of the listed species in the Tamor-Kabeli watershed, the *Tor putitora* is an Endangered species and *Schizothorax richardsoni* is a Vulnerable one while others are near threatened species. There are no Critically Endangered species reported in the Tamor-Kabeli watershed.

The species composition and quantity of fish have been reported to be in a rapidly decreasing mode for the last few years in both the Tamor and Kabeli Rivers. However, as noted in Chapter 4, the IUCN Red List is derived from the overall condition of the global population of individual species. The individual species might be in abundance in a particular region but it can be included in the Red List if its global population is decreasing. A similar approach applies to the Red List for the Tamor-Kabeli watershed. For example, Asala, which is the most common species in almost all river systems in Nepal, is included in the IUCN Red List as a vulnerable species. Similarly, the other four species that are included in the IUCN Red List are reportedly still very common in Nepal.

7.7.4 Spiritual and Religious

Along the Tamor-Kabeli river system there are several sites of spiritual and religious significance, including several cremation sites ("ghats"). The Pathibhara Devi Temple (3,794 m) is one of the major cultural sites in the Tamor basin. This is a popular attraction for pilgrims in the region. During special occasions, internal tourists, Hindus and Buddhists, seeking spiritual fulfillment and blessings from the powerful Pathibhara Devi, reach the temple for celebrations. The trek to Pathibhara is also popular among foreign visitors given the natural beauty and the cultural experience. The Singhbahini temple in Terathum district is another religious site of spiritual significance. In addition, there are numerous cultural sites of local value, representative of the cultural diversity of the basin. Many of the cultural sites are located close to the rivers, and most of the religious ceremonies involve clean running water.

Hindu burial cremation practices require clean running water in sufficient quantity and at chest-high depths, for people to perform the traditional ceremonies and rituals like bathing, and for disposing of the ashes after cremation is completed. A minimum depth of water in the river is required for these traditional cultural and religious activities. In addition, during certain festivals like Shiva Ratri and Ekadashi, large numbers of people visit the ghats for spiritual and religious purposes, and greater flows of water are required to perform the holy baths.

7.7.5 Landscape

The Tamor basin is known for its spectacular natural and cultural landscapes and it is an area with significant touristic potential. Within the basin, there are several existing places for ecotourism and adventure tourism developments including trekking, mountaineering, rafting, sight-seeing, among others. Mount Kanchenjunga, which is the third highest mountain of the world, is the main destination for mountaineering in the basin. The main trekking routes include Suketar-Mitlung-Chiruwa-Ghunsa Khola-Yabla-Ghunsa-KCA base camp, and Selele-Torontan-Yamphudin-Kheban back to Suketar (see Figure 7.2).

7.8 CUMULATIVE IMPACT ASSESSMENT OVER SELECTED VECS

A total of 13 run-of-river (RoR) projects are considered under Scenario 1. These are likely to be implemented in the Tamor basin (including 4 projects in the Kabeli basin) and are located almost in a cascade fashion as shown in Figures 7.2 and 7.4.

Most projects will have a basic design similar to that of KAHEP (see Chapter II, section 2.4 for details). In essence, water will be diverted from the main river stem by some sort of dam or weir, conducting to an intake structure that will direct water through a headrace tunnel or a pipe to the powerhouse. After the water goes through the turbines in the powerhouse, it will be released through the tailrace back into the river. Therefore, even though hydropower projects do not consume water, the stretches between the respective intakes and the powerhouses' tailrace will be subjected to reduced flows, commonly referred to as "dewatered" stretches/sections. Often, in cascading schemes such as those planned for the Tamor watershed, the tailrace of one project often lies just upstream of the diversion structure feeding the next project downstream.

Cumulative impacts resulting from simultaneous construction activities have not been considered in this RCIA. The environmental and social impacts resulting from overlapping project construction are expected to have short term additive impacts on air and water quality, ambient noise levels and increased traffic risks along the Mechi Highway. Construction related impacts should be managed by incorporating good international pollution prevention and control practices in individual projects' construction EMPs.

The sections that follow will focus only on the long term cumulative impacts expected from the operation of cascading hydropower development over the selected VECs.

7.8.1 Reduction of water quality and quantity

Under a multiple cascading scenario, it can be reasonably predicted that the natural flow regime will be modified, as the river system will be converted from a free-flowing river to a highly regulated one.

Water quality is likely to be affected. Reduced flows in the dewatered sections will likely be warmer, dissolved oxygen reduced, and any pollutants or microbiological contamination, as well as suspended solids, may be present at higher concentrations. This will be aggravated if water is extracted for human consumptive uses from any of the dewatered segments, or if they are subjected to domestic wastewater discharges.

Even though these cascading hydropower projects are not net consumers of water, the timing as well as the allocation of water flow will be modified. During dry months, the dewatered sections will likely achieve a steady state at the new reduced flows, typically of about 10% of the natural flow for that time of the year. On the other hand, during peak generation, river sections downstream from the tailraces will be subjected to daily water pulses, which could sometimes be significantly higher than the natural base flows of the receiving river. These daily water flow pulsating shocks will not allow for the downstream stretches to reach an ecologically steady state and thereby are expected to introduce a stressing river environment during the low flow season. The daily flow fluctuations might also be accompanied by a subsequent daily modification in water quality.

Furthermore, these downstream pulses of water could compromise any traditional downstream water uses (e.g., irrigation, recreation), as even though technically the amount of water released will be the same, it will be coming all at once, thus not allowing for its timely use for the intended purpose.

7.8.2 Landslides/erosion and sedimentation

Sediment transport in the Himalayas is a natural phenomenon, often aggravated by anthropogenic influences. The young Himalayan geology introduces millions of tons of sediments into surface waters every year. In run-of-river RoR projects, the in-river sediment transport is not significantly affected as these projects often flush sediments directly into the river downstream of the headworks. Peaking RoR projects have smaller pondages. Experience from projects like Kali Gandaki show that seasonally it is possible to flush accumulated sediments through drawdown flushing. Projects with big reservoirs and no flushing mechanism like the Tarbela Dam in Pakistan pose serious challenges to sediment transport. In the case of the Tamor basin, no significant impacts on sediment trapping are envisageddue to the headworks.

Catchment erosion from an increased rate of changes in land use, added to indiscriminate development of roads and transmission lines, will likely increase with access and further deforestation. Reduction of the catchment forest cover will have significant impacts on soil retention capacity, increasing surface sediment runoff and vulnerability to landslides.

Flow modification will have implications for river morphology and hydraulics/ sediment loads and dispersion dynamics. Sand, gravel, and boulder deposition dynamics will likely change. Debris flows are also likely to be modified. As stated above, Himalayan rivers are characterized by ever changing dynamics in the riverbed and in the flood plain morphology. The natural annual dynamics may be modified by the large scale development of hydropower. Increased up-slope erosion during the operation phase is likely to be significant because of the fragmentation of the river's natural morphology by the diversion structures and reduced sediment transport capacity of the river for more than 6 months annually. In addition, daily flow fluctuations and water pulses are also likely to modify the river geomorphology downstream from the tailraces.

7.8.3 Aquatic habitat degradation and fragmentation

Because of the cascading hydropower plants in the same river system, fragmentation of aquatic habitat is expected from: (i) the barrier effect of dams and weirs; and (ii) reduced flow in the dewatered reaches. This fragmentation will interfere with the upstream and downstream fish migration as well as with lateral in-stream movements in-and-out of the riverbanks.

Furthermore, natural flow disruption and reduced flow in the dewatered segments will likely reduce the quantity and quality of suitable foraging, spawning, cover and habitat for both migratory and resident species.

Under Scenario 1, once all 13 projects are built and in operation, it can be reasonably expected that during the 7 months of the low flow season (November–May), out of the total 524 kilometers of the natural river stretch that make up the Tamor watershed, approximately 79 kilometers (12%) will be dewatered[19] (Figure 7.4).

The dewatered sections will receive water only from the designed minimum downstream ecological flows (e.g., typically 10% of an average minimum monthly flow) and any additional marginal recharge from seepage and minor tributaries. This situation will likely create a mosaic of dewatered and natural river sections along the affected reaches of the river system.

[19] This includes 198 km of Tamor River plus 11 main tributaries including the Kabeli. The estimated dewatered section was calculated based only on 11 out of the 13 HPPs considered under the Scenario 1, since the information for the other two was not available at the time of this assessment. For other two an average dewater distance is considered.

7.8.4 Adverse impacts on spiritual and religious sites/practices

Reduced flows in the dewatered sections as well as overall cumulative flow regime modifications resulting from development of cascading hydropower projects in the Tamor and Kabeli basins also have the potential to significantly affect water availability and quality needed for religious ceremonies. As stated above, cremation sites ("ghats") require clean water in sufficient quantity and at chest-high depths, for people to perform their traditional ceremonies and rituals. Pure and clean flowing water is a prerequisite, along with minimum depth, for these traditional cultural and religious activities.

7.8.5 Landscape conversion

Multiple cascading hydropower plants at a national and regional level, together with the construction of ancillary facilities such as roads, transmission lines, and the induced development could significantly modify the existing landscape. This could create a significant negative impact on Nepal's tourism-based economy.

7.9 IMPACT SIGNIFICANCE DETERMINATION

7.9.1 Reduction of water quality and quantity

If unmitigated, potential cumulative impacts on water quality and availability in the Tamor-Kabeli watershed could be significant. Given the limited data available, the exact magnitude and significance of the potential degradation of water quality and the reduced quantity cannot be presently assessed with a reasonable degree of certainty. This is an area requiring further baseline data collection, simulation models, integral flow measurements, and quality monitoring across the whole watershed.

7.9.2 Landslides/erosion and sedimentation

Both RoR and storage hydropower facilities face sedimentation problems. Frequent inability of desilting facilities to reduce sediment concentrations in water flowing through turbines can result in significant deterioration of turbines in RoR facilities. Storage facilities suffer from reservoir sedimentation, reducing their ability to reliably supply power. Sedimentation can also interfere with intakes. Most of the projects in the Tamor basin are RoR types. In RoR projects, water is diverted to turbines from a river intake or from a small reservoir having only enough pondage to provide daily peaking power. These small reservoirs typically have large gates and operate as barrages, opening the gates to draw down water levels and pass sediment-laden flood flows. Because the structures associated with the RoR facilities consist of either a low weir or a barrage with large gate capacity, they can typically maintain sediment transport along the river and accumulate little sediment above the dam.

The sediment management problem at RoR facilities is that of minimizing the concentration and grain size of coarse sediment in the water diverted to the turbines. This problem can be addressed at three points:

1. by timing operations of intakes to exclude turbine flows having the highest sediment concentration;
2. by optimizing the intake configuration in the river itself, and
3. by optimizing the desilting facility design and operation.

RoR facilities are typically designed to eliminate sediment larger than 0.15 - 0.2 mm in diameter. However, when sediments consist principally of angular quartz particles, even those as small as 0.05 mm can cause serious abrasion. Because one of the factors influencing the abrasive energy is the momentum with which the sediment particle strikes against the runner, which is directly related to sediment mass, abrasivity of sediment is approximately related to the cube of the particle diameter. If unmitigated, potential cumulative impacts of poor watershed management, deforestation, and increased erosion could be significant, not only for the ecological and geomorphological integrity of the basin, but also for the technical and financial sustainability of cascading HPPs, as explained above. Given the limited data available on the current sediment load dynamics of the Tamor catchment area, it is difficult to determine the exact magnitude and significance of the consequences from the cumulative effects of the increased sediment loads. This is an area requiring further baseline data, GIS and scenario simulation / land-use change predictive models. A laser guided real time sediment monitoring program is also recommended in the basin to monitor both the grain size distribution and the sediment concentrations.

7.9.3 Aquatic habitat degradation and fragmentation

Habitat fragmentation caused by both physical structures and mosaics of intermittent free-flowing and dewatered river sections will negatively impact aquatic ecology and overall river integrity, including aesthetics and morphology. Modifications in the river's eco-morphological character, fragmentation of the river into stretches of limited natural flows, long dewatered zones, and excessive sedimentation in the riverbed will likely cause significant conversion of the aquatic habitats of the Tamor-Kabeli watershed. As stated, the precise quantification of these adverse impacts at this stage is difficult, but some brief qualification is described below.

The most important effect due to the cascade hydropower development is the closure of the ecological aquatic corridors. Closure means reduction in species diversity, change of species dominance/natural assemblies and impairment of the ability of migratory species to fulfill their lifecycle. The river system's natural upstream-downstream connectivity could potentially be significantly disrupted, especially during the dry season if a major hydropower cascade were developed. The barrier effect will likely impair fish migration from downstream to the upstream reaches for spawning and feeding. Once breeding habitats and nursing areas are lost, a gradual decline in the fish population leading to extinction of certain fish species in the watershed may be inevitable. One of the main reasons is that robust fish populations in the downstream reaches of the large river systems depend largely on the recruitment of fish fry and fingerlings from the upstream nursing areas.

Furthermore, the river fragmentation will likely cause a significant modification of organic detritus and nutrient flow downstream. If organic detritus and nutrients are retained in the upstream reaches by dams and weir structures, they may cause food scarcity and reduced productivity of fish populations in the downstream sections. This effect might cause reduced productivity and even an increased mortality in the downstream fish populations.

Therefore, if these projects are successively implemented without any mitigation measures, significant cumulative impacts are likely to occur in the Tamor-Kabeli watershed aquatic ecology, particularly leading to reduced fish productivity and a significant conversion of the existing natural assemblage of fish. Resident fish populations are likely to be favored, and the success of migratory fish species may be significantly jeopardized.

The 13 cascading projects considered under Scenario 1 are expected to be built mainly in the downstream reaches of the affected rivers. Thus the barrier effect will be felt in larger productive areas in the upstream sections. In this scenario, such areas will be likely left to the resident fish populations.

If fish migration in the Tamor River takes place as far as the KCA upstream, the barrier effect created by the hydropower power developments in the lower reaches of the Kabeli and Tamor Rivers conceivably could impact the ecology and species composition in the conservation area. Taking into account Scenario 2, with 4 additional hydropower developments, the cumulative effect would escalate, since two of the planned HPPs are situated further downstream in the Tamor and Khorunga. To build the Lower Tamor without any mitigation measures would produce the largest consequences because the Tamor is the "highway" to many rivers and tributaries.

In addition, reduced flows during the dry season are also likely to decrease wetted usable habitat availability and limit fish in-stream lateral movement in and out of river banks. This will affect both resident and migratory fish by potentially reducing spawning, foraging, feeding and covering habitat.

7.9.4 Adverse impact on spiritual and religious sites/practices

As discussed above, there are a number of cultural sites of local value, particularly cremation sites, located close to the rivers. Detailed basin level information on these sites, however, is not available at present. Most of the religious ceremonies need clean running water. If water is not available at the quantities and quality required for the religious ceremonies and spiritual cleansing, several religious sites, particularly the cremation ghats, could potentially be adversely affected.

7.9.5 Landscape conversion

Visual impacts and landscape fragmentation because of the unplanned and multiple roads and electric transmission and distribution lines, though still uncertain, could potentially be very significant. Nepal is a country that markets its natural pristine beauty as one of its main touristic features, and this image could be significantly jeopardized if the landscape is encroached upon by multiple transmission lines, towers, cables, and roads.

7.10 MANAGEMENT STRATEGY

7.10.1 Under KAHEP control

Since the KAHEP is the first HPP to be constructed and operated in the Tamor-Kabeli basin, it has an opportunity to establish good design practices, implement appropriate mitigation measures, and incorporate specific management of potential cumulative effects in its EMP.

Regarding a management approach related to overall aquatic habitat fragmentation and river ecosystem integrity, an indicator species should be selected. As indicated in Chapter 6, not all species recorded in a river have the same value, and typically species in a river will be managed according to how they are valued by society and other relevant stakeholders. When dealing with the hydropower development in the Tamor-Kabeli watershed, KEL proposes to focus its management strategies on protecting representative target species.

Target species were selected based on three criteria (see Table 6.10, chapter 6 and Table 7.8): (i) IUCN Red Listed species; (ii) migratory species; and (iii) species of local commercial, dietary or cultural values. IUCN Red List species are obvious criteria, as they reflect global conservation concerns coherent with their global population size, distribution range and current population trends. Migratory species are important when assessing cascading hydropower projects since such projects are likely to create barriers that may significantly impact successful completion of important migratory fish lifecycle phases. Species that are of value to local communities are obvious target species to select. It is assumed that if correct target species are selected, conditions and mitigation measures to safeguard them will provide favorable conditions for the rest of the fish species in the river.

Table 7.8: Proposed target fish species

S.N	Scientific Name	English Name	Local Name
1	*Tor putitora*	Golden Mahseer	Sahar
2	*Tor tor*	Dharke Mahseer	Sahar
3	*Schizothorax richardsonii*	Snow trout	Butche Asala
4	*Schizothorax progastus*	Snow trout	Chuche Asala

5	*Neolissocheilus hexagonolepis*	Copper Mahseer	Katle
6	*Bagarius yarrelli*	Fresh water shark	Goonch
7	*Anguilla bengalensis*	Eel	Rajbam
8	*Clupisoma garua*	Catfish	Jalkapoor
9	*Labeo dero*	River rohu	Gardi
10	*Pseudecheneis sulcatus*	Torrent catfish	Kabre

The following section describes mitigation measures that the KAHEP will incorporate in its design and operational EMP to mitigate its contribution to the expected cumulative impacts at the watershed level. It is expected that once KAHEP makes the investments required to develop and implement these mitigation measures, all other projects in the basin will follow suit. However, if the future projects (upstream and downstream from the KAHEP) do not implement similar and coordinated measures (such as adequate downstream flow regimes, fish ladders, contribution to native fish hatcheries, open water re-stocking, fish diversion structures at intakes to avoid entrapment), KAHEP's efforts alone will not be sufficient to maintain the ecological and socio-economic integrity of the Tamor River watershed.

In the case of KAHEP, the developer is proposing to include in its operational EMP the following measures to curb the cumulative impacts at the basin level:

- Design and construction of a fish ladder to assure upstream-downstream fish migration is not impaired;
- Design and construction of structures / check dams along cremation sites to create waist depth pools. In addition, downstream flow release will be increased during religious festivals to meet riparian communities' ritual requirements and maintain adequate sanitation;
- Design and construction of fish diversion structures to avoid fish entrapment;
- Release of a downstream environmental flow regime that will:
    - Maintain the ecological river corridor open;
    - Secure survival of substantial amounts of fry and fingerlings of the target species in the dewatered segments;
    - Ensure local populations can continue to perform their traditional burial rituals and other religious ceremonies undisturbed;
- Development and implementation of a robust monitoring program during construction and operation phases to allow for improved understanding of the potential impacts of the proposed minimum downstream release to riparian connectivity and migration challenges of the key fish species. The monitoring program, among others, will also incorporate the following:
    - Temperatures and water quality, since they play an important role in describing potential impacts of the hydropower development. Water quality measurement and temperature loggers need to be installed in the river through the annual cycle. Data logging will be a part of the monitoring program described in the EMP. Temperature logs and water quality measurement will be carried out at five sites:
        - An upstream dam site
        - Before the confluence of Tamor
        - In Tamor upstream of Tamor-Kabeli confluence
        - In Tamor before powerhouse
        - In Tamor after tailrace
    - As indicated in Chapter 6, to capture the reported diversity composition of the fish species, sampling at 8 potential locations in the Kabeli and Tamor Rivers has been initiated in July 2013 to capture seasonal migration patterns of the Tamor basin fish and will be further continued till the second year of operations; and

- Adaptive management to allow for adjustments of the downstream environmental flow regime releases as a response to the monitoring program results.

In addition, in its area of terrestrial influence KAHEP will apply:

- Soil conservation through biological and engineering solutions in the catchment areas to reduce the upland erosion and sediment load in the Kabeli River;
- Awareness programs at the catchment level for ecosystem conservation through improvements in the water retaining properties of soil;
- Afforestation and bio-engineering works for degraded areas to enhance basin vegetative cover; and
- Promotion of rural electrification as per the hydropower policy (2001) in the project VDCs to reduce reliance on fuel wood for energy.

7.10.2 Other sponsors

KEL will use its best efforts to leverage and engage the GoN and other developers in the application of good practices. Therefore:

- All hydropower developments should provide downstream flow regimes that will adequately meet ecological and social requirements, especially during the dry season. Establishing the required flow release is often a challenge and needs multi-stakeholder long term coordinated monitoring efforts;

- To assure that ecological corridors are kept open, all projects should include fish ladders and entrapment prevention measures in their designs;

- Native fish hatcheries should be supported by all developers in the basin, and open water fish-restocking should take place on an annual basis and in a coordinated fashion;

- It is envisaged that all developers involved in the Tamor-Kabeli basin shall work jointly for the overall development of the Tamor-Kabeli basin. For this purpose, a joint Catchment Area Treatment (CAT) plan could be developed. The CAT will highlight erosion control techniques, and will involve understanding of the erosion characteristics of the terrain and suggest preventive, stabilization and remedial measures to reduce the erosion rate. It shall give attention to the proper construction of rural roads and rural electrification to avoid and minimize adverse environmental impacts;[20]

- Infrastructure should be shared to avoid unnecessary land acquisition and additional habitat and landscape fragmentation as a result of overlapping access road and transmission lines; and

- Joint operation and maintenance activities (e.g., agreeing on common operation and maintenance manuals and guidelines) should be developed. Coordinated downstream environmental flow and extraordinary flow release, flushing, and other operational, maintenance and emergency prevention and response activities are crucial for increased efficiencies and reduction in maintenance costs.

[20] DDCs receive 12% of the hydropower royalty, and VDCs receive grants from the central government. A significant proportion of these resources are used in haphazard construction of rural roads. A joint mechanism may be used to support and promote proper and environment-friendly rural road construction.

7.11 FUTURE COMPLEMENTARY STUDIES

As stated above, this initial RCIA is limited as it is based on limited basin-wide baseline data. As part of the implementation phase, the IDA has allocated a total of USD 2 million to help the GON to carry out the following activities.

7.11.1 International Workshop on "Integrated River Basin Management for Sustainable Hydropower Development in Nepal"

The WBG in collaboration with the DoED and other development partners active in Nepal, assist the GoN in organizing an international workshop on "Sustainable hydroelectric project development in Nepal". This proposed workshop will focus on sharing international experiences and case studies on sustainable hydropower development and bring together key stakeholders to discuss technical assistance needs to promote sustainable hydropower development in Nepal. Some of the specific topics that will be discussed include: cumulative impact assessment methodologies and their application to hydroelectric development at the watershed level; maintenance of minimum ecological flows and regimes; ecological compensation and offsets; design of Environmental Management Plans for construction and operation; community engagement and consultation with project affected people; resettlement and land acquisition aspects; consent from affected indigenous peoples; and good practices on benefit sharing.

Target Groups: Policy makers, Regulators, Civil society, Project developers, Private sector, Government Departments connected to Hydropower development in Nepal, Academia, and Consultants.

7.11.2 Additional Basin-wide Studies to Manage Cumulative Impacts in Kabeli-Tamor Watershed

This task will provide resources for the DoED to engage national and international consultants to consolidate good baseline data and develop thematic maps of the Tamor – Kabeli watershed, including but not limited to:

(i) present and reasonably-predictable future consumptive and non-consumptive water users, including all religious sites requirements,

(ii) water flow and water quality, including gauging stations and physicochemical and biological indicators,

(iii) fish and aquatic invertebrates robust baseline, including several seasonal cycles,

(iv) sediment load dynamics

(v) Inventory of rivers and streams and their characteristics considering the river morphology

(vi) Inventory of potential GLOF in the watershed

(vii) inventory of the existing populated centers and villages, land-use and forest cover in the catchment area, including the existing landslide prone zones (development of thematic GIS maps), and

(viii) basin wide inventory of valued natural resources and key ecosystem services.

(ix) The implication of climate change on hydrology, runoff (design discharge for hydropower projects) and other resources and tools for considering these changes

(x) (this topic can be included below)

Under this component, the DoED will design measures to manage the potential cumulative impacts and risks under different development scenarios, including but not limited to:

(i) Joint Operation Rules (JOR): simulation of the base-case and optimal-case of cascading hydropower,

(ii) Short-term Hydro Operation Planning (SHOP) and similar modeling/optimization tools,

(iii) robust and efficient cascading HPP design,

(iv) soil conservation and erosion control,

(v) implementation of a functional intact river strategies and terrestrial ecological corridors,

(vi) downstream environmental flow regime simulation / optimization models,

(vii) Joint Maintenance Rules, including sediment load handling,

(viii) efficient planning of supporting linear ancillary infrastructure (e.g. transmission lines, access roads),

(ix) coordination between different line agencies and other national and international development entities, and

(x) social management, planning and benefit sharing options.

(xi) develop stringent policies for addressing the cumulative impacts

(xii) develop operation manuals and standards (environment and social) for operating the hydropower plants

7.11.3 Capacity Building

This task will focus on two aspects of environmental capacity building for regulators, consultants, private developers, construction engineers, academia etc: (a) preparation and issuance of guidelines on specific topics such as: Cumulative Impacts; Minimum Ecological Flows, Watershed Management, Sediment Management etc. and (b) offer specialized short and medium term training programs on Sustainable Hydropower Development in Nepal.

The project will provide resources to DoED to hire national and international experts to prepare the above stated specific guidelines. DoED will also hire reputed national institutions such as: Institute of Engineering (IoE), Kathmandu University, New Era, Winrock International, Nepal, and Himalayan Resources etc. to offer regular training programs for various stakeholders (policy makers, regulators, civil society, project developers, private sector, relevant Government departments, Academia, and Consultants) connected to hydropower development in Nepal.

7.12 POLICY RECOMMENDATIONS

The development scenario in the Tamor-Kabeli basin reveals the need for preparation and implementation of basin development planning by the regulating government agencies at all levels. Development practices also indicate the absence of guiding policies to approve or issue development licenses. While EIA is legally mandatory in Nepal for the projects identified as environmentally sensitive, it is limited to the project specific area and does not mandate analysis of cumulative aspects of environmental degradation from the sectoral and cross-sectoral development projects in the same area or at the basin level. KEL, in conjunction with the WBG, has detected important policy gaps in Nepal and suggests the need for the GoN to:

- Formulate guiding policies, plans and programs for environmental and social sustainability from the sectoral and cross-sectoral standpoint, and therefore engage in a **Strategic Environmental Impact Assessment (SEA)** for the hydropower sector in Nepal. This should:
  - Facilitate a more systematic government-led approach to the basin level **Cumulative Impact Assessment and Management (CIA)**, including creation of functional Intact River Programs in the selected basins;
  - Allow for the overall integration of the development plans of the local, district, and central governments at least at the basin level (by developing an integrated Basin Development Plan); and
  - Screen projects and their locations taking into account potential project specifics and cumulative impacts for guiding the sectoral and cross-sectoral development planning of the basin; and
- Develop specific standards and regulations for:
  - Environmental and social baseline determination, (e.g., standard sampling methods and parameters);
  - Downstream Environmental Flows Assessment Methodologies;
  - Design parameters for fish friendly infrastructure: fish ladders/ intakes/ spillways;
  - Consultation and stakeholder engagement;
  - Land acquisition, involuntary resettlement and livelihood restoration;
  - Free, Prior and Informed Consent of Indigenous People, and
  - Community Benefit Sharing.

Chapter VIII: ENVIRONMENTAL MANAGEMENT PLAN, MONITORING PLAN AND AUDIT

8.1 ENVIRONMENTAL MANAGEMENT PLAN

This Environmental Management Plan (EMP) for the Kabeli "A" Hydroelectric Project (KAHEP) identifies the principles, approach, procedures and methods that will be used to control and minimize the environmental and social impacts of all construction and operational activities associated with the project development. It is intended to ensure that commitments made by the Kabeli Energy Limited (KEL) to minimize project's related environmental and social impacts are upheld throughout all project phases.

The EMP is also a companion document to the Social Action Plan which includes a Resettlement Compensation and Livelihood Assistance Plan (RCLAP) which aims to mitigate resettlement impacts and avoid or minimize social impacts arising from the project. The SAP is an integrated part of the EMP; the SAP includes:

- Resettlement Compensation and Livelihood Assistance Plan
- Indigenous and Vulnerable Community Development Plan
- Health and Safety Measures
- Benefit Sharing Measures
- Public Consultation Plan and Communication Strategy
- Implementation Arrangements
- Monitoring and Evaluation
- Costs and Budget

The SAP also includes actions to address impacts on religious ritual sites downstream of the project . The basic principles under which the EMP will be implemented are:

- Fulfill all environmental and social conditions associated with the project at-approval requirements;
- Develop, promote and foster a shared sense of responsibility for environmental and social performance of the project;
- Promote environmental awareness and understanding among employees and contractors through training, identification of roles and responsibilities towards environmental and social management and linking project performance to overall environmental performance;
- Encourage an understanding of social and cultural sensitivities in local communities and the importance of minimizing project impacts on local lifestyles and culture;
- Monitor environmental and social performance throughout the project and implement an adaptive management approach to continuous improvement;
- Work with local communities and project affected stakeholders to ensure that they benefit as a result of the project development; and
- Maintain an ongoing commitment to informing, engaging and involving local stakeholders throughout all phases of the project.

8.2 EMP STRUCTURE AND ORGANIZATION

This environmental management plan has two components; the environmental management activitiesand the activities implementing agency.

8.2.1 Environmental Management Actions

The environmental management activities is a synthesised plan incorporating the elements of environmental mitigation and enhanement measures. The environmental mitigation and enhancement measures are bundled in a series of activities in the project life cycle.While developing the environmental management plans, the capacity of the implementing organs (institutions/stakeholders) have also been taken into considerations (refer section 8.2.3).

The environmental management actions for the project are broadly described in the following sectioons:

- Management of Construction Impacts
- Adaptative Management of Selected Environmental Issues

8.2.1.1 Management of Construction Impacts

This managment addresses all the issues that are associated with impacts from the construction activities. Other mitigation measures, such as fish ladder, are already included in the project design orare part of the Social Action Plan. Main mitigation measures include:

- Fish ladder and fish hatchery
- Infrastructure for cremation sites
- Protection of sacred trees during construction
- Slope stability of all earth cuts
- Maintaining minimum environmental flows
- Forest compensation and reforestation plans

The Contractor will be responsible for designing and implementing the following plans which will be approved by the Supervision Engineer/environmental and social team prior to the intiation of work:

- Permits and Approval Plan;
- Environmental Training Plan,
- Construction Camps and Traffic Management Plan;
- Pollution Abatement Plan;
- Terrestrial Ecology Management Plan,
- Aquatic Ecology Management Plan,
- Erosion Abatement and Muck/spoil Management Plan,
- Public Health and Occupational Safety Management Plan,
- Emergency Management Plan,
- Rehabilitation Management Plan
- Chance find procedures
- Labor Law compliance,
- Security personnel
- Grievance Redress Plan.

Broad content of these plans are described in Section 8.2.3 of this chapter.Based on the above Plans, Contractors responsibilities during construction in all of these plans will be detailed in a separate "Environmental Specifications for Contractors" which will be included in bidding documents and contracts and enforced by the Supervision Engineeer. These specifications will be prepared before the start of the bidding process.The Contractor, during implementation, is responsible for preparing

Environmental Management and Execution Plan (EMEP) detailing in a site specific manner each of the above topics and obtaining approval from the project's supervision team/ environmental officer prior to the start of works.

8.2.1.2 Adaptive Management of Selected Environmental Issues

This includes preparation of additional studies, complementation of baseline conditions before construction or before operation, and monitoring of key parameters to improve or assess the effectiveness of proposed mitigation measures.

8.2.2 Organization for EMP Implementation

8.2.2.1 Institutional Capacity and Strengthening Needs

The company KEL developing the KAHEP is the subsidiary company of BPC. The BPC has a history of hydropower development in Nepal since 1966. The BPC is well aware and sensitive to environmental and social issues of the HEP projects and also understands the IFC and World Bank requirements related to the environmental and social safeguards. The Jimruk, Adhi Khola, Khimti-1, and Khudi HEP are some of the projects which have been successfully implemented by BPC and its subsidiary company where environmental and social safeguard requirements have also been executed to the satisfaction of the International Funding institutions (IFIs).

At the central level, BPC has a Hydro-Consult Engineering Limited (former Hydro Consult Private Limited), a subsidiary company, to look into the environmental and social matters of the development projects undertaken by BPC and its subsidiary companies. The Hydro-Consult Engineering Limited (HCE) maintains a strong team of environmental and social professionals as a core team. At present in-house core professional team comprises six members in the field of environmental management, fishery, sociology and anthropology. This team of professionals is engaged mostly in the quality control and supervision monitoring of the environmental and social safeguard issues of the projects developed by the BPC subsidiary companies. They also provide training and backstopping support to the field level staff of subsidiary companies responsible for handling of the environmental and social safeguards.

KEL has established Kabeli-A Environment and Community Development Unit (KAECDU) to undertake social and environmental monitoring of the KAHEP. KEL mobilized full team of KAECDU including the Environmental Manager, Mitigation and Compensation Officer, Anthropologist, Livelihood Officer, Environmental Officer, Public Relation Officer, Environmental Engineer, Health and Safety Officer and three Public Relation Assistants (PRAs) on site in 2011. However, KAECDU was downsized as there have been delays in the KAHEP implementation. At present, there are three professionals engaged in the Unit namely Anthropologist, Livelihood officer and Environmental Officer in addition to the three PRAs. Three PRAs are deployed by the Project in different locations of the Project area. The roles of PRAs are important for timely communication, information dissemination, identification and documentation of issues and grievances and resolving them on time at local level. In other words, these are the front line staff to work as mediators between the Project and the people.

When the project construction work starts the remaining vacancies in the Unit will be filled accordingly. In addition, HCE, as KEL, is the subsidiary of BPC that apart from project engineering also looks into the environmental and social matters pertaining to BPC and its sister companies. The team of Environmental and Social Specialists of HCE will support the KEL team in all the issues pertaining to environmental and social safeguards during the implementation of KHEP.

If these arrangements still have some gaps, required additional experts will be hired and trained on the issues and management requirements during the implementation stage. BPC and funding agencies' support in selection and training of the selected professionals on safeguard is an essential element for the proper management and monitoring of the KAHEP during implementation stage.

Other project stakeholders (refer section 8.2.2.2), particularly the affected Village Development Committees and District Development Committee and local level Non-government Organizations, Community Based Organizations (Community Forest Users Groups, and other users groupsetc.), have a limited understanding of the project action and impacts. Despite a public disclosure and grievance handling mechanism in place, there will still be gap in the information dissemination and understanding of the project actions, impacts and measures envisaged to mitigate the impacts to the acceptable levels and the roles/responsibilities of the local level stakeholders. Proactive role of the Project Information Center (PIC) with a strong public relation backup is needed throughout the project life cycle to facilitate participation of the local level stakeholders in the project. The PIC has been established onsite in August 2011 and continuously works with the information dissemination despite the fact that there has been no project implementation.

8.2.2.2Project Stakeholders for Environmental Management

Key stakeholders, including KAHEP, to be involved in the project environmental management, in the order of hierarchy, are:

1 Project Sponsors;

2 Ministry of Energy (MOE);

3 Ministry of Forest and Soil Conservation (MOFSC);

4 Department of Electricity Development (DOED);

5 Department of Forest and its line District Offices;

6 The Proponent(KEL);

7 Kabeli - A Environment and Community Development Unit (KAECDU);

8 Supervising Engineers (SE);

9 Construction Contractor (CC);

10 Affected Village Development Committees and District Development Committee;

11 Non-government Organizations, Community Based Organizations (Community Forest User Groups, and other user groups), etc.

The main roles and responsibilities of different parties in the various phases of project development are briefly presented in Table 8.1.

Table 8.1: Roles and Responsibilities of the Stakeholders

SN	Stakeholder	Roles and Responsibilities	Time Schedule
1	Sponsors	Approval of EIA and financial arrangements	Prior to project financing
		Approval of contract bid documents	Prior to publication of contract bid for contractor
		Monitoring/auditing and feed back	During construction/operation through review mission

SN	Stakeholder	Roles and Responsibilities	Time Schedule
2	MOE/DOED	Final approval of IEE	IEE approval
		Licensing and permission for Project Implementation	After approval of EIA/IEE
		Review project design and contract documents , against approved EIA measures and national environmental standards and provide comments for corrective actions	Before contract bidding
		Review of monitoring reports of project construction and operation and provide comments for corrective actions	As and when required during construction and operation phases
		Field supervision once a year during construction and provide inputs to the KAHEP management	Once a year
3	MOFSC/DFO	Review and comment on EIA/IEE for Final approval of EIA/IEE	Prior to EIA/IEE approval
		Give approval and permission for forest clearance of the national forest land	After approval of EIA/IEE
		Assist proponent in pegging, measuring and evaluation of the forest resources of the affected forest stretch	Pre-construction phase
		Review of monitoring reports of project construction and operation and provide comments for corrective actions related to forest and ecology	Before construction starts
		Assist the proponent in identification of compensatory afforestation areas as per the plans of the district	As and when required during construction and operation phases
		Advise and assist the proponent in the forestry awareness programs	As and when required during construction and operation phases, twice a year
		Supervision to the construction sites nearby forest areas and provide input to the KAHEP management during construction	Twice a year
4	Proponent and its institutional line offices	Ensure that the EIA mitigation measures are incorporated in the final project design and tender documents of project construction and operation	Prior to contract award
		Acquire necessary permits and approval for project construction and operation	Before construction
		Ensure that the project construction and operation activities are in accordance with EIA and other GON legislative requirements	During construction, and operation phase
		Monitoring and record keeping regarding environmental measures and impacts	During construction and operation
		Ensure public participation and involvement in project implementation and operation	During construction and operation.
		Compilation of environmental monitoring and performance report and dispatch for review through proponent to stakeholders	Every 2 months during construction
		Compilation of environmental monitoring and performance report of construction activity and dispatch for review through proponent to stakeholders	Once within 3 months of construction completion

SN	Stakeholder	Roles and Responsibilities	Time Schedule
		Compilation of environmental monitoring and performance report of operation activity and dispatch for review to stakeholders	Once within 3 months for the first two years of operation
5	Kabeli-A Environment and Community Development Unit (KAECDU)	Supervision, baseline, compliance and impact monitoring of construction contractor's activities as per responsibilities in the contract document; advise the proponent and supervising engineers on needed actions on site in regular environmental management meetings	Daily, weekly, monthly, every 3 months
		Monitoring implementation of the socio-economic physical, cultural, chemical and biological environmental responsibilities of the proponent not included in the contractual documents and advise the proponent on needed actions	Regularly during construction phase
		Provide needed corrective actions as per the field requirements to minimize the impacts	Regularly during construction phase
		Prepare environmental monitoring report of the project construction and forward to the proponent for review	Bi-monthly during construction and after three months of the project construction completion.
6	Construction Supervising Engineers	Supervise the construction works as per the provisions of EIA and direct construction contractor in consultation with the environmental engineers for the environmental improvements	Regularly during construction phase
		Preside monthly Environmental Management and Health and Safety Meetings of the supervising engineers, contractors and Environmental Engineers and maintain the records for implementation status and needed corrective actions	Monthly during construction
7	Construction Contractor	Implement mitigation measures as specified in EIA or as instructed by supervising engineer	Daily during construction phase
		First hand monitoring and record keeping of environmental mitigation measures implemented and their performance	Regularly during construction phase
		Implement any corrective actions specified by supervising engineers within specified time	Regularly during construction phase
		Provide training to operator	First 1 year of operation phase
8	District Development Committees	Provide recommendations to the proponent with comments and suggestions and assist proponent in the project implementation	Prior to proposal implementation
		Assist in public consultation awareness building organized by the proponent	During construction and operation
		Assist and provide suggestions to the proponent in the matters related to community mobilization	During construction and operation
		Review monitoring reports of project construction and operation and provide comments for corrective actions	As and when required during construction and operation phases

SN	Stakeholder	Roles and Responsibilities	Time Schedule
		Ensure that transparency in the project activities is maintained by all concerned stakeholders as per IEE report and commitments	Regularly during construction and operation
9	Affected Village Development Committees	Provide recommendations to the proponent with comments and suggestions and assist proponent in the project implementation	Prior to proposal implementation
		Assist in public consultation awareness building organized by the proponent	During construction and operation
		Assist and provide suggestions to the proponent in the matters related to community mobilization	During construction and operation
		Review monitoring reports of project construction and operation and give comments for corrective actions	As and when required during construction and operation phases
		Form Environmental Enhancement committees in each of the project affected VDCs and a central committee of EEC of the affected VDCs through a public franchise process to select and assist programs of Environmental Enhancement implementation	Pre-construction and as and when required during construction and operation
		Ensure that transparency in the project activities is maintained by all concerned stakeholders as per IEE report and commitments	Regularly during construction and operation
10	NGOs ,CBOs, WUG, CFUG	Provide recommendations to the proponent with comments and suggestions and assist proponent in the project implementation	Prior to proposal implementation
		Assist in public consultation awareness building organized by the proponent	During construction and operation
		Assist and provide suggestions to the proponent in the matters related to community mobilization	During construction and operation
		Review monitoring reports of project construction and operation and provide comments for corrective actions	As and when required dueing construction and operation phases
		Assist project affected VDCs to form Environmental Enhancement committees in each of the project affected VDCs and a central committee of EEC of the affected VDCs through a public franchise process to select and assist programs of Environmental Enhancement implementation	Pre-construction and as and when required during construction and operation
		Ensure that transparency in the project activities is maintained by all concerned stakeholders as per IEE report and commitments	Regularly during construction and operation

To effectively integrate various stakeholders of the KAHEP into an Environmental Management system, an institutional framework for different phases of the project development and implementation has been established. The objective of the institutional framework is to establish linkages of various stakeholders so that project activities are taken forward through a linear command and control, while inputs from various stakeholders are internalized in the project implementation at various levels.

8.2.2.3 Interagency Coordination

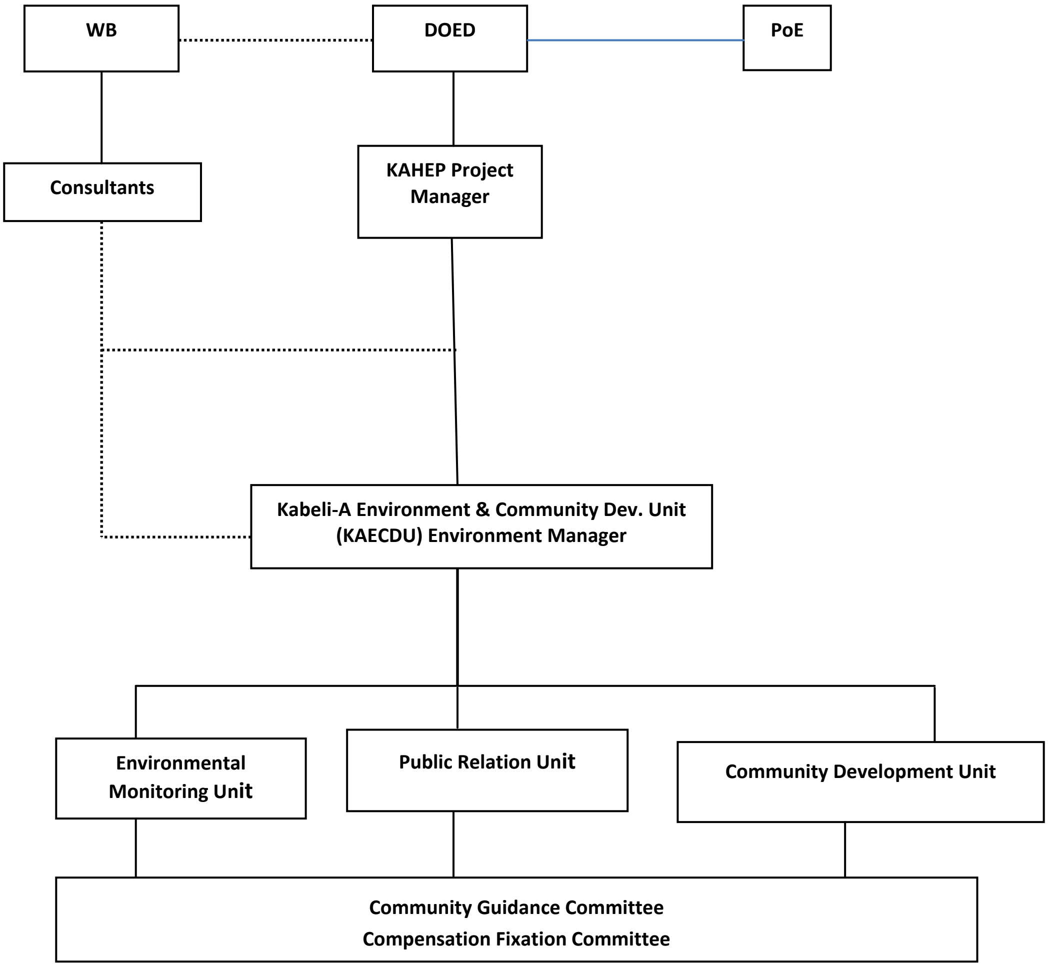
Multiple stakeholders involved in the project represent different institutions. There is a need to have an interagency coordination. Environmental and Community Development Unit of the KAHEP (KAEDU) project management office is the key agency involved in the interagency coordination. It has been assigned the key role in the information dissemination and operation of the Project Information Center (PIC) at the project site. The Environment Manager of the Unit will be responsible for the organization of meetings with the stakeholders, particularly district and VDC based stakeholders of the project affected area. At least once in two months an interagency coordination meeting will be called by KAECDU to give first-hand information of the project activities, progresses, and issues that need participatory approach for resolution, etc. KAECDU will provide issues which need participatory actions to the local level monitoring. . The inputs from the stakeholders will be taken into consideration for further actions. An update on the resolution progress of issues raised by the stakeholders in earlier meetings will be also shared with the local stakeholder in these meetings.

8.2.2.4 Institutional Arrangements

From the past experiences it has been proven that timely engagement of local people through a local organization can bridge project and people to implement EMP and Social Action Plan (SAP) effectively. Similarly, it is equally helpful to address and manage the upcoming environmental and social affairs pragmatically during the construction and operation of the project. KAHEP will be the primary agency to plan, implement and monitor the project related environmental and social action plans. A comprehensive EMP, SAP and Corporate Social Responsibility (CSR)/Benefit Sharing Strategy have been prepared based on the Governmental and corporate Policies and the World Bank safeguards.

An organizational setup for the EMP, SAP and CSR implementation is necessary to ensure compliance with policies and procedures, land acquisition and resettlement activities and implementation of mitigation measures. To ensure the achievement of these activities, organizational implementation and management for EMP and SAP will occur at both central and site levels.

Figure8.1: Organization chart for planning and implementation of EMP and SAP



Note: Bold line is the line of command

Central level arrangement

The KEL management will be responsible for overall project coordination and management of the EMP, SAP and CSR/BS implementation and budget arrangement. KAHEP Environment Manager, in close coordination with the Project manager, will lead the overall management of environmental and social issues, review and approval of EMP/SAP/CSR and their periodic monitoring and successful implementation.

Project level arrangement

KAHEP will design plans and programs that will be implemented and monitored at the project level by the Kabeli-A Environment and Community Development Unit (KAECDU) after a review by the Panel of Expert (PoE). The KAHEP site office is functioning since 2010, since the start of the project study. A full team of KAECDU has been deployed at the site since October 2011. Due to the project implementation delays, the Environmental and social team is now downsized and working at the project head office in Kathmandu with frequent site visits as necessary. A Public Information Centre has been established in August 2011 and is still functioning. The KAECDU is responsible for the periodic monitoring of the planned activities implementation.

Community Guidance Committee (CGC) will be formed with the representatives (elected or accepted persons from villages) from each of the direct project impact area. This Committee will be supported by the project and will work in close co-operation with the DDCs, VDCs, DFOs, CFUGs and NGOs during the implementation phase. The KAECDU will liaise with all relevant local GOs, NGOs and CBOs.

8.2.2.5 Roles and Responsibilities of Proponent, Environment and Community Development Unit, Supervising Engineers, Contractors and Sponsors in Monitoring/Auditing, Records and Reporting

To demonstrate compliance with the environment health and safety management, the proponent will instruct the construction contractors through supervising engineer to maintain daily records of the mitigation implementation and monitoring works in retrievable forms during the construction phase. Additionally, contractors will keep record of the local area people employment, Nepali and foreigners and will submit such records to the Supervising Engineers every month. Similarly, records of occupational health will be documented in retrievable forms and submitted to the Supervising Engineer every month. Records of instructions, trainings, and land area rented with agreements will also be submitted to the Supervising Engineers regularly. Similarly, theKAECDUwill maintain records of tree felled, land area acquired, and expenses of land acquisition, resettlement and rehabilitation and other environmental enhancement programs implemented.

The KAECDU will carry out monitoring/auditing works of the activities of the construction contractors, will keep the retrievable records of contractors and forward them to the project engineer. KAECDU in coordination with the Supervising Engineer will fix dates for monthly meetings on environmental management and health and safety with the contractor. Such meetings will be chaired by Supervising Engineers, while the Environment Manager of unit will be present in the meeting. Environmental Manger will brief on the project performance related to environment and social issues and flag issues to be resolved in the construction sites with recommendations on corrective actions. The meetings deliberation and agreements with the contractors will be recorded and signed for future actions. As per the requirement, the Environmental Manager will send the corrective actions to be taken by the contractor through the supervising engineer.

Bi-monthly reports produced by the KAECDU will be distributed to the concerned stakeholders for their comments and suggestions.

The KAECDU will compile the environmental monitoring/auditing report of the construction phase within 3 months of the construction completion and submit to the proponent. Proponent will pass the report to the stakeholders to obtain their feedback and develop a database of environmental management works of the proposal for the future use.

During the operation phase, the Operation Manager will keep records of the mitigation and monitoring as required in the retrievable forms. Once a year, the Operation Manager will prepare a compiled report of the project operations. The report will be passed to the concerned stakeholders for comments and suggestions. The operation management office will implement stakeholders' recommendations and suggestions.

Additionally, an independent Panel of Experts (POE), comprising an environmental expert and a social expert, was established for the project preparation phase as per the World Bank Operational Policy on Environmental Assessment and Involuntary Resettlement of Indigenous People. The POE will be continued during the implementation of the project. The Panel will, inter alia, review, comment, provide suggestions/ recommendations as necessary and appropriate, or as requested by the KEL or its consultants, for a successful completion and approval of the environmental and social studies.

8.2.3 Environmental Management of Construction

8.2.3.1 Contractor's Responsibility for Environmental and Social Compliance

The contractor is responsible for preparation of the site specific plans as stipulated in the EMP and its subsequent obligations under each plan. The plans will be inclusive in a broader Environmental Management and Execution Plan (EMEP) of contractor to be submitted by the contractor to the client. The project management will include the above provision in the contract documentation as a priority clause for compliance.. The EMEP shall be approved prior to the implementation of contractor's mitigation obligations or as per deadline highlighted in the contract documentation.

1. The contractor should prepare EMEP and submit it to the engineer or KAECDU within 60 days of mobilization of the contract.
2. This requirement will be spelled out in the contract documentation.
3. The plans to be submitted by the contractor within EMEP include:
    - Construction camps and traffic management plan,
    - Temporary land acquisition plan,
    - Pollution abatement plan,
    - Terrestrial ecology management plan,
    - Aquatic ecology management plan,
    - Erosion abatement and muck/spoil management plan,
    - Public health and occupational health and safety plan,
    - Emergency management plan
    - Rehabilitation management plan
    - Chance find procedures
    - Labor law compliance
    - Security personnel
4. The implementation modality of above plans shall be clearly mentioned by the contractor in the EMEP.
5. The implementation modality shall include the organizational structure of the EMEP implementers, timeframe, methods, monitoring and reporting mechanisms.

The minimum obligation of the contractor to be included in each of the specified plans will be as per the basic features of the plans discussed above (section 8.2 and in the mitigation section of Chapter VI) with details of actions, timing of actions andredress mechanism in the event of failure to comply with the actions.

8.2.3.2 Permits and Approvals

The objective of permits and approvals is to comply with the government legislative mechanism and to keep cordial relationships with the project stakeholders.

There is a number of legislative provisions which require prior permits and approvals from the concerned government agencies to commence the works. Besides, some activities would require general concensus of the project area communities or individuals for smooth operation of certain activities of construction and operation.. In these cases, project management will obtain prior permits and approvals or concensus of the affected communitiesand general public before the start of activities.. The permits and approval or concensus required for the project are presented in Table 8.2.

Table 8.2: Permits and Approvals

SN	Required Permits and Approvals	Agency from where permits and approvals or consensus required	Implementation Timeline in project lifecycle	Responsibility
1	IEE Approval and construction license	Ministry of Energy	Pre-construction	KAHEP Management
2	Tree clearing from government managed forests	District Forest office and Ministry of Forests and Soil Conservation	Pre-construction	KAECDU
3	Tree clearing from community Forest/Leasehold forest	District Forest Office, Forest User Groups	Pre-construction	KAECDU
4	Permanent land acquisition	Chief District Officer	Pre-construction	KAECDU
5	Temporary land acquisition	Landowners	Pre-construction	Contractor
6	Entry to private land and property , if required	Landowners	Construction	Contractor
7	Relocation or disturbance of obstruction to infrastructure such as foot trails, irrigation facilities, water supply facilities, telephone lines, electricity lines etc.	Affected parties/individuals	Construction	Contractor

All approvals and permits will be procured at least a week before the start of pre-construction and construction works by the reponsible stakeholders as listed in the table above. The permits and approval will be documented and recorded iat the Project information Center at the site.

8.2.3.3 Environmental Training

The objective of the environmental training plan is to make aware and educate the project management team, engineers, supervisors, contractors and the workforce on the environmental issues of the project and on how each individual could contribute to the upkeep of the environmental resources of the project area. The training will also focus on the key responsibilities of the individuals involved in project management for environmental related decision making on implementation, monitoring, reporting and corrective actions.

Since environmental management is a continuous process, apart from the general training to the managers, engineers and contractors, a trainers training will be provided to the section heads responsible for the KAHEP's environment management and community development units. The objective is to roll out the daily training needs during the project construction period for the old and new construction workers and engineers. The Environmental Training Plan is presented in Table 8.3.

Table 8.3: Environmental Training Plan

SN	Actions	Target Groups	Timing of Action	Responsibility
1	Orientation and Environmental Training related to KAHEP,including OHS requirements	Project decision making Project Management Team	Pre-construction	KAECDU in co-ordination with EIA consultant
2	Orientation and Environmental Training related to KAHEP, including OHS requirements	Project decision Making Contractor Management Team	Pre-construction	KAECDU in co-ordination with EIA consultant
3	Orientation and Environmental Trainers Training related to KAHEP with focus on mitigation and monitoring actions (EMP Implementation), including OHS requirements	Section staff of Environment and Community Development Unit	Pre-construction	KAECDU in co-ordination with EIA consultant
4	Orientation and Environmental Trainers Training related to KAHEP with focus on mitigation and monitoring actions, including OHS requirements	Section staff of Environment and Community Development Unit of Project Contractor	Pre-construction	KAECDU in co-ordination with EIA consultant
5	Orientation and environmntal training to the project operators on oil handling, storage, and recycling, occupational health and safety, and emergency prepardness	Project operation team	At the begining of the operation phase	KAECDU in co-ordination with the electro-mechanical contractor and EIA consultant

The environmtal training will be provided at least a month before the start of the actual construction works. All training materials and the stafftaking training will be documented and a copy will be kept in the public information center at the site. For the operation phase such a training will be provided before the handover of the electromechanical facilities to the KAHEP management. The training materials will be documented and kept at the project site office as a reference document through the construction period.

8.2.3.4 Construction Camps and Traffic Management

Transportation of construction equipment and accessories and establishment of various camps for engineers, contractors, workers, storage yards, and mechanical yards are the first activities of the inception phase of HEP. The construction preparation activities at the site have a lasting consequences both environmentally and socially. Therefore, planning for traffic management (on site and along the road corridor) and management of construction camps and storage facilities (fuel, hazardous materials, and explosives) are crucial for the overall environmental management plan. A proper and sensible planning at this stage will avoid likely environmental and social adverse consequences in the future. The highlights of construction camps and traffic management plan are presented in the Table 8.4.

Table 8.4: Construction Camps and Traffic Management

SN	Activities	Timing of Actions	Responsibilities
1	Pre-information to the local area people on the start date of project preparation works and the range of activities to be undertaken	Pre-construction (Start of construction preparation at site)	KAECDU
2	Preparation of environmental management plan for the construction camps (issue based and site based)	Pre-construction (Start of construction preparation at site)	Contractor
3	Checking and approval of plan (check landscape harmony, adequacy of space, room size, ventilation system, fire hazard equipment placements, toilets, water supply system, communication systems, medical facilities, drainage system, common cooking and dining space, sewage treatment system, recreational facilities, solid waste collection and storage facilities, top soil excavation, and storage area for later use, muck placement site for later final disposal in muck spoil disposal sites, fencing, hoarding board placement sites etc.)	Pre-construction (Start of construction preparation at site)	Supervising engineer and KAECDU
4	Identification and preparation of sites for the parking of the project vehicles (off the road site)	Pre- construction(Start of construction preparation at site)	KAECDU/Contractor
5	Identification and preparation of sites for material storage and staying facilities for the early construction workers/contractors with adequate facilities of water supply, drainage, cooking, dining, toilets, solid waste collection and storage, place of disposal of various categories of wastes etc.	Pre-construction (Start of construction preparation at site)	KAECDU/Contractor
6	Site clearance and construction plan for construction camps (engineer, contractor, labor force, mechanical yards, long term storage facilities for lubricants, fuel, and explosives, etc.) with plans to save top soil for later use	Pre-construction (Start of construction preparation at site),	Contractor
7	Preparation of a Guideline for construction vehicle operation (speed, use of horn, parking on the road and off the road etc.) and meet pollution criteria green stickers, OD equipment movement, Hazmat movement, Transport Emergencies, timing of movement, traffic personel deployment	Pre-construction (Start of construction preparation at site)	Supervising engineer and KAECDU
8	Construction of camps and facilities including fuel storage yards, lubricant and other hazardous material storage yards, explosive bunkers for storage of explosives etc.	Pre-construction (Start of construction preparation at site)	Contractor
9	Monitoring of related activities (as per Table, 8.12, 8.13, and 8.14).	Pre-construction (Start of construction preparation at site)	Supervising engineer and KAECDU
10	Operation management guideline for permanent operation camps, transport vehicle, code of conduct	Start of the operation	Project Operation managemnt team of

SN	Activities	Timing of Actions	Responsibilities
	of the operation personnel, of sanitation facilities etc.	Phase	KAHEP

The contractor will be responsible for the preparation of issue based and site specific environmental management plans for construction camps and traffic management immediately after the contract award and a joint site inspection. The plans will be checked to the adequacey as per the minimum requirements for the management of construction camps and construction vehicle traffic management and will be approved by the supervising engineers and the environmental officer before the start of the work. All plan documents will be kept in retrivable form by the project management office. One copy of the document will be kept at the Project Information Centre. All data as per the plan will be kept in a retrivable form by the contractor at its site office and will regularly furnish the information as demanded by the supervsing engineer and a project environmental officer. For the operation phase, the project operation manager will prepare and implement the plan, and keep implementation records as required by the plan in a retrivable form to present the report when demanded by the KAHEP management or the an external auditor.

8.2.3.5 Pollution Abatement

The objective of the pollution abatement plan is to avoid or minimize the pollution streams (gaseous, liquid, solid and acoustic) from the project activities during pre-construction, construction and operation periods of the project. Both preventive and remedial measures will be implemented by the project. The preventive measure focus on preventing pollution streams whereas the remedial measures will focus on the measures to minimize the effects of pollution through end of the pipe treatment technologies. A number of measures have been listed in the mitigation measures in Chapter VI for air, water, land, and noise pollution. Table 8.5 highlights the key features of the pollution abatement plan.

Table 8.5: Pollution Abatement Plan (Key Features)

SN	Activities	Timing of Actions	Location	Responsibilities
A	**Air Pollution Abatement**			
1	The earthern and gravelled road corridors will be sprinkled regularly to minimise the fugitive dusts generated by construction related vehicles plying particularly in the winter and sumer dry season.	Pre-construction, Construction period	From Bhanu Chowk to headwork construction sites and Bhanu Chowk to Powerhouse construction site	Contractor
2	The aggregate crushing sites and active construction sites will be sprinkled regularly by water as to the requirement on the advice of supervising engineers	Construction period	Aggregate crushing site, and active construction site	Contractor
3	All persons at the construction sites, engineers and supervisors will be provided with PPE (air masks, helmetsand safety goggles as per IFC EHS guideline) and provided OHS training at regular interval (once in 6	Pre-construction, Construction, operation period	All construction sites	Contractor in preconstruction and construction phase and KHEP operation management in Operation phase

SN	Activities	Timing of Actions	Location	Responsibilities
	months)			
4	Ventilators of adequate capacity for ventilating the tunnel area during blasting and mucking period	Construction period	Adit portals to tunnel	Contractor
B	**Water and land pollution abatement**			
1	All construction sites (headworks, and powerhouse) will be failitated with runoff drainages during construction period and later remodified to suit to the local conditions in the operation period as a permanent network. The run off water collected will be safely discharged to the natural water bodies.	Construction Period	All construction sites	Contractor
2	All drainage networks at the construction sites and camp areas, spoil disposal sites etc are maintained and kept functional at all times	Operation Period	All project sites	KAHEP operation management
3	All project facility sites (camps, STP mechanical yards, storage facilities, muck diosal sites etc.) will be failitated with temporary drainage facilities to collect and discharge the run off water after required treatment (sedimentation and oil and grease removal)safely to the natural water bodies.	Pre-construction, Construction period	All camp and facility sites	Contractor
4	The quarry operation will not be carried below the flowing water level of the river	Construction period	Quarry site	Contractor
5	Excavation of the aggregates from river wet channels will be prohibited	Construction period	Quarry site	Contractor
6	Flood plain quarrying will be carried out only in the dry season i.e from November through May only	Construction period	Quarry site	Contractor
7	Discharge of construction waste such as cement, and concrete slurry will not be discharged to the river water.	Construction period	Headwork, powerhouse	Contractor
8	The tunnel seepage water discharges will be collected in settling tanks/ponds outside the portal areas in a suitable location for sedimentation and treatment before final discharge (minimum water retention time of the tanks is 2 hours)	Construction period	Tunnel discharge points	Contractor

SN	Activities	Timing of Actions	Location	Responsibilities
9	The water discharged from aggregate washing plant will be collected in settling tanks/ponds at suitable location for sedimentation and treatment (minimum water retention time of the tanks is 2 hours)	Construction period	Aggregate waste water discharge point	Contractor
11	All spent grease and mobil and unused or date expired toxic chemicals will be collected separately in plastic drums and stored in a safe place under the shade	Pre-construction, Construction /operation	All construction sites, camps and other facility sites/operation	Contractor /Operation manager
12	All containers of the grease, mobil, and toxic chemicals will be punctured and stored in a safe place under the shade	Pre-construction, Construction /operation	All construction sites, camps and other facility sites/ powerhouse	Contractor/Operation manager
13	The unused chemicals, spent mobil, grease etc. will be stored in plastic drums for disposal and will be disposed with the approval of the project environment and community development unit	Pre-construction, Construction period and operation period	All construction sites, camps and other facility sites	Contractor /operation manager
14	The petroleum bunkers will be placed in a separate area in a concrete bounded area with the facility of oil and grease separator	Pre-construction, Construction period	Storage yards	Contractor
15	The waste water from the mechanical yards will be collected in a separate area. The water will be treated for the oil and grease and then released into the water bodies.	Construction period	Mechanical yard waste water discharge point	Contractor
16	Provisioning of adequate toilet facilities will be made in the camps and active construction sites. The toilet waste of the camps will be drained to a single treatment facility in each camp. The treated water will only be released to the nearby area.	Pre-construction, Construction period	All camps and active construction sites	Contractor
17	Open defecation will be prohibited in and around the construction sites, camp sites and in the river bank area. Hoarding sign boards will be placed in the construction camps, and active construction sites.	Pre-construction, Construction period	In areas surrounding the construction sites	Contractor
18	A solid waste collection and storage system will be established in all the construction related camps and construction sites. The collected waste will be segregated as to the property of the waste as degradable, glass,	Pre-construction, Construction /operation	All camps and active construction sites/Operation camps	Contractor / Operation Manager

SN	Activities	Timing of Actions	Location	Responsibilities
	metals, plastics, cloths and leather etc. and will be stored in separate bounded areas. These materials will be disposed as to the recommendations and approval of the project environment and community development unit			
19	Garbage containers of adequate size will be placed at critical places in the construction related camps and construction sites. The collected garbage will be collected daily for segregation and storage as outlined above	Pre-construction, Construction /operation	All camps and active construction sites/Operation camp	Contractor /Operation Manger
20	Stockpiling and storage of the construction materials in designated sites only away from the water paths. Prohibition on the stockpiling of construction materials in other areas	Pre-construction, Construction period	All camps and active construction sites	Contractor
21	Muck disposal will be carried out in the designated sites only. Prohibition of muck disposal in other non-designated areas	Construction period	All camps and active construction sites	Contractor
C	**Noise Pollution Abatement**			
1	Operation of noise generating construction actvities in the day time zone as far as possible	Pre-construction, Construction period	All camps and active construction sites	Contractor
2	Prohibition on blasting operations in the night time zone only. Prior information should be given through siren blow 10 minutes before the blasting operation and 10 minutes after the balsting operation	Construction period	Tunnel, headwork, and powerhouse	Contractor
3	Regular maintenance of the vehicles to reduce the mechnical and body noise while plying	Pre-construction, Construction period/ operation period	All vehicle and machinery	Contractor/Operation manager
4	Prohibition in the blowing of horns in critical stretches close to villages and near the school area along the road	Pre-construction, Construction period and operation period	Villages and school areas	Contractor /Operation manager
5	Fitting of noise reducing equipments in the ventilators compressors and diesel generator sets	Pre-construction, Construction period	ventilator compressors and desiel generator sets	Contractor

SN	Activities	Timing of Actions	Location	Responsibilities
6	Controlled blasting will be practiced at all times while excavating the surface or underground area to have a minimum noise vibration impact	Construction period	All sites of blasting	Contractor
D	**Monitoring**			
1	Compliance Monitoring of A,B,C activities (as per Table, 8.13 and 8.14)	Construction /Operation	All above sites	KAECDU/ Operation Manager
2	Impact Monitoring related to A, B, and C (as per Table, 8.12,8.13 and 8.14)	Construction /Operation	All above sites	KAECDU/ Operation Manager

The contractor will prepare issue based and site specific pollution abatement plan incorporating the minimum provisions listed above and in the mitigation section of Chapter VI. This plan will be submitted to the supervising engineers for a prior approval of a concerned environmental officer before the project construction works start. The approved pollution abatement plan of the contractor will be documented and placed in the public information center at the site office as a reference document.

8.2.3.6 Terrestrial Ecology Management

The objective of terrestrial ecology management plan is to ensure that the terrestrial resources such as forests/vegetation, and wildlife of the project site and surroundings will not face adverse impact due to the project implementation. However, project efforts will help to safeguard ecosystem and enhance its goods and services. The activities of the terrestrial ecology management plan are presented in Table 8.6.

The contractor will be made contractually responsible for provisioning local employment, supply of kerosene and LPG at the labor camps, for prohibiting the use of local NTFP and wildlife within the camp etc**.** The project management will ensure that the above provisions are adequately covered in the bid documents. The project management and its environment and community development unit will be responsible for drawing terrestrial ecology management plan, particularly the public awareness and compensatory afforestation management plan, based on the wider consultation with the local communities, community forest user groups, leasehold forest user groups and concerned government line agencies.

Table 8.6: Terrestrial Ecology Management Plan

SN	Activities	Timing of Actions	Location	Responsibilities
1	Preference to the local for project employment	Pre-construction, construction and operation	All project works	KAECDU/contractor /Operation Manager
2	Provision of kerosene to the outside workforce for cooking	Pre-construction, construction	Construction workers of all project sites	Contractor

SN	Activities	Timing of Actions	Location	Responsibilities
3	Provision for camp lodging to the outside workforce with a common LPG cooking facility	Pre-construction, construction	All outside construction workers camp	Contractor
4	Prohibition on the sale and purchase of the local NTFP and fishes in the camps	Pre-construction, construction and operation	All project locations	KAECDU/Contractor /Operation Manager
5	Prohibition in roaming in the local forest area by the outside workforce	Pre-construction, construction and operation	Surrounding areas of project site	KAECDU/Contractor /Operation Manager
6	Compensatory afforestation as per the forest guideline (2006) ▪ Consultation with the District Forest Officer and the local community forest, lease holders/ forest user groups and local community to identify the required area for compensatory afforestation ▪ Preparation of nursery beds for seedling preparation preferably of the lost species plantation in 1:25 ratio ▪ Seedling preparation ▪ Plantation of the seedling in the afforestation area as per forest norms ▪ Taking care of the plantation area for 5 years to ensure that the planted trees or deposit the required amount to the district forest office to grow to sufficient height ▪ Handover the afforested area to the district forest office after 5 years	Construction and Operation	Areas as designated by the District Forest Office	KAECDU
7	Lease Compensation to the Forestland Area	Construction and Operation	All permanently occupied forest areas	KAECDU/ Operation Manager
8	Clearing of the forest vegetation and stockpiling the vegetation products before handover:	Construction	All permanently occupied forest areas	KAECDU
9	Clearing of the forest vegetation as to the requirement of project structures and facilities only	Construction	All permanently occupied forest areas	KAECDU
10	Technical and Financial assistance to the Affected Community Forests and Leasehold Forest User Groups	Construction	Project affected community forest and leasehold forest	KAECDU

SN	Activities	Timing of Actions	Location	Responsibilities
11	Project will inform in time to the local authorities, VDC chairperson, Community forest user groups, leasehold forest user groups and the forest range post office, if it finds the forest area is encroached close to the construction site	Construction	Surrounding forests of the project site	KAECDU
12	Project will assist the local authorities in the protection works of the forest areas close to the construction sites.	Construction	Surrounding areas of the project site	KAECDU
13	Hoarding boards will be placed at critical location of the access road on the preventive actions to control the forest fire	Construction	Surrounding areas of the project site	KAECDU
14	Public awareness programs will be launched to prevent the forest fires in the local area	Construction	Surrounding areas of the project site	KAECDU
15	Project workers will be regularly informed not to throw lighted cigarette tips in the forest areas and not to use forest area as picnic spots	Construction	Surrounding areas of the project site	KAECDU
16	Compliance and impact monitoring of the related activities as per Table 8.13 and 8.14	Construction/operation	All sites as designated	KAECDU/Operation Manager

8.2.3.7 Aquatic Ecology Management

One of the key impacts of KAHEP will be on the aquatic ecology of the Kabeli River with potential long term implications on the aquatic ecology of the Tamor River basin as well. Though the impacts of the river diversion cannot be completely avoided, however, it could be minimized to the extent possible by implementing the activities listed (Table 8.7) as a part of the aquatic management plan in the project life cycle.

Table 8.7: Aquatic Ecology Management

SN	Activities	Timing of Actions	Location	Responsibilities
1	Restriction on fishing activities by the construction workforce on the Kabeli and Tamor River	Pre-construction and construction	Kabeli and Tamor River	KAECDU and Contractor
2	Implementation of the activities of Table 8.5, B. Water and land pollution abatement	Pre-construction, Construction and operation	All project sites	KAECDU and Contractor
3	Restriction on the use of pesticides, electrical gears and explosive for fish capture in Kabeli and Tamor River	Pre-construction, Construction and operation	Kabeli and Tamor River	Project VDC authorities, District administration and Local NGOs

SN	Activities	Timing of Actions	Location	Responsibilities
4	Design and construction of a fish ladder as an inbuilt structure in the barrage and operation of the fish ladder at all times to allow upstream fish migration	Design/Construction/ Operation	Headworks	Design engineers/supervising engineers/ operation manager
5	Establishment of a fish hatchery for the target red list fish species and migratory fish species close to the project site	Construction	At suitable location close to the project site	KEL
6	Complete prohibition on the discharge of muck/spoil into the river bed	Construction	All construction sites	Contractor
7	Prohibition on aggregate mining on the river wet channel	Construction	Quarry sites	Contractor
8	Design the provision of releasing 10% of the minimum mean monthly flow as a inbuilt structure of the barrage and ensure that the structure is constructed	Design	Barrage	Design Engineer , Supervising engineer
9	Release an environmental residual flow of 10% of the minimum monthly flow for all times from the barrage through the fish ladder	Operation	Barrage	Operation Manager
10	Complete prohibition of fishing on the specified locations of the Kabeli River	Operation	Dewatered section below barrage,/ fish ladder	Project VDC authorities, District administration and Local NGOs/ Operation manager
11	Assit the local communties for the improvement of the on site sanitation management and in the use of agrochemicals in the Kabeli catchment area on regular basis	Operation	Kabeli catchments	Operation manger
12	Regular removal of the algal mat from the reservoir area from November through May each year to avoid enhancement of algal blooms.	Operation	Reservoir	Operation Manger
13	Restriction on the fishing activities in the dewatered section in the dry season (November through May)	Operation	Dewatered stretch	Operation Manager
14	Operation of the fish hatchery for the production of target fish species and release of the fingerlings of target species in the upstream areas of Kabeli and Inwa Khola	Operation	Section above the Dam site in the Kabeli and InwaKhola	Operation manager
15	Monitoring of related activities as per Table 8.12,8.13 and 8.14.	Pre-construction/construction	All project sites as designated	KAECDU

SN	Activities	Timing of Actions	Location	Responsibilities
		and operation		

The above plan elements will be subject to changes as the further assessment of the aquatic ecology, particularly environmntal flow assessment and the cumulative impact assessment, is confirmed by the third party assessment. The respective responsible agenceis will prepare the plans. The plans prepared by the contractor and NGOs will be reviewed and approved by the environmental officer of the KAHEP.

8.2.3.8 Erosion Abatement and Muck/Spoil Management

The KAHEP development works involves a number of activities that directly interact with the existing landform. The topographic setting in the Himalayan terrain is dynamic and is constantly eroding to form stable landform in equilibrium with the acting geomorphic and tectonic agents. Any interaction with the landform means promoting land erosion. The objective of this plan is to minimize the landform instabilities to reduce land erosion to the extent possible. The secondary objective is to conserve the top soil, the lifeline for any vegetative productivity. The key elements of the management plan are presented in

Table 8.8: Erosion Abatement and Muck/Spoil Management:

SN	Activities	Timing of Actions	Location	Responsibilities
1	Preference to the local people for the project employment	Pre-construction, Construction and operation	All project sites	KAECDU and Contractor
2	While preparing the site for construction at the access road, power house and headworks, the top soil will be managed separately and saved separatly for later rehabilitation works	Pre-construction/ Construction	All project sites	Contractor
3	All surface excavation above 3m vertical height will be excavated through benching	Construction	All project sites	Supervising engineer/ KAECDU/Contractor
4	The excavated surface will be protected against the water erosion by adequate vertical and horizontal drainages and the water collected from the excavation area will be discharged into safe area.	Construction	All project sites	Supervising engineer/ KAECDU/Contractor
5	Stockpiling and storage of the construction materials in designated sites only. Prohibition on the stockpiling of construction materials in other areas	Construction	All project sites	Contractor
6	Muck disposal will be carried out in the designated sites only. Prohibition of muck disposal in other non-designated areas	Construction	All project sites	Contractor
7	Prior to the start of muck disposal, the contractor will make a plan for muck disposal	Construction	Muck disposal site	KAECDU/ Contractor

SN	Activities	Timing of Actions	Location	Responsibilities
	and get approval from the project environmental officer. The plan, among others, will have measures for toe protection from the monsoon washout			
8	The muck deposited will be properly compacted and will be facilitated by surface runoff drainge facilities to avoid air pollution and run off erosion	Construction	Muck disposal sites	KAECDU/ Contractor
9	All construction sites (headworks, and powerhouse) will be failitated with runoff drainages during construction period and later remodified to suit to the local conditions in the operation period as permanent network. The run off water collected will be safely discharged to the natural water bodies	Construction	All project construction sites	Contractor
10	All project facility sites (camps, mechanical yards, storage facilities, muck diosal sites etc.) will have temporary drainage facilities to collect and discharge the run off water safely to the natural water bodies.	Construction	All project facility sites	Contractor
11	The access roads will have permanent side drain structures to collect water from the upslope area. The collected water of the side drains will be discharged to suitable natural waterways to avoid upstream and downstream erosion	Construction	All project sites	Contractor
12	Road upgrading works requiring road widening will avoid further cutting of slopes by maximizing back filling operation taking benefit of the micro-topography and retention walls wherever required	Construction	All project sites	Contractor
13	Access roads across agricultural fields, provisions will be made to drain the slope water to the downslope agricultural land such that the water required for irrigation is not blocked with prior consultation and agreement with farmers	Construction	Access roads across agricultural fields	Contractor
14	Cleaning of the road side drains and other drainage structures regularly once before the onset of monsoon, twice during monsoon and once after the monsoon such that the drains are maintained to operate as designed and are not filled with the sediments derived from the side slopes	Construction	Access roads and drainages in other areas	Contractor
15	The river bank erosion due to bed level rise and damage to the agricultural field will be minimized by the river bank protection measures in the critical areas successively as the erosion potentials are noted or reported by	Operation	Reservoir Area	Operation Manager

SN	Activities	Timing of Actions	Location	Responsibilities
	the farmers			
16	Monitoring of related activities as per Table 8.12. 8.13 and 8.14	Pre-construction, construction /operation	All project sites as designated	KAECDU/Operation Manager

The contractor will prepare a muck /spoil disposal plan and topsoil saving and reuse plan in the designated areas provided by the project management at least a month before the actual excavation works and will take approval from the project environmental officer. The spoil disposal and top soil saving plan will incorporate the minimum provisions as stipulated in the mitigation section in Chapter VI. This document will be placed in the project information center as a reference document.

8.2.3.9 Public Health and Occupational Safety ManagementPlan

The project development sites are areas of high human concentration. High human concentration at one location is always associated with high pollution loads to the environment, particularly sanitary and solid waste. Normally, the project development sites in the rural areas are thinly populated and the population is not exposed to high pollution loads of diverse types. This increased pollution, in an infrastructure deficient area to treat the pollution, becomes the primary cause of public health degradation. Apart from this, people from different places and with different diseases come in the area as project workers or economic opportunity seekers. They may also act as carriers of the communicable diseases which are otherwise alien to the local population of the project area.

As the construction work is associated with diverse types of risk prone activities. The workers involved in the construction works are exposed to these occupational risks. Sickness, injuries, and even fatal accidents cannot be ruled out. The increased traffic of construction vehicles and associated fugitive dust and noise are yet another source of direct imperative health effects, even fatal to both the project area people and occupational workers.

Taking the above mentioned probabilities into consideration, this public health and occupational safety management plan will be developed to minimize the risk on public health and occupation health of the construction workers. Table 8.9highlights the key features of the Plan.

Table 8.9: Public Health and Occupational Safety Management Plan

SN	Activities	Timing of Actions	Location	Responsibilities
1	Implement Pollution Abatement Plan (Table 8.5)	Pre-construction, construction/operati on	All project sites	Contractor /Operation Manager
2	Preparation of occupational health and safety plan and submission to Environment and Unit of KAHEP for approval	Pre-construction	For all project sites construction workers	Contractor
3	Approval of the occupational health and safety plan by Environmental and Community Development Unit of KAHEP for	Pre-construction	For all project sites	KAECDU

SN	Activities	Timing of Actions	Location	Responsibilities
	implementation			
4	Provision of First aid facilities	Construction	All active construction sites and residential and non-residential camps and yards	Contractor
5	A 15 bed hospital with a medical doctor (1) a nurse (2) and 2 health workers at the construction site	Construction	Construction Camp	Contractor
6	Medical checkup of the workforce before employment	Construction	All Project construction workers	Contractor
7	Regular medical checkup of the construction workers every 6 months	Construction	All Project construction workers	Contractor
8	Provision of health check-ups to the local public	Construction	People of surrounding settlement	Contractor
9	Water supply facility with a treatment unit	Construction	All project camps	Contractor
10	Establishment of garbage collection and management system	Construction	All project camps	Contractor
11	Establishment and construction waste collection system and management	Construction	All active construction sites	Contractor
12	Fencing of all construction sites and restriction on entry to the outsiders others than authorized person	Construction	All active construction sites	Contractor
13	Appropriate danger signs in all active construction sites work areas as to the degree of risk in the site	Construction	All active construction sites	Contractor
14	Provision of Personal Protective Equipment (such as boots, gloves, masks, ear plugs, helmets, safety goggles etc.) to the construction workers as appropriate to the requirement and risk of the working area and implement the use effectively	Construction	All construction workers	Contractor
15	Regular training as required to the construction workers and health and safety	Construction	All construction workers	Contractor

SN	Activities	Timing of Actions	Location	Responsibilities
	issues of the construction works			
16	Regular training to operation staffs as required on occupation health and saety issues and preparedness along with emergency drills	Operation period	All operation staffs and workers	Operation Manager
17	Monitoring of compliance and impact related to the above measures as per Table 8.12 and 8.13 and 8.14	Pre-construction	Areas as designated	KAECDU
18	Insurance of workers	Pre-construction	All workers	Contractor
19	Insurance of workers	operation	All staffs and workers	Operation Manager

Community and occupational health and safety plan will be prepared by the contractor at least a month before the start of the construction works and will take approval from the project environmental officer. The plan will include the provisions as specified in the IFC EHS specifications. This document will be placed in the public information center at the site office as reference document for the monitoring works.

8.2.3.10 Emergency ManagementPlan

The emergency management (KAHEP management and Contractor management) need to be prepared to handle unforeseen events during emergency operations. This emergency management plan highlights some key features of the emergency preparedness in the event of such unforeseen events (Table 8.10).

Table 8.10: Emergency Management Plan

SN	Activities	Timing of Actions	Location	Responsibilities
1	Provision of helipad for emergency evacuation of injured or other people	Pre-construction	Construction site	Contractor
2	Provision of standby ambulance to evacuate the injured at the earliest to the project site hospital	Construction	Powerhouse and headwork area	Contractor
3	Provision of stabilizing equipment and facilities to the injured before moving him to the nearest hospital with good facilities	Construction	Project Hospital/Health care facility	Contractor
4	Provision of medical stock particularly for water borne disease to tackle the epidemic in the camp or in the villages	Construction	Construction site hospital/health	Contractor

SN	Activities	Timing of Actions	Location	Responsibilities
	surrounding the project site		care facility	
5	Provision of firefighting equipment and regular fire fighting training and drills at least once in 6 months	Construction/operation	Construction site/powerhouse area	Contractor/ Operation Manager
6	Provision of sirens to inform people of the emergencies (fire hazards, blasting operations, chemical hazard, traffic accidents, earthquake ect.) and drill operations at least once in 6 months	Construction/operation	Powerhouse, camp sites, Headworks, Tunnel portals	Contractor and KAECDU
7	Emergency preparedness training and on drill operation (floods, release of water from dam, epidemic outbreak, earthquake etc.) at least every 6 months	Operation	All project site/powerhouse and headwork and dewatered stretch	Operation Manager
8	Monitoring of the above activities	Construction/operation	All project site/Powerhouse and headwork	KAECDU/Operation Manager

Emergency management related to community health and safety, occupational health and safety, traffic related accidents and congestions, fire outbreak, leakage of chemicals, water pollution, floods, earthquakes, any other untoward hazards will be prepared by the construction contractor including the minimum provisions listed in the table above and in the mitigation section of Chapter VI and get approval from the project environmental officer at least a month before the start of the construction works. This document will be placed in the public information center as a reference document for the monitoring.

8.2.3.11 Chance Find Procedures for Archaeological and Paleontological Artifacts

Although the EIA report did not identify any archaeological site in the area of the project, the following measures will be put in place in case sites or artifacts are discovered during the construction process:

- Workers will report the findings to the Contractors, the Supervision Engineer immediately;
- Construction activities shall stop immediately;
- The Contractor will notify the KEL that in turn shall notify the Nepal Authorities;
- The Supervisor Engineer will delineate the discovered site or area;
- The Supervisor Engineer will be responsible for guiding the Contractor to maintain the site unchanged and notify the consultative group on the field of culture and history and local authorities;
- In cases of removable antiquities or sensitive remains, the site will be secured to prevent any damage or loss of removable objects and a night guard will be arranged until the responsible local authorities arrive;
- Relevant local or national authorities will arrive to the site within 48 hours and will be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. The job of these authorities is: (i) describe the artifact or historical remain; (ii) define the scale

of the site/object; (iii) perform a preliminary evaluation; (iv) set up a plan to protect and handle the discovery; and, (v) determine the significance of the discovery. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage; those include the aesthetic, historic, scientific or research, social and economic values;

Objects with no Significant Value

If the discovery is a single object or artifact, it will be studied by the relevant authorities and then removed from the site. Construction activities can resume after permission is given by the Supervision Engineer. The survey concerning the discovery will be performed in 48 hours.

Cultural sites or relics with Significant Value

- If the cultural sites and/or relics are of high value and site preservation is recommended by the consultative group and required by Nepal Law, KEL will need to make necessary design changes to accommodate the request and preserve the site;
- If the finding is an artifact, based on the scale and nature of that artifact, the following time will be allowed for salvage V:
  - Small scale (<50m^2): 15 days
  - Large scale (>50m^2): more than 15 days
- Expenses for salvage will be included in the budget allocated for the research of cultural heritage provided by KEL. These expenses will not cover damages which may occur to the contractor caused by suspension of works.
- The Contractor will stop all works immediately at the location where cultural sites, artifacts or relics are found. To ensure that the project schedule is not affected, the construction activities shall continue in other areas;
- KEL staff and the Contractor will work together to reach an agreement regarding compensation for damages caused by suspension of construction activities;
- Construction works could resume only after a permission is granted from the responsible local authorities concerning safeguard of the heritage.

Chance-Find Report

The Contractor will, at the request of KEL or the Supervisor Engineer, and within a period of two working days, make a Chance-Find Report, recording:

- Date and time of the discovery;
- Location of the discovery;
- Description of the discovery;
- Estimated weight and dimensions;
- Temporary protection measures implemented.

The Chance -Find Report should be submitted to all related parties including relevant ministries and institutes in Nepal.

8.2.3.12 Rehabilitation Management

The primary objective of the plan is to rehabilitate the affected land area, facilities, construction sites, muck/spoil disposal sites, quarry sites, storage and mechanical yards, temporary camp sites, solid and liquid waste storage and treatment sites etc. once the construction works and its utility for the construction period is over in the designated site. This activity is envisaged to clean up the pollution created by the construction activities on land, water and air and help to restore the general aesthetic of the area similar to pre-construction period. The key highlights of the plan are presented in Table 8.11.

Table 8.11: Rehabilitation Management

SN	Activities	Timing of Actions	Location	Responsibilities
1	Rehabilitate the excavated slopes of the construction areas using appropriate bio-engineering, plantation/vegetation	Post-Construction	Access roads, headworks, tunnel portals, penstock area, powerhouse, tailrace	Contractor
2	Rehabilitate the drainage networks as to the requirement (some area might need strengthening while in some it might have to demolish completely to give the land and drainage the natural condition)	Post-Construction	Access roads, headworks, camps, storage area, powerhouse, muck and spoil disposal sites etc.	Contractor
3	Demolish all unnecessary structures, their foundations, clean up and reclaim the sites to pre-construction phase	Post-construction	Temporary residential camps, storage yards, mechanical yards, batching plant, aggregate crushers, aggregate washing plants, waste water treatment sites of tunnel and aggregate washout discharges etc.	Contractor
4	Rehabilitate the muck disposal site with proper drainage facility as per approved plan. Use the saved top soil on the top of the muck sites to develop the land in an usable land for afforestation/ or other purpose as per the recommendation of the Environment and Community development Unit of KAHEP	Post-Construction	Muck deposal site	Contractor
5	Rehabilitate quarry area in such that puddles and depressions are not left out	Post-construction	Quarry area	Contractor
6	Handover the temporary land acquired sites to the respective owners and get a certificate of handover for submission to Environment and Community Development Unit of KAHEP	Post -construction	Quarry Area /Labor camps	Contractor

The rehabilitation plan with the above provisions will be prepared by the contractor including the provisions listed in the mitigation section in Chapter VI and agreement with the private parties by the contractor at least a year before the closure of the construction works. The environmental officer will review and approve the document with needed changes. This document will be placed in the public information center as a reference document for monitoring.

8.2.3.13Grievance Redress Plan

The project company will establish grievance redress mechanism to allow the project affected persons (PAPs) to appeal any disagreeable decisions, practices and activities arising from compensation for land and assets. There are potential two types of grievances: grievances related to land loss and grievances related to compensation or entitlement.

All grievances relating to the project including land purchase and compensation or entitlement will be referred to the Project Grievances Redress Cell, Grievance Redress Committee (GRC) at local level, Grievances Committee (GC) at central project level and a formal court of appeal system.

At field project level, the project will open a Public Information Centre (PIC) at site. A project introduction and a SAP booklet will be developed and distributed among the communities. The project company will designate a Grievance Redress Officer (GRO) to receive routine emerging complaints of PAPs and stakeholders with clear responsibility to address their concerns. PAPs, as well as local people, can lodge their complaints related to acquisition and construction related activities. Grievance recording register will be established at the KAHEP site offices and all grievances, filed orally or in writing, will be registered.

The local level GRC will be comprised of GRO, one representative from Kabeli Concern Committee and one representative from the civil contractors. The chair and the convening person will be the GRO and this committee will meet every week or as deemed necessary to review all cases. The central project level GC will be comprised of Project Manager, Chief District Officer (CDO) and Chairman of the Kabeli Concern Committee (KCC). The CDO and the Chairman of KCC will be the independent members of this committee. The committee will gather as deemed necessary and the Project Manager will be the chair and the convening person. The GC will look after the grievances that cannot be resolved at the site by GRO and GRC. The proposed mechanism for the grievance resolution is provided below:

Stage 1:

Complaints of PAPs on any aspect of compensation, or unaddressed losses shall in first instance be settled verbally or in written form in the field based project office. The complaint can be discussed in an informal meeting with the PAP by the concerned personnel to settle the issues at the local level to GRO. The community consultation, involvement of social and resettlement experts will facilitate the process in this regard. All the grievances will be reviewed and the decision will be made and informed in writing to the complaining party within two weeks of complaint receipt. .

Stage 2:

If the complaining party is not satisfied with the response, the complaining party can appeal to the GRC. While lodging the complaint, the complaining party must produce documents to support the claim. All the grievances will be reviewed and a decision will be informed to the concerned party within two weeks of the receipt of the complaint.

Stage 3:

If the complaining party is not satisfied with the response from the GRC, the complaining party can appeal to the GC. While lodging the complaint, the complaining party must produce documents to support the claim. All the grievances will be reviewed and a decision will be informed to the concerned party within four weeks of the complaint receipt.

Any complaining party can exercise its constitutional right to approach the court at any time.

8.2.4 Adaptive Management of Selected Environmental Issues

8.2.4.1 Supplemental Baseline Surveys

The EIA report identified key areas in which additional information is needed to improve mitigation measures. The main supplemental baseline surveys are:

Baseline Information on the Aquatic Life and Community Water Uses of Tamor River

The baseline information on the aquatic life and community water uses of the Tamor River downstream and upstream of the Powerhouse location are not adequate. To fill this data gap KAHEP will conduct a study on the aquatic life and community water uses in the Tamor River, particularly downstream the powerhouse tailrace. The study will include fishery, phytoplankton, zooplankton and aquatic insect survey downstream of the Tamor Kabeli confluence up to 5 km downstream of the tailrace outlet once before the start of the construction to generate baseline data. Apart from this, the study will include community water uses of the Tamor River including uses of the Tamor riverine zone for various livelihoods, religious, water supply and irrigation etc. The monitoring indicators, location, methods, frequency and responsibility are described in the Table 8.12 "Baseline Monitoring Plan for Updating".

Baseline Information on the Aquatic life of Kabeli River and Its Tributaries

Available baseline information on the aquatic life of the Kabeli River and its tributaries is fragmentary or limited only to the KAHEP directly affected sections. The distribution of various fish species and their upper habitat range is not well understood within the Kabeli basin. To fill this gap of information, KAHEP will conduct a study on the aquatic life of the Kabeli River and its tributaries in the Kabeli basin in the beginning of the construction phase. The study will include fishery, phytoplankton, zooplankton and aquatic insect survey upstream of the KAHEP diversion structure. The monitoring indicators, location, methods, frequency and responsibility are described in the Table 8.12 "Baseline Monitoring Plan for Updating" .

Baseline Information on the Status of Houses and Infrastructure along Tunnel Alignment

The assessment of risks during blasting of the tunnels identified some concerns for dwellings and other infrastructure along the tunnel alignment. This baseline study will identify all dwellings and other infrastructure in a 500 meter row along the alignment. Baseline study will include: survey of all houses and infrastructure identifying ownership, materials, use; register of the current status of all infrastructures with photographic evidence. During and especially after the tunnel construction, these dwellings and infrastructure will need to be assessed. If any damage attributable to the project is identified, the Proponent will repair or replace the damages as needed at no cost to the owners of the infrastructure.

8.2.4.2 Additional Studies

Three studies are proposed to be carried out during the construction period.

Fish Hatchery Planning Study

The water diversion projects such as KAHEP do impact the fish diversity and population through barrier and dewatering effects. The KAHEP, to minimize the impacts, has integrated fish ladder provision in the dam body. The uncertainty of the effective use of the fish ladder for upstream and downstream migration of the fish is one of the issues of concern. It is therefore, a fish hatchery annexed with an open water fish stocking is proposed for KAHEP to minimize the uncertainty risks of the fish ladder with an objective to maintain the fish diversity and population in the upstream section of the Kabeli River.

The target fish species for hatching in the fish hatchery are the red list species and the migratory species of the Kabeli River (refer Table 6.10, Chapter 6 for target species). The observed target fish species have been successfully breed in captivity in Nepal. To duplicate the experience, at the KAHEP site, a fish hatchery plan will be developed by KAHEP. This proposal is made because of the transportation difficulties of the fingerlings of target species from the existing facilities in the western and central Nepal to the KAHEP site. The study will include a review of the fish hatching experience of the target fish species in Nepal; identification of suitable fish hatching site close to the KAHEP, design of the fish hatching facility with required accessories, and draw operation management and costs of the fish hatching facility for construction and operation.

Catchment Area Treatment Plan

Upland erosion and downstream sedimentation is one of the issues of concern in Himalaya including Kabeli basin. Various development activities and changing land use have accelerated downstream sedimentation activities in the basin. Construction of unplanned rural roads in the basin with the budget allocated for each VDC by the local government have also aggravated the erosion problems in the basin leading to the sediment increase.. The roads which are supposed to be labor based are now being constructed with bull dozers and excavators without any engineering design. The erroneous construction procedures of these rural roads have contributed in triggering landslides and slope instabilities in the rural area. These roads stretching all over the basin will definitely support in increasing the sediment load in the Kabeli River and its tributaries thus affecting the life and performance of the hydro plants.

To minimize the effects of erosion and sedimentation, there is a need of basin wide identification of the vulnerable areas and activities that result into the erosion and subsequent sedimentation in the basin. As of the date there are no such studies at the Kabeli Basin. The KAHEP will conduct a basin wide study for the identification of the key erosion prone areas and activities that are likely to enhance erosion and sedimentation in future. Based on such study, a catchment area treatment plan will be drawn for the Kabeli basin during the construction phase. This study will form a basis for responsibility sharing between the various development agencies including KAHEP developer for the minimization of the erosion and sedimentation in the basin. The catchment treatment plan needs to be integrated into the project activities and overall developed activities in the basin.

Cumulative Impact Assessment Study

The rapid CIA, Chapter 7 of this report, study undertaken by KAHEP at this planning stage has many limitations due to lack of information at the basin level. Nevertheless, the study has flagged a number of environmental and social issues of ongoing and planned sectoral and cross sectoral developmental activities in the basin. Further elaboration and verification of the environmental issues highlighted by the rapid CIA is essential through a detailed CIA study of the basin during the construction phase. Only such study will provide inputs for the development decision makers (government regulating agencies and the developers) within the basin for the better environmental management. KAHEP financing agency IDA has provisioned a USD 2 million Technical Assistance to the Ministry of Energy to enable the GoN to carry out any additional basin-wide studies that are necessary to design specific measures to manage potential cumulative impacts and risks at the Tamor River watershed including Strategic Environmental Assessment (SEA). The proposed CIA study apart from the evaluation of the basin level development planning will also conduct the environmental flow requirements in the Kabeli dewatered stretch in different hydropower development scenario. In addition, it will conduct the efficiency of the various fish ladder designs in the Nepalese river to draw conclusions on the best design for the

Nepalese fish diversity. The study will also include the feasibility of an "Functional Intact River" strategy for the Tamor River watershed in order to preserve habitats and alternate routes for fish.

8.3 ENVIRONMENTAL MONITORING

Environmental monitoring plans include the activities to be monitored (parameters and indicators) during pre-construction, construction and operation phases. The purposes of monitoring are to investigate and understand the quality of the environment prior to project and keep records of the project impact on the environmental quality during construction and operation phases of the project so as to provide reliable information and scientific basis for environmental management. Therefore, environmental monitoring is a mechanism which evaluates whether the mitigation and monitoring actions were actually carried out or not and evalutes the effectiveness of the implemented measures to curb the percieved impacts or identify unforeseen impacts for further corrective actions to avoid or minimise the impacts before it is too late.

8.3.1 Monitoring Agency

Regular monitoring of EMP implementation will be conducted by the implementing agency as well as by an independent external monitoring and evaluation organization or individual designated by Ministry of Energy (MoEn) to verify:

- Actions and commitments described in the EMP are implemented fully on time;
- EMP actions and compensation measures are effective enough to enhance (or at least restore) affected environmental components;
- Complaints and grievances lodged by project affected people are followed up and, where necessary, appropriate corrective actions are implemented; and
- If necessary, changes in EMP procedure are made to improve delivery of entitlements to project affected people.

For the KAHEP, primary monitoring responsibility will rest with KEL. KEL has established a Kabeli-A Environment and Community Development Unit (KAECDU) to undertake social and environmental monitoring of the project.

8.3.1.1 Internal

The internal monitoring will be carried out by KAECDU on a regular basis to assess progress against the schedule of actions defined in the EMP/SAP. Activities to be undertaken by KAECDU for EMP implementation will include:

- Liaison with the EMP implementation team, land acquisition team, construction contractor and project affected communities to review and report progress against the EMP;
- Assess the progress on implementation of actions and commitments described in the EMP;
- Verify that agreed measures to restore or enhance affected environmental components are being implemented;
- Identify any problems, issues or cases related to environmental degradation and hardship of affected communities resulting from the resettlement process;
- Assess project affected peoples' satisfaction with environmental and resettlement outcomes through informal interviews of village heads and households;
- Collect record of grievances, and follow-up to check that appropriate corrective actions have been undertaken and that outcomes are satisfactory; and

- Prepare brief quarterly progress and compliance report for KEL and external monitoring team, World Bank Group and MoEn.

8.3.1.2 External

An independent external monitoring and evaluation organization or individual designated by MoEn will carry out a review of the EMP implementation every six months. External monitoring will be conducted during the implementation period to ensure that the project activity comply with the environmental standards, the EMP is properly implemented, and grievances are addressed in a prompt manner.

Activities that will be undertaken by the external consultants include:

- Review internal monitoring procedures and reporting to ascertain whether these are being undertaken in compliance with the EMP;
- Review internal monitoring records as a basis for identifying any areas of non-compliance, any recurrent problems, or potentially disadvantaged groups or households;
- Review grievances record for evidence of significant non-compliance or recurrent poor performance in the resettlement implementation;
- Discuss with KEL, KAECDU staff, and others involved in land acquisition, compensation disbursement or livelihood restoration to review progress and identify critical issues;
- Survey affected households and enterprises to gauge the extent to which project affected peoples' standard of leaving and livelihood have been restored or enhanced as a result of the project;
- Assess overall compliance with the EIA and the EMP requirements; and
- Prepare a summary monitoring report for KEL (KAECDU), MoEn and the World Bank Group on the progress of EIA/ EMP implementation, any issues arising and any necessary corrective actions.

8.3.1.3 Panel of Experts

A Panel of Experts (POE), comprising an environmental expert and social expert is established as per the World Bank Operational Policy on Environmental Assessment, Involuntary Resettlement of Indigenous people for the project preparation phase. This Panel will be continued during the construction stage. The Panel will, inter alia, review, comment, provide suggestions or recommendations as it deems necessary and appropriate, twice during the project life-time (mid-term and at the end of the project completion) or as requested by the KEL or its consultants on any subject it considers vital to the successful completion and approval of the environmental and social studies of the project. The key tasks of the POE are to:

- Carry out an independent review of the EIA and SA processes and steps followed. Provide guidance on the treatment of environmental and social issues associated with the Project at critical stages of EIA and SA;
- Review the methodology, work-plan, approaches to consultations proposed by the EIA and SA team and provide expert opinion and advice on them as well as review EIA and SA reports;
- Provide specialized guidance on the main and critical environmental and social issues of the Project such as environmental flows, cumulative impact assessment, and construction stage impacts, and advise the EIA and SA teams on the preparation of the Environmental Management Plan (EMP) and SAP of the KAHEP in compliance with relevant national and World Bank Group policies;
- Advise KEL on incorporating the environmental and social findings and recommendations into the project and on ensuring adequate interaction between the Engineering Consultant and EIA

& SA teams, providing timely and strategic social and environmental inputs to the Engineering Consultant in potential conflict areas with locals and helping avoid unnecessary delay in the implementation of the EMP and the SAP;

- Assess and advise on incorporating the environmental and social obligations in bidding documents and contract documents; and
- Review and advice on the implementation of the agreed and approved social and environmental action plans during project's construction.

The POE will provide report to KEL including the topics reviewed, areas of concern, request for additional analysis and conclusions and recommendations for action, if any. The KEL will forward the report to the financing agencies (World Bank Group and any others), including a statement of actions taken on the recommendations of the previous meeting of the Panel.

8.3.2 Monitoring Phase

Three types of monitoring; Baseline Monitoring, Impact Monitoring and Compliance Monitoring have been proposed to implement during the project pre-construction, construction and operation phases. Details are following.

The KEL has started quarterly sampling of fish in the Kabeli and Tamor river in June 2013 as one of the continuing activities of the project. The findings and results from the sampling will be helpful not only in assessing the impacts of the project during the construction period but also in evaluating the long term implications (post construction) of the project on the aquatic life.

8.3.2.1 Pre-construction Phase (Baseline Monitoring)

Most of the baseline databases of the project area environment (local and site specific) have been gathered during this EA process (Refer Chapter IV of this report). Since there will be a considerable time gap in decision making based on this report and actual construction time, it is recommended to undertake the following monitoring activities at the pre-construction phase, just before the start of actual construction works as part of the internal monitoring by KAECDU of KEL. Besides, indicators (parameters) established during this monitoring phase will be continued for monitoring during the construction and operation phases to understand the range and degree of influence on the environmental quality by the project construction and operation. Table 8.12 presents the Baseline Monitoring Plan for updating.

Table 8.12: Baseline Monitoring Plan for Updating

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Landslides and slide erosion	Number of landslides/ debris flows/gully formation sites/ major/ minor	Headwork site Powerhouse Site Internal access roads, camp sites, quarry site, reservoir area hill flanks and tunnel alignment areas	Direct observation and mapping in the appropriate scale map	Once	KAECDU
Air Quality	TSP , $PM_{10}$and	Lower Dhuseni	As per National Ambient Air	Once	KAECDU

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
	$PM_{2.5}$	settlement. Lower Pinase settlement	Quality Standards, Nepal, 2003 (Annex 8.1)		
Water Quality including micro biology and water temperature	As there is no water quality standard set for fresh water bodies and rivers, parameters as per Generic Standard Part I: Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, Nepal, 2003 (Annex 8.2) will be used for monitoring indicators. In addition, Microbiology and temperature measurement with relevance to the regulated situation would be algae, bacteria and parasites.	Just upstream dam site Just before the confluence of Tamor In Tamor upstream of Kabeli-Tamor confluence In Tamor before powerhouse In Tamor after tailrace	As per Generic Standard Part I: Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, Nepal, 2003 (Annex 8.3). In situ and laboratory water analysis Water temperature will be measured through loggers installed in the river	Temperature will be measured for an annual cycle. Micro biology and other water quality parameter measurements will be measured every alternating month (six times a year)	KAECDU
Noise level	LAeq (dBA)	Lower Dhuseni settlement. Lower Pinase settlement	Type 1 and type 2 sound level meter meeting IEC standard	Once	KAECDU
Land pollution	Open defecation and garbage disposal places	Kabeli river banks Reservoir to Rajabesi Tamor left river bank and PipleKhola river bank	Direct observation	Once	KAECDU
Springs and water holes	Number, discharge/uses/ household dependence	300 m stripe of tunnel alignment	Field Survey and documentation in maps and photographs	Dry season, wet season	KAECDU
Structural conditions of built structures	Number of houses, built of material, cracks, house owner	500m stripe of tunnel alignment	Field Survey and documentation in maps and photographs/ /discussion with	Once	KAECDU

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
			water users		
Forest Ecology	Forest Status in terms coverage, species present	Forests within 2 km distance of the Headwork Forest within 2 km distance of the powerhouse	Three sample plots in the headwork surrounding and three samples in the powerhouse surrounding And photographic documentation showing the forest area from a fixed distant spot (locate the sample plot and photograph taken spot in map)	Once	KAECDU
Wildlife / Wildlife status	Wildlife status in terms of species present and reported, raider wildlife (monkey, porcupine, jackal, leopard)	Dhuseni, Rajabesi,Pinase, Kabeli Bazaar and surrounding areas	Consultation with locals, note season of raiding, frequency of raiding, and the place raided	Once	KAECDU
Aquatic life	Fishery Study of Kabeli and Tamor River	Upstream of Kabeli-Tamor confluence at Tamor. Upstream of Kabeli-Tamor confluence at Kabeli Headwork area At least 5 KM upstream headwork At least 10 KM upstream headwork About 2.5 KM downstream from dam Downstream of the Kabeli-Tamor confluence half distance to powerhouse Downstream of tailrace at Tamor	Castenet at least 200 times in a sampling stretch	Four times in the first year starting from monsoon 2013 to capture four seasons	KAECDU

Issues for Monitoring	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Markets	No of Hotels/Tea stall and Restaurants	Dhuseni, Pinase, Kabeli Bazaar	Direct enumeration	Once	KAECDU
Consumer price	Price of local and imported consumer items such as rice, wheat, maize, millet, milk, meat (chicken, mutton, buff), sugar, kerosene, LPG, vegetables, food/person with meat and without meat, rental for night stay etc. Labor cost/day (male and female)	Dhuseni, Rajabesi, Pinase, KabeliBazaar	Market survey and documentation	Once	KAECDU
Sanitation	Number of HH having toilets, practice of sanitation (child defecation, solid waste disposal), source of water (piped, springs, river etc.)and their quality	Dhuseni, Rajabesi, Pinase, KabeliBazaar	Field survey and documentation, photographs and testing water quality samples as per drinking quality standards	Once	KAECDU
Energy use	Wood fuel, kerosene, LPG, biogas	Dhuseni, Rajabesi, Pinase, KabeliBaazar	Field survey and documentation,	Once	KAECDU
River Use	Community use of water and riverine areas	Tamor River Downstream powerhouse tailrace for at least 5 km	Field survey and documentation	Once	KAECDU

8.3.2.2 Construction Phase

Two types of internal monitoring, namely compliance and impact monitoring will be undertaken during the construction phase. The compliance monitoring will monitor whether the mitigation measures recommended in Chapter 6 of the EA report were actually implemented as designed for the construction phase, while the impact monitoring will monitor the indicators as elaborated for the baseline environment. Table 8.13 presents the compliance and impact monitoring for the construction period. The KAHEP management will include the contractors' obligation in the bidding documents.

Table 8.13: Construction Phase Monitoring

Monitoring Issues	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Compliance monitoring					
Mitigation Measures	All mitigation actions listed in Chapter VI for construction phase, all management plans that will be developed as listed in section 8.2.1	All structural sites and facility sites and their surroundings	Direct supervision and documentation	Daily/weekly/monthly depending upon the measure	KAECDU
Water quality	Parameters listed in "Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters" 2003 – for compliance Annex 8.2	Tunnel discharge after treatment Sanitary discharge of camps after treatment Aggregate washing point discharge after treatment	As per Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters" 2003, Annex 8.3/ In situ and laboratory analysis of water samples	Monthly	Contractor
Tunnel Air Quality	TSP/PM_{10}, CO, CO_2, NOx, SOx	Active tunnel working face, and midway between active tunnel working face and outlet portal	As per international norms for air quality monitoring at the tunnels	Monthly	Contractor
Water quality in the camps	As per Nepal Drinking Water Quality Standard for compliance (Annex 8.4)	Water supply reservoir and one end tap of the camps (8 Nos)	As per Nepal Drinking Water Quality Standard (Annex 8.5) Laboratory analysis	Monthly	Contractor
Public and Occupational Health (ambulance, medical doctor, first aid, PPE)	Outbreak of epidemic disease in the village, in the construction camps, number of workers reporting sickness, number of workers injured, number of construction accident, number of fatal incidents etc.	All surrounding villages, construction camps,	Direct obsevation, consultation with local people/communitiesand health workes, managers of camps and construction workforce, health care facilites of the construction camps and sites	Twice a month	Contractor for labor camps, construction sites, KAECDU for engineer camps, villages, and off construction sites

Monitoring Issues	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Law and order and security	Theft, burglary, quarrels, social unrest, no of police cases etc.	Construction areas, labor camps	Direct observation and consultation with the local communities and affected VDCs authority and reports of the construction camp management	Monthly	KAECDU
Impact Monitoring					
Landslides and erosion	Number of landslides/ debris flows/gully formation sites	Headwork site Powerhouse Site Internal access roads, camp sites, and quarry site, reservoir area hill flanks	Direct observation and mapping in the appropriate scale map	Three times a year	KAECDU
Air Quality	24 hours TSP and PM 10 (to examine impact on ambient air quality in relation to NAAQS standards Annex 8.1)	Lower Dhuseni settlement. Lower Pinase settlement	As per National Ambient Air quality Standards, Nepal, 2003 (Annex 8.1)	Twice a year (November, April)	KAECDU
Water Quality including Micro biology and water temperature	Parameters listed in "Tolerance Limits for Industrial Effluents to be discharged into Inland Surface Waters" 2003 – to examine impact on the receiving water body - Annex 8.2.	Just upstream dam site Just before the confluence of Tamor In Tamor upstream of Kabeli-Tamor confluence In Tamor before powerhouse In Tamor after tailrace	As per Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters" 2003, Annex 8.3. Laboratory analysis	Every alternating month (six times a year) (November, January, March, May, July, Septemberl)	KAECDU
Noise level	LAeq (dBA)to examine impact on communities reference guideline IFC, EHS guideline (2007) – Annex	Lower Dhuseni settlement. Lower Pinasi settlementand the construction	Type 1 and type 2 sound level meter meeting IEC standard	Twice a year (November, April)	KAECDU

Monitoring Issues	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
	8.6.	camps			
Land pollution	Open defecation and garbage disposal	Kabeli river banks Reservoir to Rajabesi Tamor left river bank and Piple Khola river bank	Direct observation	Daily	KAECDU
Springs and water holes	Discharge/second, for the complained spring	200 m strip of tunnel alignment	Field survey and documentation in maps and photographs	Only when there is a complaint (monitoring in March/April only)	KAECDU
Structural conditions of built structures	Cracks of the complaining owner	500m strip of tunnel alignment	Field survey and documentation in maps and photographs	Only when there is a complain	KAECDU
Forest Ecology	Forest status in terms of density, coverage and species	Forests within 2 km distance of the Headwork Forest within 2 km distance of the powerhouse	Three sample plots in the headwork surrounding and three samples in the powerhouse surrounding and photographic documentation showing the forest area from a fixed distant spot (spot and sample plot same as baseline monitoring)	Twice a year (September and March)	KAECDU
Wildlife	Wildlife status in terms of presence of species	Raider wildlife (monkey, porcupine, jackal, leopard)	Consultation with locals, note season of raiding, frequency of raiding, and the place raided	Twice a year (September and March)	KAECDU
Aquatic ecology	Fish types available	Upstream of Kabeli-Tamor confluence at Tamor. Upstream of Kabeli-Tamor confluence at Kabeli Headwork area At least 5 KM upstream	Cast net, 200 times in one stretch	Twice a year (September and March)	KAECDU

Monitoring Issues	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
		headwork At least 10 KM upstream headwork About 2.5 KM downstream from dam Downstream of the Kabeli-Tamor confluence half distance to powerhouse Downstream of tailrace at Tamor			
Markets	Number of hotels/tea stall and restaurants	Dhuseni, Rajabesi, Pinase	Direct enumeration	Every month	KAECDU
Consumer price	Price of local and imported consumer items such as rice, wheat, maize, millet, milk, meat (chicken, mutton, buff), sugar, kerosene, LPG, vegetables, food/person with meat and without meat, rental for night stay etc. Labor cost/day (male and female)	Dhuseni, Rajabesi, Pinase	Market survey and documentation	Every month	KAECDU
Sanitation	Number of HH having toilets, practice of sanitation (child defecation, solid waste disposal), source of water (piped, springs, river etc.)	Dhuseni, Rajabesi, Pinase	Field survey and documentation, Photographs	Once a year	KAECDU
Energy Use	Wood fuel, kerosene, LPG, biogas	Dhuseni, Rajabesi, Pinase, Kabeli Baazar	Field survey and documentation,	Once in a year	KAECDU

8.3.2.3 Operation Phase Monitoring

Similar to the construction phase, the operation phase internal monitoring will conduct two types of monitoring: compliance and impact monitoring. Table 8.14 presents the operation phase monitoring plan.

Table 8.14: Operation Phase Monitoring

Monitoring Area	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
Compliance monitoring					
Mitigation Measures	All mitigation actions listed in Chapter VI for operation phase	All structural sites and facility sites and their surroundings	Direct supervision and documentation	Daily/weekly/monthly depending upon the measure	KAHEP operation Management
Water quality in the operation camp	As per Nepal Drinking Water Quality Standard (Annex 8.4)	Supply water reservoir and one end tap of the camps (3 Nos)	As per Nepal Drinking Water Quality Standard (Annex 8.5) Laboratory analysis	Once in six months	KAHEP operation Management
Impact Monitoring					
Landslides and erosion	Number of landslides/ debris flows/gully formation sites	Headwork site Powerhouse Site Internal access roads, reservoir area hill flanks	Direct observation and mapping in the appropriate scale map	Twice a year for the first 5 years	KAHEP operation Management
Water Quality including Micro biology and water temperature	Parameters listed in "Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters" 2003 – to examine impacts on the receiving water body - Annex 8.2	Just upstream dam site Just before the confluence of Tamor In Tamor upstream of Kabeli-Tamor confluence In Tamor before powerhouse In Tamor after tailrace	As per Tolerance Limits for Industrial effluents to be discharged into inland surface waters" 2003, Annex 8.3. Laboratory analysis	Twice a year (November, April) for the first 5 years	KAHEP operation Management
Noise level	LAeq (dBA)to examine impact	Lower Dhuseni	Type 1 and type 2 sound level	Once after	KAHEP operation

Monitoring Area	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
	on communities Reference guideline IFC, EHS guideline (2007) – Annex 8.6.	settlement. Lower Pinasi settlement and the boundary of the powerhouse compound	meter meeting IEC standard	operations	Management
Springs and water holes	Discharge/second, for the springs monitored in the baseline monitoring	300 m strip of tunnel alignment	Field survey and documentation	Once a year in dry season for the first 5 years	KAHEP operation Management
Forest Ecology	Forest status in terms of coverage, density and species	Forests within 2 km distance of the headwork Forest within 2 km distance of the powerhouse	Three sample plots in the headwork surrounding and three sample plots in the powerhouse surrounding Photographic documentation showing the forest area from a fixed distant spot (spot and sample plot same as baseline monitoring)	Twice a year for the first 5 year (September and March)	KAHEP operation Management
Wildlife	Wildlife status in terms of presence and siting species	Raider wildlife (monkey, porcupine, jackal, leopard)	Consultation with locals, note season of raiding, frequency of raiding, and the place raided	Twice a year (September and March)	KAHEP operation Management
Aquatic ecology	Fish types available	Upstream of Kabeli-Tamor confluence at Tamor. Upstream of Kabeli-Tamor confluence at Kabeli Headwork area At least 5 KM upstream headwork At least 10 KM upstream	Cast net, 200 times in one stretch	Twice a year for the first 5 years (September and March)	KAHEP operation Management

Monitoring Area	Monitoring Indicator	Monitoring Location	Monitoring Method	Monitoring Frequency	Monitoring Responsibility
		headwork About 2.5 KM downstream from dam Downstream of the Kabeli-Tamor confluence half distance to powerhouse Downstream of tailrace at Tamor			
Markets	Number of hotels/tea stall and restaurants	Dhuseni, Rajabesi, Pinase, Kabeli Bazaar	Direct enumeration	Every month/ for the first year of operation	KAHEP operation Management
Consumer price	Price of local and imported consumer items such as rice, wheat, maize, millet, milk, meat (chicken, mutton, buff), sugar, kerosene, LPG, vegetables, food/person with meat and without meat, rental for night stay etc. Labor cost/day (male and female)	Dhuseni, Rajabesi, Pinase, KabeliBazaar	Market survey and documentation	Every month for the first year of operation	KAHEP operation Management
River Use and Safety	Community water use and safety	i. Tamor River up to 5 km downstream tailrace ii. Kabeli River between dam and Kabeli-Tamor Confluence	On site survey, discussions with communities	Once a year for the first five years	KAHEP operation Management

8.4 POST-CONSTRUCTION ENVIRONMENTAL AUDIT OF KAHEP

Though monitoring /auditing will be carried out bi-monthly and by external entities during construction, the environmental audit of KAHEP will begin only after two years of the completion of the project as per the Environmental Protection Rule of the Government of Nepal. The KAHEP will make necessary arrangements for this Audit through GON or its nominated auditor. The role of the environmental auditor is to identify environmental change arising from the project and to assess the effectiveness of the mitigation measures adopted, suggesting additional measures where appropriate. In addition, auditing of the project will indicate where initial predictive methods were weak or environmental knowledge lacking, thus indicating areas where further research or attention to detail may be necessary. Additionally, close liaison with the implementing agency will secure valuable insights into the EA process and strengthen the capacity of the agency.

The environmental auditor needs to record the nature and scale of actual changes to baseline conditions and compare them with the predicted impacts. Where mitigation measures have been adopted, some assessment of their effectiveness must be made. Where measures are inadequate or impacts unforeseen, a strategy for restoration needs to be formulated in consultation with the relevant bodies. It is also essential that the effectiveness of mitigation measures be assessed over time to ensure that temporary stopgap solutions are not employed and that any gradual, but potentially serious, deterioration in environmental quality is detected.

The function of the environmental audit may, therefore, be summarized as follows:

- Verify compliance with the stated mitigation/performance targets
- Verify compliance with relevant environmental legislation
- Ensure minimum human exposure to environmental risk
- Advise on environmental improvements
- Liaise closely with the parties involved in the monitoring process and initiate a counterpart program for the audit to ensure institutional memory;
- Review the overall success of the project in relation to its environmental goals and suggest where improvements in procedure could be made in the future.

8.4.1 Environmental Audit Framework for KAHEP

Environmental audit framework for KAHEP is presented in Table 8.15.

Table.8.15: Environmental Audit for KAHEP

SN	Parameters	Location	Methods	Indicators
A	**Physical Aspects**			
1	Change in river morphology particularly downstream changes	Downstream of power house, between powerhouse and dam site	Inspection	Bank erosion, sand deposition patterns
2	Water Quality	Dam site and powerhouse	Laboratory analysis of water samples	DO, pH, BOD
3	Air Quality	Lower Dhuseni settlement. Lower Pinasi settlement	Analysis of air samples	TSP, $PM_{10}$and $PM_{2.5}$
4	Watershed	Dam site, road, powerhouse site	Observation	Eroded and unstable area, coverage of vegetation
5	Land use pattern and	Dam site, canal, powerhouse	Inspection	Change in the land use

SN	Parameters	Location	Methods	Indicators
	land lake area	and in the vicinity		
6	Minimum release	Downstream of dam	Measurement of minimum release	Discharge in the river
7	Water use and water rights	Dam site, powerhouse site, dewatered stretch	Inspection and information from the local people	Flow in the river
B	**Biological Aspects**			
8	Vegetation cover (increase and decrease)	Project site	Counting and visual observation	Decrease in the forest cover
9	Numbers of trees felled	Project site	Counting and visual observation	Number of cut trees stumps
10	Wild life affected	Project site	Interview with local people and observation, photographs	Decrease in the wild life seen
12	Change in the species of fish in the river	Kabeli River	Sampling at the project sites	Species if fish in the river (increased or decreased)
12	Fish migration	Kabeli	Sampling at the project sites and interviewing fisherman	Species if fish in the river (increased or decreased)
C	**Socio-economic and cultural Aspects**			
12	Economic status of the affected people(present and past income)	Project site	Questionnaire survey and interview, observation	Economic status of the people
13	Review of compensation paid out	Project site	Questionnaire survey and interview	Status of the affected people, beneficial use
14	Community development works	Project site	Records from the local offices	Numbers of development works, number of shops increased and decreased
15	Occupational health and safety	Project site	Records	Number and type of accidents/diseases
16	Religious site	Dam site, powerhouse site	Observation	Protection works
17	Water supply and sanitation	Project site	Records and observation	Epidemic, complaints

8.4.2 Agencies Responsible for Auditing

The project proponent will be responsible for the auditing activities after the completion of the project as per the Environmental Protection Regulation of the Government of Nepal. However, agencies like the Ministry of Science, Technology and Environment, Ministry of Energy, Ministry of Forest and Soil Conservation and other relevant organizations will be consulted during the auditing. Local NGOs and National NGOs may also be entrusted to carry out the task, if they are engaged to do so by the government.

The auditing should focus on impacts of forest clearance, compensatory plantation, geological and soil condition, status of affected people, land use pattern and infrastructure development, etc. The auditing of the KAHEP will focus on parameters as mentioned in table above.

8.4.3 Environmental Auditing Schedule

Environmental Audit will be carried out after two years of commencement of the project. However, audits during construction and operation phases of the project lies under the purview of the auditing agency.

Chapter IX: ENVIRONMENTAL MITIGATION, MONITORING, AUDITING AND MANAGEMENT COSTS

The chapter VI, VII and VIII have presented in detail the requirements of environmental mitigation, monitoring, auditing and management for the KAHEP project. Non-action on mitigation, monitoring and auditing for the project environmental management will have an adverse effect on the project area's natural environment. The cost of the adverse effects will be borne by the project area communities in the long run. Since the impacts to the project area resources are the result of the project implementation, the project has to internalise the cost of environmental mitigation, monitoring and auditing for the project environmental management in the project costs.

This section presents the required costs for the project environmental mitigation, monitoring and auditing for environmental management of the project, which the project will ensure to invest as part of the project costs.

9.1 Cost for Environmental Mitigation

Table 9.1 presents the project environmental mitigation cost for construction and operation periods. The cost items presented in the table are only for the items which are not customarily included in the civil costs of a project. The mitigation measures presented in Chapter VIII are not listed in the Table 9.1, as these are the measures for which the costs are internalised in the project civil costs. The project has estimated a cost of NRs 152,058,935 as a part of civil environmental costs excluding the project environmental and social management costs of NRs 30,223,575.

Table 9.1: Environmental Mitigation Cost

SN	Mitigation Action	Estimated Cost (NRs)	Remarks
A	**Primary Environmental Impacts**		
1	**Construction Phase**		
i	Compensatory afforestation as per the Forest Guideline, 2006, calculations as per forest norms	*936,250.00*	
ii	Lease compensation to the lost forest area ***for 30 years as per the Forest Act.***	*278,915.00*	
iii	Clearance and stockpiling of the felled forest products	*467,000.00*	
iv	Joint supervision with the official of DFO to mark the trees and poles for felling	225,000.00	
v	Technical and financial assistance to the affected community and leasehold forest user group	1,100,000.00	
vi	Compensation to the timber and fodder loss to community and leasehold forests based on the production loss of the forest for 5 years	1,586,012.00	
2	**Operation Phase**		
i	Assistance for on-site sanitation management and in the use of agrochemicals to watershed communities @ rate of 1,50,000/year for 30 years	4,500,000.00	
Iii	Construction of fish ladder		Estimated NRs 5,699,914.00 has been included in project civil cost.
Iv	Study and construction of fish hatchery	10,000,000.00	
V	Physical barrier to avoid fish entrapment at intake	3,500,000.00	

Vi	Siren establishment and community awareness, Tamor River	2,800,000.00	
	Sub-total of A	**25,393,177.00**	
B	**Secondary Issues**		
1	Construction Phase		
I	Survey of spring location and discharge measurement	215,000.00	
Ii	Temporary water supply arrangements in the event of the effect on use springs	600,000.00	
B	**Operation Phase**		
I	Provision for water supply arrangements in the event of affects to on use water sources on permanent basis	3,500,000.00	
	Sub-Total of B	**4,315,000.00**	
C	**Other Issues**		
1	**Construction Phase**		
i	Prior survey of house structures along the tunnel alignment	500,000.00	
Ii	Provision of compensation in the event of damage to structures	3,000,000.00	
Iii	Assistance to the local authorities in the protection works of the forest areas close to the construction sites	1,536,000.00	
Iv	Hoarding boards costs at critical location of the access road on the preventive actions to control the forest fire	100,000.00	
V	Public awareness programs to prevent the forest fires in the local area	300,000.00	
2	**Operation Phase**		
I	Hoarding boards at critical locations and their maintenance to generate awareness to the visitors on the significance of forests and wildlife of the area @ 1,00,000/year for 30 years	3,000,000.00	
Ii	Assistance to Leasehold forest user groups and community forest user groups for the protection and conservation of the forested areas @ 20,000/year for 30 years	600,000.00	
	Sub-total C	**9,036,000.00**	
D	**Additional Studies**		
I	Baseline information on aquatic ecology Kabeli/Tamor River and fish hatchery		Already included in the mitigation and baseline monitoring costs
ii	Cumulative Impact Assessment, Catchment Area Treatment Plan and other future complementary studies		Funding agency has included 2 million US $ for this purpose
iii	Baseline of dwellings along tunnel alignment	-	Already included Refer C.1.i
	Sub-total of D		
	Grand Total	**38,744,177.00**	

Note: cost included in civil cost, or by financial agencies not added in the sub-total and grand total

9.2 Costs for Environmental Monitoring

The cost for environmental monitoring of the project is presented in Table 9.2. The costs included in this section present only the costs where KAHEP management is responsible for the compliance and impact monitoring through an instrumental monitoring. The costs of the other monitoring activities through technical support staff at site are included in the environmental management costs of the project. The costs where contractor is responsible for monitoring are part of the project civil costs and not included here.

Table 9.2: Environmental Monitoring Cost

SN	Monitoring Items	Estimated Cost (NRs.)	Remarks
A	**Pre- Construction Phase**		
1	Air Quality (TSP and PM 10)	450,000.00	
2	Noise	75,000.00	
3	Water Quality including microbiology and temperature	500,000.00	
4	Monitoring of Landslides and slide erosion, Land pollution,	65,000.00	
5	Monitoring of Springs and water holes and Structural conditions of built structures		Estimated NRs 715,000.00 has already included in Mitigation.
6	Monitoring of Forest ecology and Wildlife	130,000.00	
7	Aquatic Life (fish study of Kabeli and Tamor River)	450,000.00	
8	Community use of water and riverine areas in Tamor River	150,000.00	
	Sub-Total A	**1,820,000.00**	**Excluding items included in mitigation**
B	**Construction Phase**		
1	Air Quality (TSP and PM 10) twice a year for 4 years	3,600,000.00	
2	Noise level twice a year for 4 years	600,000.00	
3	Water Quality including microbiology and temperature for 4 years	400,000.00	
4	Aquatic Life twice a year for 4 years	500,000.00	
5	Support for other construction phase monitoring as per Table 8.13	1,200,000.00	Additional cost to KAECDU
	Sub-Total B	**6,300,000.00**	
C	**Operation Phase**		
1	Water quality in the operation camp (twice a year for 30 years)	1,500,000.00	
2	Water Quality (River) Twice a year (November, April) for first 5 years	500,000.00	
3	Noise level	75,000.00	
4	Springs and water holes (once a year for first 5 years)	1,007,500.00	
5	Forest Ecology (Twice a year for first 5 years)	650,000.00	
6	Wildlife (Twice a year for the first 5 years)	650,000.00	
7	Aquatic Life (Twice a year for the first 5 years)	1,000,000.00	
	Total of C	**5,382,500.00**	
	Grand Total	**13,502,500.00**	

9.3 Environmental Management Cost

The environmental management cost of the project is envisaged to be about 0.75% of the base civil cost i.e. NRs 30,223,575. The basic civil cost of the project estimated is NRs 4029,810,000. This cost is already included in the civil management cost of the project costs. The above cost will also be used for the staff and consultants of the ESU of the PMO.

In addition, the IDA has provisioned for a USD 2 million Technical Assistance to the Ministry of Energy to enable the GoN to carry out any additional basin-wide studies that are necessary to design concrete measures to manage potential cumulative impacts and risks at the Tamor River watershed level.

9.4 Environmental Audit

The Cost estimated for the environmental audit after two years of project operation is NRs. 750,000. The cost will comprise the auditor's remuneration, transportation and report preparation.

9.5 Summary of Environmental Mitigation, Monitoring, Management and Audit Cost

Table 9.3 presents the summary of the project environmental costs.

Table 9.3: Summary of the Project Environmental Costs

SN	Particulars	Costs (NRs)
1	Environmental Mitigation construction	10,844,177.00
2	Environmental Mitigation Operation	27,900,000.00
3	Environmental Monitoring Pre-Construction Phase	1,820,000.00
4	Environmental Monitoring Construction	6,300,000.00
5	Environmental Monitoring Operation	5,382,500.00
6	Environmental Management Construction	30,223,575.00
7	Environmental audit - post construction	750,000.00
8	Additional study costs included in mitigation	3,000,000.00
9	Cumulative Impact Assessment, Catchment Area Treatment Plan and other future complementary studies (US$ 2 million is included in the project for government agency to commission these studies. KEL is not responsible for this activity).	
10	Environmental cost in civil costs including camps, resettlement rehabilitation and other	152,058,935.00
Total Environmental Cost		**238,279,187.00**

REFERENCES

1. Altmann, J., 1974. Observational Study of Behavior: Sampling Methods. Behavior, 49: 227-265.
2. Arunachalam M, 2000. Assemblage Structure of Stream Fishes in the Western Ghats (India), Klunwer Academic Publisher
3. Badola, S.P. and Singh, H.R. 1984. Spawning of some important coldwater fish of the Garhwal Himalaya. Journal of the Bombay Natural History Society 81, p. 54-58.
4. Baskota, N., 2012. South Asia Trade and Energy Security, The Role of India, Universal-Publishers, Boca Raton
5. Bibhuti Ranjan Jha, 2006: Fish Ecological Studies and its application in assessing Ecological Integrity of Rivers in Nepal; Thesis Submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in The Department of Biological Sciences and Environmental Science, School of Science, Kathmandu University, Dhulikhel, Nepal, January 2006
6. Birdlife International, 2012 Important Bird Areas factsheet: Kanchenjungha Conservation Area. Downloaded from http://www.birdlife.org on 04/12/2012
7. BPP (1995). Biodiversity Profile of the Midhills Physiographic Zone. GoN/Gov. of The Netherlands.
8. BPP (1995f). Biodiversity Project Profile, Government of Nepal/Netherlands
9. Catherine, B. Jacqueline K (2003): Water Resources and Environmental Technical Note, C.2, Environmental Flow Concept and Methods, The World Bank, Washington D.C
10. Chalise, M.K., 2003. Assamese Monkeys (Macaca assamensis) in Nepal. Primate Conservation. Conservation International No. 19: 99-107. The Journal of the IUCN/SSC Primate Specialist Group, USA.
11. Chaudhary, R.P. 1998. Biodiversity in Nepal: status and conservation, S. Devi, Saharanpur India and Tec. Press Books, Bangkok, Thailand.
12. Daniels, 2002
13. Department of Hydrology and Meteorology, (1995, 2000). Climatological Records of Nepal
14. Department of Hydrology and Meteorology, (1995, 2000). Climatological Records of Nepal
15. Department of Mines and Geology (1996). Geological Map of Nepal
16. Department of Mines and Geology (1996). Geological Map of Nepal
17. DHM (1995, 2000). Climatological Records of Nepal
18. DHM (1995, 2000). Climatological Records of Nepal
19. DHM, 2004. Hydrological Estimations in Nepal
20. Dobrenmez, 1976: Le Nepal Ecologe et Biogeography, Editions du Centre National de la Recherche Scientifique, Paris, France.
21. DOED, (2001). Manual for Preparing Scoping Document for Environmental Impact Assessment (EIA) of Hydropower projects
22. DOED, (2001). Manual for Preparing Terms of Reference (TOR) for Environmental Impact Assessment (EIA) of Hydropower Projects, with notes on EIA Report Preparation
23. DOED, (2004). Manual for Conducting Public Hearings in the Environmental Impact Assessment Process for Hydropower Projects
24. Dyson et.al edited (2003), Flow, the Essentials of Environmental Flow, IUCN Publication
25. Dyson, M., Bergkamp, G., Scanlon, J.; 2003 :Flow: the essential of environmental flows.Gland, Switzerland: IUCN, Water and Nature Initiative.

26. Edds, D.R. 1987. Foods of some Nepalese fishes. Journal of Natural History Museum (Nepal) 11, p. 1-14.
27. Edds, D.R. 2007. Fishes in Nepal: ichthyofaunal surveys in seven nature reserves. Ichthyological Exploration of Freshwaters 18, p. 277-287.
28. Edmondson W.T. (1959) Fresh Water Biology (Second edition)
29. Edmondson, W.T. 1965, Fresh Water Biology – Second Edition.
30. EIA-Kali Gandaki 'A', 1996. Kali Gandaki 'A' Hydro-Electric Project Detailed Design, EIA, Vol.1. Report by HMG Nepal, Nepal Electricity Authority, with ADB, UNDP and Finish International Agency, Kali Gandaki 'A' Associates, Morrison Knudsen Corp., USA, Norconsult Int'l., Norway IVO International Ltd. Finland, February
31. EIA-Tamur, 1998. NEA Medium Hydropower Study Project. EIA Report of Fisheries Baseline and Impact Assessment, Tamur Hydropower Project by Canadian International Water Energy Consultant (CIWEC). July
32. Freeman, M.C; et.al, 2001. Flow and Habitat Effects on Juvinile Fish abundance in Natural and Altered Flow Regiem. Ecological Applications, 11(1), 2001, pp 179 -190.
33. GoI, MoP, CEA, 2011. CO2 Baseline Database for the Indian Power Sector User Guide, Version 6.0, March 2011, Government of India, Ministry of Power, Central Electricity Authority, New Delhi, India.
34. Government of Nepal, (1997). Environment Protection Act
35. Government of Nepal, (1997). Environment Protection Rule
36. Gurung, T.B., A.K. Rai, P.L. Joshi, A. Nepal, A. Baidya and J. Bista 2002, Breeding of pond reared golden mahseer (Tor putitora) in Pokhara, Nepal. In (Petr, T., ed.): Fish and fisheries at higher altitude: Asia. FAO Fisheries Technical Paper. No. 385: 13-40. FAO, Rome.
37. Heimsath A., 2005. Downloaded from www.public.asu.edu/~aheimsat/publications/Heimsath%2000%20%20Himalayan%20Erosion.pdf
38. Hora, S.L. and Mukerji, D.D. 1936. Fish of the Eastern Doons,United Provinces, Records of the Indian Museum 38, p.
39. Hossain, M.A. and Haque, M.A. 2005. Fish species composition in the river Padma near Rajshahi. Journal of Fresh water fishes of India. Zoo Outreach Organization, Conservation Breeding Specialist Group, Coimbatore, Freshwaters 18, p. 277-287.
40. HPC, 2006, 2007, 2008. Environmental Monitoring Report, Khimti I Hydropower Project, Project Number: 27707
41. Imran, Mudassar and Tjaarda P. Storm van Leeuwen (2006, NepaL Power Development Project Sectoral Environmental Assessment, Strategic Environmental Assessment in Energy Project, 2006
42. IUCN 2011.The Status of Nepal's Mammals: The National Red List Series
43. IUCN Nepal, 2004,National Register of Medicinal and Aromatic Plants (Revised and Updated), Xii+202pp. IUCN The World Conservation Union Nepal.
44. IUCN Nepal, 2010, Tinjure-Milke-Jaljale Rhododendron Conservation Area: A Strategy for Sustainable Development, IUCN Nepal, Kathmandu, Nepal
45. IUCN. 2012. IUCN Red Data Book
46. J.Power 2012, Nationwide Master Plan Study on Storage-type Hydropower Development in Nepal, Interim Report, submitted to JICA?NEA
47. Joshi, K.D. 2004. Artificial breeding and rearing of *Schizothorax richardsonii* (Gray). Indian Journal of Fisheries 51, p. 233-237.
48. KCAMC 2003 downloaded fromassets.wwf.org.uk/downloads/kangchenjunga_conservation_area.pdf
49. KEL, 2011. Updated Feasibility Study and EIA of Kabeli-A Hydroelectric Project Prepared by Hydro Consult Engineering Limited Volume 1: July 2011, Kathmandu
50. KEL, 2011.Additional Report to UFSR August 2011
51. KEL, 2013. Social Assessment of Kabeli-A Hydroelectric Project, Prepared by Hydro Consult Engineering Limited, July 2013, Kathmandu

52. KEL, 2013. Social Action Plan of Kabeli-A Hydroelectric Project, Prepared by Hydro Consult Engineering Limited, July 2013, Kathmandu
53. Lilleso, J.P.B., T.B. Shrestha, L.P. Dhakal, R.P. Nayaju and R. Shrestha, 2005. The Map of Potential Vegetation of Nepal- a forestry/agro-ecological/biodiversity classification system. Forest and Landscape Development and Environment Series 2-2005 and CFC-TIS Document Series No.10.
54. Menon, A.G.K. 1999. Check list — freshwater fishes of India. Records of the Zoological Survey of India, Occasional
55. MHSP/NEA, 1998. Koshi River Basin Master Plan Study (1983-85).
56. Molur, S. and Walker, S. (eds.) 1998. Conservation assessment and management plan (CAMP) workshop report on
57. Mukherjee D. 2007. Resource Utilization Patterns of Reptiles in the Tropical Dry Mixed Deciduous Forest of Anaikatty Hills, Western Ghats, India. PhD Thesis, Bharathiar University, Coimbatore Pages: 146+18+14.
58. NARMSAP, 2002. Forest and Vegetation Types of Nepal, TISC Document Series No 105, GoN / MOFSC/NARMSAP, 1-179.
59. National Planning Commission, 2002. Tenth Five Year Plan (2059-2064)
60. Nepal Biodiversity Strategy, 2002, Government of Nepal
61. Nepal Consult (P) Limited.,1998. Environmental Impact Assessment Study of Kabeli – A Hydroelectric Project.
62. Petr, T, 2002, Cold water fish and fisheries in countries of the high mountain arc of Asia (Hindu Kush-Pamir-Karakoram-Himalayas). A review. Symposium on coldwater fish species in the trans-Himalayan region. 10-14 July 2001.Kathmandu, Nepal,
63. Press, J.R., K.K.Shrestha and D.A Sutton, 2000. Annotated Checklist of flowering plants of Nepal, Natural History Museum, London.
64. Rajbansi K.J, 1982, A General Bibliography on Fish and Fisheries of Nepal, Royal Nepal Academy, Kamaladi, Kathmandu, Nepal.
65. Rajbansi K.J, 1996, Conservation status of the inland fish fauna of Nepal. Royal Nepal Academy of Science and Technology, Kathmandu, Nepal.
66. Rajbansi K.J, 2002; Zoogeographical distribution and the status of cold water fishes of Nepal. Paper presented in symposium on coldwater fish species in the trans-himalayan region. 10-14 July 2001.Kathmandu, Nepal
67. S. Lamichane, 2012 Observation of functioning of Kanchenjunga Conservation Area (KCA): the region's first community owned conservation area, downloaded from satoyama-initiative.org/.../area.../observation-of-functioning-of-
68. Shaw, G.E. and Shebbeare, E.O. 1937. The fishes of northern Bengal. Journal of the Royal Asiatic Society of Bengal.
69. Shrestha B.C. Napit R.K. (2004): Test fishing program in Upper Tamakoshi Hydroelectricity Project.
70. Shrestha et.al, 2012, Fishes of Nepal: Mapping distributions based on voucher specimens, Emporia State Research Studies Vol. 48, no. 2, p. 14-21 (2012)
71. Shrestha T.K. 1990. Rare fishes of Himalayan waters of Nepal. J. Fish Biol. 37 (Suppl.A): 213-216.
72. Shrestha T.K. 1995 . Fish Catching in the Himalayan Waters of Nepal. Published by Mrs. Bimala Shrestha, Kuleswor, Kathmandu, Nepal.
73. Shrestha T.K. 1996, Environmental Impact Assessment of Kali Gandaki 'A' Hydroelectric Project. A Project HMG/Nepal, Nepal Electricity Authority/ADB/UNDP and Finish International Agency.
74. Shrestha T.K. 1998, Medium Hydropower Study Project of Dudh Koshi Hydroelectricity Project. Project Preparation & Studies Directorate, Project Preparation Department, NEA, Kathmandu.
75. Shrestha T.K. 2002; Cold water Fisheries Development in Nepal, . In (Petr, T., ed.): Fish and fisheries at higher altitude: Asia. FAO Fisheries Technical Paper. No. 385: 13-40. FAO, Rome.

76. Shrestha, H.M. 1983. Rivers of Nepal, a preliminary introduction. A glimpse of water resources development in Nepal. Nepal Digest.
77. Shrestha, J. & Team (2010): Survey on fish diversity and conservation management of Tamor River and its major tributaries of Eastern Himalayan region, Nepal.
78. Shrestha, J. (1994): Fishes, Fishing Implements and Methods of Nepal. Smt. M. D. Gupta, Lalitpur, Laskar (Gwaliar) India 11-150.
79. Shrestha, J. (1995): Enumeration of the Fishes of Nepal, Bio-diversity Profiles Project, Publication No. 10, Department of National Parks and wildlife Conservation, Ministry of Forest & Soil Conservation, GoN, Kathmandu, Nepal.
80. Shrestha, J. (1998): Aquatic Habitats and natural water fish and fisheries in Nepal. Paper presented at Environmental Assessment Background Training ADB- TA 2613-NEP. NEA-ED Feb. 2-6, Kathmandu, Nepal.
81. Shrestha, J. 1978, Fish fauna of Nepal. J. Nat. Hist. Mus. 2(1 - 4): 33-43
82. Shrestha, J. 1994, Fishes, Fishing Implements and Methods of Nepal, Smt, M.D Gupta, Lalitpur
83. Shrestha, J. 1995, Enumeration of the Fishes of Nepal. Bio-diversity Profiles Project, Publication No. 10, Department of National Parks and Wildlife Conservation, Ministry of Forest & Soil Conservation, His Majesty's Govt. of Nepal, Kathmandu, Nepal.
84. Shrestha, J. 1999, Environment Impact Assessment Study Report on Melumchi Diversion Scheme. EIA Study Team - IUCN, Nepal & METCON Consultants, Kathmandu.
85. Shrestha, J. 2002; Cold Water Fish & Fisheries in Nepal. In (Petr, T., ed.): Fish and fisheries at higher altitude: Asia. FAO Fisheries Technical Paper. No. 385: 13-40. FAO, Rome.
86. Shrestha, J. 2009 . Survey on fish diversity and conservation management of Tamor river and its major Tributaries of Eastern Himalayan Region, Nepal. A Final report submitted to WWF/CEPF Nepal, Baluwatar, Kathmandu
87. Shrestha, J. and Swar D. B. (1998): Environmental Impact Assessment Report on Tamur Hydropower Project – Fisheries Baseline & Impact Assessment, Medium Hydropower Study Project, NEA, Kathmandu.
88. Shrestha, J., Singh, D. M., and Saund, T. B., 2009. Fish Diversity of Tamor River and Its Major Tributaries of Eastern Himalayan Region of Nepal, Nepal Journal of Science and Technology 10 (2009) 219-223
89. Shrestha, K., 1998. Dictionary of Nepalese Plants Names, Natural History Museum, Mandala Book point, Kathmandu, Nepal.
90. Shrestha, T. K., 1990: Rare fishes of Himalayan Waters of Nepal, J. Fish Biol. 37 (Suppl. A): 213-216.
91. Shrestha, T. K., 1990: Resources Ecology of the Himalayan waters. Curriculum Development Center, TU, Kathmandu, Nepal.
92. Shrestha, T. K., 1990b: Behavior of the golden mahaseer *Tor putitora* (Ham.) in nature and Captivity. J. Fresh water Boil. 2:3: 209-219.
93. Shrestha, T. K., 2002: Ranching Mahaseer (*Tor tor, Tor puttitora* in the running water of Nepal). Cold Water fisheries in the trans-Himalayan Countries. FAO, Rome,Italy.
94. Shrestha, T. K., 2008: Icology of Nepal Astudy of Fishes of the Himalayan Waters.
95. Stainton, J.D.A., 1972. Forests of Nepal, John Murray, London.
96. Stainton, J.D.A., 1988. Flowers of the Himalaya. Oxford Press, New Delhi, India.
97. Stainton, J.D.A., 1998. Flowers of the Himalaya, Oxford Press New Delhi, India.
98. Sutherland W. J. 1997. Ecological Census Techniques. A Handbook. Cambridge University Press.
99. Swar and Upadhya, 1998 Fisheries Baseline and Impact Assessment of Kabeli "A" Hydropower Project Area.
100. Tennant, D. L., 1975. Instream flow regimens for fish, wildlife, recreation and related environmental resources. U.S. Fish and Wildlife Service, Billings, Mont.

101. Tennant, D. L., 1976. Instream flow regimens for fish, wildlife, recreation and related environmental resources. Fisheries 1(4):6-10.

102. Tharme, R. E. 2003: A Global Perspective on Environmental Flow Assessment: Emerging Trends in the Development and Application of Environmental Flow Methodologies for Rivers. River Research and Applications, 19 (5-6), 397-441.

103. Tharme, R.E, 2003, A global perspective on environmental flow assessment: Emerging trends in the development and application of environmental flow methodologies for rivers.

104. WECS, 2002. Water Resource Strategy Nepal. Water and Energy Commission Secretariat, Singha Durbar, Kathmandu

105. WECS/DHM, 1990, Methodologies for Estimating Hydrologic Characteristics of Ungauged Locations in Nepal

106. WWFUK, 2006. downloaded from assets.wwf.org.uk/downloads/kangchenjunga_conservation_area.pdf

107. Zobel, D.B., M.J. Behan, P.K. Jha, U.K.R. Yadhav, 1987: A Practical Manual for Ecology. Ratna Book Distributors, Kathmandu.

WEBSITE

www.iucnredlist.org

www.icimod.org/hkhconservationportal/PA.aspx?ID=1

www.doed.gov.np

www.aepc.gov.np/