Environmental and Social Impact Assessment Study of the Upper Arun Hydroelectric Project (UAHEP)

FINAL DRAFT

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Disclaimer: *This Upper Arun Hydro-electric Project's draft Environmental and Social Impact Assessment (ESIA) was prepared by UAHEL broadly following Good International Industry Practices (GIIP) as those required under the Bank's Environmental and Social Framework (ESF).*

The review of this ESIA is a key part of the Bank's due diligence process and is currently ongoing. This draft ESIA may still contain gaps to fully address all pertinent E&S issues in the project. Any gaps will be covered through supplemental studies, assessments, and/or plans that will be completed in a reasonable timeframe to ensure compliance with the ESF.

For the benefit of potentially project affected people (PAP) and other interested stakeholders, and in alignment with the Bank's Policy on Access to Information this draft ESIA is being disclosed as soon as it became available. This disclosure, however, should not be considered as a final clearance of the ESIA by the World Bank.

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CONTENTS

LIST OF APPENDICES

Appendices available on request.

List of Tables

Executive Summary

Main Document

List of Figures

Executive Summary

Main document

Acronyms and Abbreviations

ACSR	Aluminum Conductor Steel Reinforced
ADB	Asian Development Bank
AJ	Aadibasi/Janajati
ANC	Antenatal Care
ARI	Acute Respiratory Infection
asl	above sea level
ATV	All-Terrain Vehicle
BMEP	Biodiversity Monitoring and Evaluation Plan
BMP	Biodiversity Monitoring Plan
BRCH	Building Resilience to Climate-Related Hazards
BS	Bikram Sambat
BZ	Buffer Zone
BZCF	Buffer Zone Community Forest
BZ-CFUG	Buffer Zone Community Forest Users Group
CB-IMNCI	Community-Based Integrated Management of Neonatal and Childhood Illnesses
CBS	Central Bureau of Statistics
CESMP	Construction Environmental and Social Management Plan
CESMMP	Construction Environmental and Social Management and Monitoring Plan
CF	Community Forest
CFUG	Community Forest Users Group
CFP	Chance Finds Procedure
CITES	Convention on International Trade in Endangered Species
CLO	Community Liaison Officer
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
CPUE	Catch Per Unit Effort
CR	Critically Endangered
CSPDR	Changjiang Survey, Planning, Design and Research Co. Ltd.
CSW	Commercial Sex Worker
CTEVT	Council of Technical Education and Vocational Training
DCC	District Coordination Committee
DD	Data Deficient
DFO	Divisional Forest Office
DHM	Department of Hydrology and Meteorology
DIA	Direct Impact Area
DNPWC	Department of National Parks and Wildlife Conservation
DO	Dissolved Oxygen
DoED	Department of Electricity Development
DoHS	Department of Health Services
DoR	Department of Roads
DPR	Detailed Project Report
EA	Environmental Assessment
EAAA	Ecologically Appropriate Area of Analysis
EBA	Endemic Bird Area
EBRD	European Bank for Reconstruction and Development
EF	Emissions Factor
EFlow	Environmental Flow
EHS	Environmental, Health, and Safety
EHSG	Environmental, Health, and Safety Guidelines
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMF	Electrical and Magnetic Field

EN	Endangered
ENT	Ear, Nose and Throat
EOO	Extent of Occurrence
EPA	Environment Protection Act
EPR	Environment Protection Rules
ERM	Environmental Resource Management, Inc.
E&S	Environmental and Social
ESCP	Environmental and Social Commitment Plan
ESF	Environmental and Social Framework
ESHS	Environmental, Social, Health, and Safety
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standard
ESSD	Environmental and Social Studies Directorate
FCHV	Female Community Health Volunteer
FGD	Focus Group Discussion
FP	Federal Parliament
FPIC	Free, Prior, and Informed Consent
FSL	Full Supply Level
FY	Fiscal Year
GAP	Gender Action Plan
GBV	Gender-Based Violence
GHG	Greenhouse Gas
GLOF	Glacial Lake Outburst Flood
GN	Guidance Note
GoN	Government of Nepal
GRM	Grievance Redressal Mechanism
GWh	Giga-Watt Hours
Ha	Hectare
HEP	Hydroelectric Project
HH	Household
HT	Himalayan Thrust
HP	Horsepower
HPHT	High Pressure Headrace Tunnel
H&S	Health and Safety
HSE	Health, Safety, Environment
IBA	Important Bird Area
IBAT	Integrated Biodiversity Assessment Tool
ICIMOD	International Centre for Integrated Mountain Development
ICOLD	International Commission on Large Dams
ICOMOS	International Council on Monuments and Sites
IDA	International Development Association
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IHA	International Hydropower Association
IIA	Indirect Impact Area
ILO	International Labor Organization
IP	Indigenous Peoples
IPLC	Indigenous Peoples and Local Communities
IPP	Indigenous Peoples Plan
IUCN	International Union for the Conservation of Nature
JICA	Japan International Cooperation Agency
KBA	Key Biodiversity Area

KEC	Kyongdong Engineering Co., Ltd
KII	Key Informant Interview
km	Kilometer
kW	KiloWatt
LC	Least Concern
LLO	Low Level Outlet
LRP	Livelihood Restoration Plan
LRTI	Lower Respiratory Tract Infection
m	Meter
m^2	Square Meter
m^3	Cubic Meter
masl	Meters Above Sea Level
MBNP	Makalu Barun National Park
MBT	Main Boundary Thrust
MCE	Maximum Credible Earthquake
MCT	Main Central Thrust
MFT	Main Frontal Thrust
MHT	Main Himalayan Thrust
MKE	Morrison Knudsen Engineers
MLO	Mid-Level Outlet
MoALD	Ministry of Agriculture and Livestock Development
MoEWRI	Ministry of Energy, Water Resources, and Irrigation
MoFE	Ministry of Forests and Environment
MOL	Minimum Operating Level
MW	MegaWatt
MSDS	Material Safety Data Sheet
LPG	Liquefied Petroleum Gas
NA	Not Applicable
NAAQS	Nepal Ambient Air Quality Standards
NCD	Non-Communicable Disease
NDWQS	National Drinking Water Quality Standard
NEA	Nepal Electricity Authority
NESS	Nepal Environmental & Scientific Services (P) Ltd
NGO	Non-Governmental Organization
NH	Nepal Highway
NO_2	Nitrogen Dioxide
NPR	Nepali Rupee
NT	Near Threatened
NTFP	Non-Timber Forest Product
NTU	Nephelometric Turbidity Units
OESMMP	Operation Environmental and Social Management and Monitoring Plan
OHS	Occupational Health and Safety
O&M	Operation and Maintenance
OPD	Outpatient Department
PA	Provincial Assembly
PAF	Project Affected Family
PAH	Project Affected Household
PAP	Project Affected People
PGA	Peak Ground Acceleration
PIC	Project Information Center
PID	Project Information Document
PM	Particulate Matter
PMF	Probable Maximum Flood

PMP	Probable Maximum Precipitation
PNC	Postnatal Care
PPE	Personal Protective Equipment
PR	Proportional Representation
PRoR	Peaking Run-of-River
PS	Performance Standard
PSRSHDP	Power Sector Reform and Sustainable Hydropower Development Project
RAP	Resettlement Action Plan
RCC	Roller-Compacted Concrete
RoR	Run-of-River
RoW	Right-of-Way
SBT	Sediment Bypass Tunnel
SCI	Shah Consult International
SD	Scoping Document
SEA/SH	Sexual Exploitation and Abuse and Sexual Harassment
SEP	Stakeholder Engagement Plan
SGBV	Sexual and Gender-Based Violence
SO_2	Sulphur Dioxide
STD	Sexually Transmitted Disease
STDS	South Tibetan Detachment System
STI	Sexually Transmitted Infection
TAR	Tibet Autonomous Region (also known as Xizang Autonomous Region)
TB	Tuberculosis
TBM	Tunnel Boring Machine
TDS	Total Dissolved Solids
TIP	Trafficking in Persons
TM	Total Material
TMS	Total Management Services Pvt. Ltd.
ToR	Terms of Reference
TSP	Total Suspended Particles
TSS	Total Suspended Solids
UAHEL	Upper Arun Hydro-Electric Limited
UAHEP	Upper Arun Hydroelectric Project
UNDP	United Nation Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
URTI	Upper Respiratory Tract Infection
US$	United States Dollars
VDC	Village Development Committee
VEC	Valued Environmental and Social Component
VU	Vulnerable
WB	World Bank
WHO	World Health Organization

EXECUTIVE SUMMARY

Introduction

Nepal’s economic and social development is being hampered by inadequate energy supply. To address this, the Upper Arun Hydro-Electric Limited (UAHEL), a subsidiary of the Nepal Electricity Authority (NEA), proposes to construct the Upper Arun Hydroelectric Project (UAHEP or Project), with an installed capacity of 1,040 MW, on the Arun River in the Bhotkhola and Makalu rural municipalities of Sankhuwasabha District, in Koshi Province of Nepal. The UAHEP’s very high head (508 m) and relatively firm river flow will result in approximately 4,549.57 GWh of average annual energy generation. With its proposed peaking run-of-river operations, the Project will generate nearly 1,250 GWh of critical dry season energy, with 67% of that energy coming during peak demand periods.

The UAHEP project site lies in a straight line about 200 km east of Kathmandu, and about 10 km south of the China border. The Project is located in a relatively remote area of eastern Nepal, which is only now obtaining vehicular access with the ongoing construction of the Koshi Highway. To provide access, the Project will still need to construct a bridge over the Arun River and an approximately 21.6 km road, including a 2.0 km tunnel, to access the headworks site.

The proposed UAHEP dam site is located in a narrow gorge about 350 m upstream from the confluence of the Chepuwa Khola and the Arun River near the village of Rukma. The powerhouse lies near the villages of Limbutar and Sibrun, about 750 m upstream from the confluence of Arun River with Leksuwa Khola. The right (west) bank of the Arun River lies within the Makalu Barun National Park Buffer Zone. The Barun River drains much of the national park and flows into the Arun River between the UAHEP dam and powerhouse.

The Project’s Direct Impact Area (DIA) encompasses the access road, hydropower facility, and transmission line footprints and other nearby areas that may be affected by noise, dust, vibration, changes in river flow, increases in vehicular traffic, labor influx, and changes in social organization, economic activities, and cultural heritage. The DIA includes 29 small, primarily agricultural, villages totaling about 1,400 households (see ***Figure ES.1***), most of which are located well above the Arun River due to the fact that in this area the river is flanked by a steep gorge. Some of the steep slopes along the river are used to cultivate cardamom, the primary cash crop in the area. It is only in the area downstream from the confluence with the Barun River that the river valley widens sufficiently for some small villages to be established near the river. Nearly all of the settlements are occupied by a range of indigenous peoples, representing several different ethnic and religious groups. The Indirect Impact Area (IIA) includes the areas within the administrative boundaries of the Bhotkhola Rural Municipality and Makalu Rural Municipality, Wards 3 and 4, and includes those areas that could be affected by changes in ecosystem services, community health, or cultural heritage.

Figure ES.1: UAHEP Direct Impact Area

Legal and Institutional Framework

A separate and independent Environmental and Social Impact Assessment (ESIA) has been undertaken, in accordance with the World Bank Environmental and Social Framework (ESF), to ensure that the Project conforms with good international standards and practices on social and environmental standards. Likewise, the Environmental Impact Assessment (EIA) was conducted, as per Environment Protection Rules 2020, to comply the national requirements of Nepal. Key standards and requirements are listed below.

- World Bank standards:
  - Environmental and Social Framework
  - Environmental and Social Standards
- Good practice notes, handbooks, templates, and checklists
  - General Environmental, Health and Safety (EHS) Guidelines
  - IFC Good Practice Note 2018 Environmental, Health, and Safety Approaches for Hydropower Projects
  - Industry sector guidelines for electric power transmission and distribution
- Environment Protection Rules and other key legal and institutional requirements of the Government of Nepal

Project Description

The UAHEP includes a project access road, hydropower facility, transmission line, and various ancillary facilities, all of which are included for assessment in this report (***Figure ES.2***).

Project Access Road

There is currently no road access to the UAHEP site, so the Project will require construction of a 21.6 km long access road, with a 4.5 m wide carriageway within a 20 m wide right-of-way (RoW), which will branch off the Koshi Highway, providing access to both the project powerhouse and headworks. This road will include a 2.03 km long tunnel with a 4.0 m wide carriageway and two 1.0 m wide shoulders, and bridges over the Arun River and Chepuwa Khola. Construction of the access road will require several ancillary facilities including three workers' camps, two aggregate crusher and batching plants, and four spoil disposal areas. The access road is considered an associated facility, as the World Bank will not be funding the construction of this road.

Hydropower Facility

The UAHEP hydropower facility will involve the construction of a 100m-high dam on the Arun River, which will form a 20.1 ha reservoir; a headrace tunnel of 8,362 m in length; an 8.4 m section net diameter for transporting water from the reservoir to the powerhouse; and a powerhouse with an installed capacity of 1,040 MW. The Project will create a 16.45 km long diversion reach along the Arun River (i.e., the river segment between the dam, where a significant amount of some river flow will be diverted to, the powerhouse, and via the tailrace will be returned to the same river), which will be subjected to reduced or minimum flows. Construction of the hydropower component will require a variety of ancillary facilities focused in the headworks area, headrace tunnel (horizontal access tunnel to the headrace tunnel) portal area, and powerhouse area, including two owner's camps, four contractor's camps, three power plants for construction, two water plants, four wastewater treatment plants, a quarry, several borrow areas, a crushing plant, two batching plants, two fabrication shops, two maintenance shops, four spoil disposal areas, a fuel depot, and an explosives magazine.

Figure ES.2: Proposed UAHEP Facilities

Transmission Line Component

The UAHEP will require construction of a transmission line to evacuate the electricity generated at the powerhouse and connect it to the Nepal electricity grid. UAHEL proposes to construct a 5.8 km long, 400 kV double circuit transmission line within a 46 m wide RoW extending from the UAHEP switchyard to the proposed Arun Hub substation at Hitar. The transmission line towers will be located along the centerline of the RoW. Construction of the transmission line will require a variety of ancillary facilities, including workers' camps and storage areas at each of the 16 towers. No access roads will be constructed for transmission lines, rather construction materials and equipment will be transported by porters, pack animals, and, if necessary, helicopters to each tower location, which is common practice in Nepal for transmission line construction. The health and safety standards applied will be in compliance with national standards and World Bank standards (ISO 45001 or equivalent standards). Based on preliminary information available at present, there are no people living in or using the land in the RoW. A detailed E&S assessment will be followed by the, construction of the transmission line, which is planned to occur during the last year of hydropower construction so that the transmission facilities will be in place in time for hydropower commissioning.

Project Alternatives

Based on the World Bank guidelines and the provisions of Environment Protection Rules 2020, the following alternatives were considered in finalizing the project design, construction methods, and operational modalities.

Without Project Alternative

Under the Without Project Alternative, the UAHEP would not be constructed. This would avoid all of the environmental and social risks and impacts associated with the construction and operation of the Project. Not constructing the Project, however, would not address the shortages in meeting Nepal's projected power demands, and especially peak demands during the dry season. The other way of looking at the Without Project Alternative is to consider the likely impacts associated with other "replacement" projects that would be needed to provide the equivalent annual average energy and dry season peak demand energy provided by the UAHEP. The UAHEP takes advantage of a unique and highly valuable water resource in the Upper Arun River. As there are relatively few sites available in Nepal that can support over 1,000 MW capacity project, it is reasonable to assume that multiple smaller projects would be needed to provide equivalent energy to that provided by the UAHEP. Multiple smaller projects would almost certainly mean additional dams, access roads, transmission lines, and ancillary facilities, resulting in more adverse and significant direct, indirect, and cumulative environmental and social risks and impacts.

System Alternatives

Nepal does not have its own reserves of gas, coal, or oil, plus projects financed by the World Bank should have lower carbon emissions and reduce their impact on the climate. Hence, these options are not considered viable. Many households in Nepal currently rely on biomass (e.g., firewood, dung) for cooking and heat, but increasing the use of biomass would threaten the country's valuable forests and biodiversity and raise health concerns due to indoor air pollution. So, biomass is not considered a viable option. This leaves the renewable energy sources of hydropower, wind and solar as the most viable for Nepal. While both wind and solar power could contribute to meeting Nepal's power demands, relatively little have been developed thus far and they would struggle to provide the overall average annual energy needed or meet the peak dry season power demands that the UAHEP is intended to address. For these reasons, hydropower is considered the preferred energy source for meeting the purpose and need of the UAHEP.

Location Alternatives

Alternative locations were considered for all project facilities, including the headworks, water conveyance system, powerhouse, tailrace, access road, transmission line, and ancillary facilities. Several changes were made in the adopted location of these facilities as a result of the alternatives analysis, including changes in the transmission line route and the location of various ancillary facilities (i.e., spoil disposal areas, workers' camps, powerhouse water plant, headrace employer's camp, quarry access road, borrow areas, and fuel depot). These changes in specific facility locations were made to minimize physical displacement, the placement of permanent facilities within the Makalu Barun National Park (MBNP), impacts on agricultural land, and forest clearing, and to maximize buffers to the villages of Sibrun, Namase, and Rukma.

Design/Technology Alternatives

Design/technology alternatives included the evaluation of alternative dam design, reservoir elevations, powerhouse types, sediment management, blasting technologies, transmission towers types, tower foundations, and transmission voltage. The selected designs reduce environmental and social risks and impacts (e.g., optimize spoil disposal, reservoir inundation area) and incorporate environmental protection measures (e.g., transmission towers designed to separate conductors by more than the width of the largest bird wingspan to effectively eliminate the potential for collision injuries and electrocution).

Construction Alternatives

Construction alternatives included river diversion options and tunnelling methods. The selected alternatives avoid impacts on the MBNP (i.e., diversion tunnel located outside of MBNP) and reduce spoil disposal impacts.

Operational Alternatives

Operational alternatives considered peaking, peaking run-of-river (PRoR), and run-of-river (RoR) operating modes. Although RoR is generally preferred from strictly an environmental and social perspective, as it maintains as close as possible a natural flow regime, it would not support the project purpose of meeting Nepal's dry season peak electricity demand, which requires some water storage and peaking operation to meet peak electricity demand periods. In this case, the proposed PRoR operation would achieve the project purpose, while limiting the reservoir size and reducing downstream water level fluctuations.

In summary, potential environmental and social risks and impacts were considered, along with technical and cost factors, in finalizing the proposed project design. The proposed design reflects the environmentally and socially preferred alternative, inclusive of the concerns and issues raised during consultations with affected communities and project affected households, within the constraints of the project purpose of helping to meet Nepal's dry season peak demand.

Stakeholder Engagement

The Project prepared a Stakeholder Engagement Plan (SEP) early in the ESIA process to guide engagement with stakeholders. The objectives of the SEP were to:

- Establish a systematic approach to stakeholder engagement that will help UAHEL build and maintain a constructive relationship with stakeholders, especially project-affected parties.
- Assess the level of stakeholder interest and support for the Project, enable stakeholders' views to be considered in project design, and improve the environmental and social sustainability of the Project.
- Provide means for effective and inclusive engagement with project-affected parties and other interested parties throughout the project life cycle on issues that could potentially affect them.

- Ensure transparent and timely disclosure of appropriate project information on environmental and social risks and impacts on stakeholders in a timely, understandable, accessible, and appropriate manner and format.

A grievance redress mechanism (GRM) was established to receive, record, and respond to stakeholder concerns and complaints. Aggrieved persons are able to notify community leaders, UAHEL, or submit grievances anonymously in one of eight grievance boxes placed in local villages, as described in detail in the SEP. Furthermore, there are GRMs in the IPP, which will be integrated with the project GRM, and an extended GRM linked with project GRM for sexual exploitation and abuse and sexual harassment (SEA/SH), with trained GRM personnel on SEA/SH, a SEA/SH point person in the Project GRM team, a referral protocol, and a GBV Service Provider for referrals. Various disclosure and communications materials were developed and shared with stakeholders including a Project Information Document (PID), a Frequently Asked Questions (FAQ) document, and a brochure describing the GRM, all of which were available in Nepali. These communication materials were distributed to stakeholders and are also available at the Project Information Centre (PIC), which was established in Gola in September 2019 and staffed by a project representative. The project team has held regular meetings with stakeholders since the initial ESIA scoping meetings in January 2019, and approximately 160 stakeholder engagement activities have been undertaken (see ***Table ES.1***).

Table ES.1: Stakeholder Engagement Activities Undertaken to Date

Date Period	Engagement Activity/ Topic	Stakeholders Participated
January 2019	Scoping consultation	Directly and indirectly affected stakeholders
May–June 2019	ESIA baseline studies and consultation	Directly and indirectly affected stakeholders
October 2019	ESIA baseline studies and consultation	Directly and indirectly affected stakeholders
December 2019–February 2020	Grievance consultation	Directly and indirectly affected stakeholders
December 2019–January 2020	Social baseline/RAP census and consultation	Directly impacted households
January–February 2020	ESIA and Gender Action Plan	Directly and indirectly affected stakeholders
March 2020	CIA	Directly and indirectly affected stakeholders
November 2020	RAP consultation	Directly impacted households
December 2021	RAP & ESIA Disclosure meetings	Directly and indirectly affected stakeholders
February 2023	GBV Assessment consultation and SEA/SH Action Plan	Directly affected and other local stakeholders
October 2020-December 2023	FPIC consultations and IPP development	IP communities affected by the Project, AJAC and LG

These engagements were focused on:

- Disclosing project information including alternatives
- Informing stakeholders about the status of the Project

- Seeking stakeholder input on various environmental and social issues, management measures, and benefit enhancers
- Obtaining stakeholder insights that would help the evaluation of project alternatives

The feedback from the affected villages during the ESIA disclosure meetings generally reflected cautious support for the project. The affected people are primarily concerned about receiving proper compensation for their land and structures, potential effects on their way of life, and ensuring the proposed mitigation and management plans are effectively implemented. They requested that UAHEL keep the communities well informed about all aspects of the Project.

Baseline Conditions

This section describes the baseline physical, biological, and social conditions in the DIA.

Physical Baseline

Physiography, Climate, Geology, and Soils

The Project lies within the High Mountain Physiographic Zone in Nepal, with the project footprint located between elevations 1,065 (near powerhouse tailrace) and 2,010 m (in the headworks area). From a climate perspective, the Project is located in the sub-tropical (up to 1,200 m) and temperate (1,200–2,400 m) climatic zones, with cool to cold winters and occasional snowfall at upper elevations, and warm summers. The area has distinct wet and dry seasons, with about 70% of the annual precipitation occurring during the monsoon period between June and September. The Arun River valley in this area is a deeply incised gorge with steep slopes rising directly up from the riverbanks. The river substratum and the flooded banks are characterized by large boulders mixed with pebbles and cobbles, with little or no sandy admixture. This reflects the Arun River's high sediment transport capacity. Project soils are relatively thin (<50 cm), acidic, well drained, loamy sands with high organic matter content and relatively rich in nutrients, with shallow depth to bedrock.

Water Resources

The UAHEP is located on the Arun River, which is a tributary of the Sapta Koshi River, which in turn is a tributary of the Ganges River in India, which ultimately discharges into the Bay of Bengal in the Indian Ocean. The river originates from a glacier in the southern part of the Tibetan highlands in China. At the headworks site, which is about 14 km (by river) downstream from the Nepal-China border, the Arun River has a drainage area of 25,700 km^2, with approximately 98% of that draining from China. The Arun River is a relatively high volume, high gradient/high velocity, glacier-fed (i.e., cold with high sediment load) river, with an average annual flow of 217 m^3/s at the dam site.

The Arun River is one of the most highly sediment-laden rivers of Nepal. Recent measurements reveal a sediment load of 16.24 million tons per year, of which 13.81 million tons is suspended sediment (average suspended sediment load is 2.01 kg/m^3) and 2.43 million tons is coarse bed load (CSPDR, 2020). Further, these studies also show that most sediment transport (95.5% of sediment load) occurs during the months of May to October.

There are many springs and small streams found in the DIA, many of which are used for water supply, irrigation, to power a mill, and four micro-hydropower projects that provide electricity to local villages. The water quality of the Arun River is good, other than the high turbidity (range of 17–1,702 nephelometric turbidity units [NTU]) resulting from its high sediment load. Similarly, the water quality of most of the springs is also considered good, with much lower turbidity levels (maximum of 7 NTU) relative to the Arun River. Some small streams show evidence of fecal coliform contamination, likely from animal or human waste.

Air Quality and Noise

The ambient air quality of the DIA is very good, well below Nepal Ambient Air Quality Standards, as there are no industrial emission sources, although areas along the Koshi Highway show elevated particulate matter concentration (PMC). Similarly, noise levels in the DIA are generally low reflecting the rural residential setting, with higher noise levels found from monitoring sites near schools and along the Koshi Highway.

Land Cover

The Project is located in a relatively remote portion of northeast Nepal. Since 2019, vehicular access has been available along the west side of the Arun River, currently only as far as the Barun River. There is still no vehicle access to the east side (left bank) upstream from Arun-3 Hydroelectric Project (HEP). Forest is by far the dominant land cover (67%), with agriculture (primarily cardamom, millet, and small plots of crops grown for local consumption) representing most of the remaining land (26%). Some residents grow crops within the forested areas.

Landscape Values and Visual Amenity

The DIA is rich in natural beauty, cultural heritage, and ethnic diversity, including the MBNP and Barun Bazar, which is the site of the annual Barun Mela (see Section 6.3.14). Waterfalls are common throughout the DIA, with Chepuwa Khola falls, located about 350 m downstream from the UAHEP dam, being one of the largest and most visible. There is also a large waterfall on the Barun River approximately 100 m upstream from its confluence with the Arun River, which is visible from Arun Valley from locations near Sibrun and Hema. The Arun River gorge cuts through steep forested slopes and fields of cardamom and millet. The area is of high scenic value.

Biological Baseline

World Bank Environmental and Social Framework (ESF) ESS 6 requires the designation of an Ecologically Appropriate Area of Analysis (EAAA), which is defined as an area that delineates the extent to which a proposed project may affect the surrounding biodiversity, especially in terms of assessing potential effects on species or features that could trigger critical habitat. The Terrestrial EAAA was defined as the areas below the 4,000 m elevation contour with, which generally reflects the tree line in the project area. The Aquatic EAAA was defined based on the ecological requirements of the Golden mahseer, as this species was identified as being the species most likely to trigger critical habitat. The Aquatic EAAA was defined as the aquatic habitat upstream from the 700 m elevation contour, which reflects the lower elevational range for golden mahseer spawning habitat.

Protected and Key Biodiversity Areas

The background assessment considered several types of protected and key biodiversity areas, including national/legally protected areas, WWF Ecoregions, Key Biodiversity Areas (KBA), UNESCO World Heritage Sites, and Ramsar Wetlands of International Importance. There are several legally protected and internationally recognized areas of high biodiversity value within the Project's EAAA, including the MBNP, an Important Bird Area (IBA) (the Khandbari-Num Forests IBA), and the Qomolangma UNESCO Man and the Biosphere Reserve. The EAAA does not include any Ramsar Wetlands of International Importance, Alliance for Zero Extinction Sites, or World Heritage Natural Sites. The MBNP and IBA, which are located along the entire west (right bank) of the Arun River from the Project's dam/reservoir downstream to the powerhouse, consists of a Core Area and is surrounded by a designated Buffer Zone, both of which are part of the MBNP and included in the IBA. The Khandbari-Num Forests IBA is located on the east (left bank) of the Arun River, but about 15 km downstream, near the Arun-3 HEP.

Terrestrial Habitat

The Project's DIA consists of 74% natural habitat (mostly forest) and 26% modified habitat (mostly agricultural land and small villages). Four distinct forest communities are found within the DIA – *Alnus-schima* mixed forest, *Lyonia-rhodendron* forest, *Alus-pinus* forest, and *Alnus-castonopsis-lyonia* forest. There are eight community forests found within the DIA, which are government owned, but community managed.

Aquatic Habitat

The Arun River is a cold, turbid, snow-fed river, as are some of its major tributaries (e.g., Barun River), which drain the high Himalayas. Other tributaries that only drain lower elevations tend to have slightly warmer and less turbid water (e.g., Leksuwa Khola, Ikhuwa Khola), and are referred to as “warm tributaries”. The Upper Arun River is fast flowing with relatively limited ecological value, a low number of fish species (11) and a low number of other aquatic species, compared to downstream reaches of the river. The larger perennial warmer tributaries probably play a limited role in the Upper Arun aquatic ecosystem. The most important fish species in the Arun River, the common snow trout (*Schizothorax richardsonii*), spawns in the Arun River. The entire Arun River is considered natural habitat in accordance with World Bank definitions (ESS 6).

The most ecologically valuable sections of the warm water tributaries are their confluence with the Arun River. This is because upstream migrating fish species such as common snow trout use these areas for spawning. The common snow trout (IUCN VU) was by far the most abundant species in the collected fish samples in the upper part of Arun River, representing over 80% of all individuals caught. The few other relatively common species included the mid-range migrant species *Psilorhynchus pseudecheneis* (IUCN LC) and *Neolissochilus hexagonolepis* (IUCN NT). Golden mahseer *(Tor putitora)* a critical habitat species, widely distributed in the Himalayan Rivers, has not been observed in the upper part of the Arun River since 2018 (it has been observed downstream of Arun 3 HEP).

Critical Habitat Assessment

Critical habitat is defined in the World Bank ESS 6 as “areas with high biodiversity importance or value, including: (a) habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches; (b) habitat of significant importance to endemic or restricted-range species; (c) habitat supporting globally or nationally significant concentrations of migratory or congregatory species; (d) highly threatened or unique ecosystems; (e) ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described in (a) to (d).” These criteria were used to screen species and habitats potentially present in the Ecologically Appropriate Area of Analysis (EAAA), which identified four mammal fauna species that trigger critical habitat. These were as follows:

- **Himalayan red panda** (*Ailurus fulgens*) – This species is categorized by the IUCN Nepal and Global Red List as Endangered and has been captured by camera trappings carried out for the UAHEP ESIA. It has also been reported in Sankhuwasabha District where the Project is located. It prefers moist montane forest, but can also use high altitude shrub land. Habitat types include temperate and subalpine forest zones of the Himalayan ecosystem between 2,400–4,000 m elevation in Nepal (Thapa *et al.* 2020). This species was identified during field surveys conducted for the Project, considering its preferred habitat preference (high altitude with a core elevation range of 2,800–3,200 m), it is present in the EAAA (elevation range of 410–4,410 m).
- **Himalayan black bear** (*Ursus thibetanus*) – This species is categorized by the IUCN Red List as Vulnerable, and the National Red List as Endangered. It has a large distribution range, extending from Iran, Northern Pakistan, India, Nepal, Bhutan, Northeast India, and mainland Southeast Asia. The EAAA contains suitable habitat for this species. Habitat types include forest, wetlands (inland), grassland, shrubland, artificial/terrestrial, with a lower and upper elevation limit of 0 m and 4,300 m respectively. This nationally Endangered species was observed in the project area. Interviews with locals and expert consultations revealed that this species is recorded.
- **Clouded leopard** (*Neofelis nebulosa)* – This species is categorized by the IUCN Nepal as Endangered and by IUCN Global as Vulnerable. It has been observed in the project area. Also called mainland clouded leopard, the clouded leopard (*Neofelis nebulosa*) is a wild cat inhabiting dense forests from the foothills of the Himalayas through Northeast India and Bhutan to mainland Southeast Asia and into South China. The clouded leopard is the first cat that genetically diverged 9.32 to 4.47 million years ago from the common ancestor of the pantherine cats. Today, the clouded leopard is locally extinct in Singapore, Taiwan, and possibly in Hainan Island and Vietnam. The wild

population is believed to be in decline with fewer than 10,000 adults and no more than 1,000 in each subpopulation. It has been listed as Vulnerable on the IUCN Global Red List since 2008. The population is threatened by large-scale deforestation and commercial poaching for the wildlife trade.

- **Spotted linsang** (*Prionodon pardicolor*) – This species is categorized by the IUCN Nepal as Endangered and by IUCN Global as Least Concern. Native to much of Southeast Asia, the spotted linsang has been observed in the project area. It is widely distributed, although usually sparsely recorded. The range of the spotted linsang includes eastern Nepal, Sikkim, Assam and Bengal in India, Bhutan, northeastern Myanmar, northern Thailand, Laos, northern Vietnam, and western Sichuan, Yunnan and Guizhou and southwestern Guangxi in southern China. It is uncommon to rare throughout this range. It primarily inhabits evergreen forests and shrubland. A large portion of this habitat is not protected, and this may cause the spotted linsang to be threatened with extinction due to habitat loss.

Social Baseline

Demographics, Ethnicity and Religion

The Project is located in Sankhuwasabha District, where the majority of the population live in rural municipalities and only about 20% of the population live in municipalities (Census 2011, CBS 2012). In Bhotkhola, aadibasi/janajati (indigenous people) comprise 95% of the total population, as compared to 35% of the total population in Nepal (Nepal Census 2011, CBS 2012). The major ethnic groups in Bhotkhola Rural Municipality are Bhote (43%), Rai (32%), and Tamang (11%); the other aadibasi/janajati groups (e.g., Lhomi, Sherpa) comprise the remaining 9% of the population.

Most of the households are followers of the Tibetan-influenced schools of Buddhism (80%), about 9% reported themselves as Hindus, and 8% still follow Kirat or animism. At national level the distribution is app. 81% Hindus, 11% Buddhist, Muslim 4%, and Kirant almost 4%.

Within the DIA, children below the age of 5 years comprise 9% of the total population. The education level for the population above 5 years of age shows that 26% of the population is illiterate and another 9% has only functional literacy (limited to reading and writing simple sentences). The overall national adult literacy rate was 71% (CBS 2021). Most of the children are enrolled in primary and lower secondary schools available in the project area.

Land Use and Ownership

The average land holding in the Project DIA is 2.3 ha or 47 ropani (1 ropani = 509 m^2). Within the DIA, women in approximately 18% of the households own land jointly or in their name. Although, women own land in their name, the decision to sell or not to sell land is usually made by male family members.

Most households own some agricultural land, some own private forestland, and often have a small orchard or at least fruit trees. This composite use of different types of land is crucial for meeting various requirements of the households and helps in making the household self-sufficient. Apart from cultivating their own land, some households cultivate additional land obtained through sharecropping or on lease (*bandagi*). Some households also report cultivating some of the government-owned land.

Most villages in the DIA make little use of the Arun River, because the larger villages are found on more gently sloping land well above the river elevation. In the DIA, water from the Arun River is not used for drinking water, irrigation, or transport purposes. However, the Arun River is considered holy in several religions and the oral traditions (mythology) of prominent ethnic groups describe its spiritual significance. Several ethnic groups use the Arun and Barun rivers for cremation rituals.

Households get their drinking water from streams and springs. The flow of some springs is channeled to farmland for irrigation purposes or to operate *ghatta* (water mills), which are used to grind maize, millet, barley, and other grains. Some streams are used to generate electricity through micro hydroelectric plants, which supply power for a fixed number of hours to one or multiple villages.

Economics and Livelihoods

In the DIA, about 74% of the working population are engaged in agriculture and allied activities, such as livestock keeping and harvesting forest products. Participation in trade or small business and services are reported by 9% and 8% of working population, respectively. Only 3% of the working population report being engaged in wage labor, which includes both agricultural and construction work.

Many residents of the DIA participate in some form of multi-year or seasonal migration, primarily because of poverty, remoteness of villages, extreme climatic conditions, and lack of access to jobs, hospitals, and schools within their own villages. About 3% migrate outside of the country for employment, typically for several years if not permanently. According to the DIA socioeconomic survey, about 24% of the residents leave the area for at least part of the year. This includes some adults seeking temporary/seasonal work in cities such as Kathmandu, Khandbari, Dharan, and Darjeeling (India), where there is greater access to employment and economic opportunities to supplement their income, but these residents typically return to their home village to live for at least part of the year. Many families in the higher elevations (e.g., Chepuwa, Rukma) will move to lower elevation villages during the winter to escape the cold, where they sell medicinal herbs and other non-timber forest products (NTFPs) to generate income.

The livelihood strategy of most households involves subsistence agriculture and livestock keeping, along with the collection and sale of medicinal herbs or forest products, supplemented by working in trekking-tourism when the opportunity arises. Agricultural crops include rice, where suitable land is available (only 35% of households), otherwise millet, maize, and barley, along with vegetables, oilseeds, and fruits. Cardamom is the main cash crop in the DIA, with approximately 85% of households cultivating cardamom. Livestock (large domestic animals such as cattle, yaks, and mules; small livestock such as sheep, goats, and pigs; and poultry) are an integral part of the subsistence lifestyle, with 96% of the households keeping livestock.

Most households in the DIA are members of a community forest user group (CFUG), which enables them to access, manage, and collect various NTFPs, which are a key component of their subsistence livelihoods. For example, small farmers rely heavily on forests for grass and fodder to feed their livestock. They also collect leaf litter for use on their farms and firewood, which is the main source of energy for cooking and heating.

Hunting was an important feature of traditional subsistence life of local communities until the MBNP was declared and community forests were established in the 1990s, both of which restrict hunting. MBNP rangers enforce the ban on hunting by regular patrolling efforts and check posts. The Arun River has several native fish species, but fishing is limited because of the difficulty in accessing the river in the upper gorge area and relatively low fish populations. The little fishing that occurs is mainly done for recreation and personal consumption; no commercial fishing occurs.

The gender disaggregation of the working population reveals that more women (54%) are engaged in agriculture than men (46%). The representation of women in services, however, is low (30%) in comparison to men (70%). There are more men in wage labor and foreign employment than women. In trade and business, though more men (56%) are engaged, women (44%) are well represented. The age distribution of working population reveals some instances of child labor (below 14 years) in wage labor or agriculture activities, but their number is small. However, there are a considerable number of adolescents (15–18 years) who are working in agriculture and allied activities.

Community Services and Infrastructure

Overall, community service provision and infrastructure development within the DIA is inadequate. The area has poor road connectivity. There is no public transport connecting Khandbari, the district headquarters, to Bhotkhola. Four private operators provide public transport service between Khandbari and Gola/Barun Bazar. In terms of policing, the DIA is within Area-1 of Sankhuwasabha District, which is controlled by a Sub-Inspector stationed at Hedengna. Other police posts include Hatiya, Chepuwa, Gola, and Syaksila. Armed Police Force are stationed in the border town Kimathanka. There are two Nepal Army posts, one in Gola and the other in Hatiya.

The DIA does not have a waste collection or disposal service, with most organic waste retained as compost, and inorganic waste reused or thrown away indiscriminately. Households primarily obtain drinking water from local perennial springs, which, in most cases, are piped from locations above the village to a central location for use by multiple households. Most households (99%) have toilets and an individual septic tank or drain-field. Only a small number of households use basic pit latrines.

Most households have access to electricity from locally operated micro-hydropower projects, which provide power for fixed hours each day. Other households use solar lamps or traditional kerosene or oil lamps for lighting. Firewood is the most commonly used cooking fuel, with 97% of the households surveyed stated that they depend entirely on firewood for their cooking needs. Households running commercial shops and home-stay arrangements often use LPG cylinders.

Community Health and Wellbeing

According to the Health Department of Bhotkhola Rural Municipality, approximately 7,000 cases of communicable diseases were reported during 2016–2019 period. Cases of water- and food-borne disease were the most common (43%), followed by respiratory tract infections and viral influenza. A total of 246 sexually transmitted diseases (STDs) were reported between 2016 and 2019. There were also 62 cases of nutrition and metabolic diseases (anemia, malnutrition) reported. The number of cases of anemia almost doubled from 2017/18 to 2018/19, which were the most recent data available when study was conducted. Although gender disaggregated statistics are not available, the health reports cite anemia as a major concern among women, as it leads to increased maternal morbidity and mortality and poor birth outcomes, as well as a reduction in work productivity. Dog, insect, and snake bites are common health hazards. The number of road accidents are very few, as there are few roads or vehicles, but when they occur, they often result in fatalities because of the steep slopes.

There are health posts or community health units in Chyamtan, Gola, Chepuwa, Namase, and Sibrun, and, for more severe problems, a district hospital in Khandbari. However, there are insufficient numbers of health workers in these health posts and units. Many residents, especially the elderly, prefer to rely on traditional medicine/healing practices, which have a strong cultural and religious connection. Based on stakeholder consultations it was learned that most residents prefer to seek treatment from traditional healers and using herbal remedies before visiting the health posts and units.

Cultural Heritage

Most of the tangible and intangible cultural heritage resources in the DIA reflect Buddhist practices including prevalence of *gompa* (monastery), *chhorten* (stupa or chaitya), and *manewall* (stone wall containing prayer wheels and/or inscribed stone slabs), among other things. Engraved and etched stones, including figurines from Buddhist pantheon and stupas, as well as writings in Tibetan script, were found in some of the old *gompas*. Other tangible heritage sites present in the DIA include *devithans*, a religious site that has been worshipped by local people since before living memory; *naagthans*, where Bhote snake worship ceremonies are held; and *chautari*, which are rest areas built under a tree to provide shade for travelers, but often are used as a gathering space for community meetings. None of these cultural sites are nationally protected monuments, although they have cultural significance for local communities.

Each ethnic group (e.g., Tamang, Bhote, Gurung, Rai) in the DIA possesses a wide spectrum of intangible cultural heritage, including migration history, belief system, oral traditions, life-cycle rites and rituals, belief systems linked to the cosmos and natural world, performing arts, and traditional handicrafts (e.g., straw mats, bamboo baskets, and woven woolen carpets). Festivals, rituals, funerals, and ceremonies are a significant part of community life, and bring entire communities together, reflecting the tight-knit kinship that they share. In addition, labor exchange among households, participation in festivals and ceremonies, and the *Kiduj Samaj*[1] underpin a strong sense of community spirit.

[1] The *Kiduk Samaj* plays a central role in decision-making on village matters mostly related to birth, marriage and death rituals. The decisions made in *Kiduk Samaj* are accepted as legitimate collective decisions and, as such, it is a respected and legitimate body in each village.

Death rituals vary by ethnic group and to some extent by community. The Bhote, Gurung, Sherpa, and Tamang communities perform death rituals on the hills above their villages, referred to as “Chihan Danda”. Brahmin, Gurung, and Dalit communities conduct death rituals by the Arun River. It was reported that the number of Christians in the area has increased over the years, and they have started practicing burial rather than cremation. There are no specific burial grounds for Christians. Rai and Kirat communities usually have graveyards in their own gardens.

Communities in the DIA have a spiritual connection to their land, as well as their surroundings, and worship mountains, hills, and forests as the abode of gods, goddesses, or souls and spirits, for good harvest, good health, and prosperity. The Phalo of Bhote and Mindum of Rai, both sacred chants, invoke the gods and natural spirits of mountains, rivers and springs around them. Some of the natural sites have cultural importance, including Tatopani Kunda (a natural hot spring near Hatiya), the Arun-Barun Dovan (the site for Barun Mela in Barun Bazar), and the Bhembhema waterfall (on the Arun River just downstream from the proposed UAHEP dam).

Impact Assessment and Mitigation

The Project has been assigned an overall environmental and social (E&S) Risk Classification of High Risk, based on the type and scale of the Project (large 1,040 MW hydropower project); its location in the developing country of Nepal; the magnitude of the project risks, especially to biodiversity (e.g., critical and natural habitat), indigenous peoples, and cultural heritage; and taking into consideration the capacity of the Borrower. The key findings relative to project impacts and risks, are as follows, together with the proposed measures to mitigate or manage these impacts/risks.

Physical Environment

Erosion and Sediment Control

The Project will disturb 232.14 ha of land, much of which is relatively steep and susceptible to erosion and sedimentation, especially during the monsoon season. Side-casting is a common practice in Nepal, where excavated soil is simply pushed off to the side of construction works. This practice damages downslope vegetation and crops, causes property damage, and can trigger land instabilities in the form of landslides and debris flows, undermining the stability of the road or facility being constructed above.

The Project will implement the following measures to reduce the risk of erosion and sedimentation during construction:

- Prohibit the Contractor from clearing or disturbing any land beyond those approved by the Government of Nepal in the Environmental Impact Assessment (EIA) and Forest Clearance Permit approvals.
- Require the Contractor to prepare a detailed erosion and sediment control plan, with special provisions for controlling all disturbed areas during the monsoon season, for approval by UAHEL and the World Bank.
- Install approved sediment control measures before initiating land disturbing activities such that drainage from all disturbed areas is directed to a sediment control facility (e.g., silt fence, sediment trap, sediment pond).
- Prohibit the Contractor from side-casting or discharging any excavated material to streams. All excavated material must either be re-used as fill material or hauled and properly disposed of at an approved spoil disposal site.
- Provide an experienced sediment and erosion control inspector as part of the Project’s EHS Team.

Effects on River Flow

The UAHEP will operate in a peaking run-of-river (PRoR) mode, with essentially no net daily water storage (i.e., all inflow into the reservoir will be discharged on a daily basis, with only temporary storage to allow daily peaking operations). This operating regime will affect flow in the Arun River differently upstream from the project dam, in the diversion reach, and downstream from the powerhouse, as described below:

- Upstream from the UAHEP Dam – The Project will have no effect on Arun River flow or hydrology upstream from the dam. The dam, however, will create a 2.1 km long reservoir with a surface area of 20.1 ha. The peaking operation will result in up to 15 m of daily water level fluctuations within the reservoir.
- Diversion reach – The Project will have its most significant effect on flow along the 16.45 km long diversion reach between the UAHEP dam and the powerhouse tailrace. Flows in this section will be reduced by over 90% during the dry season (October to May) and between 39–79% during the monsoon season (June to September), as all flows up to the powerhouse's hydraulic capacity of 235.4 m^3/s, except for the required EFlow release of 5.41 m^3/s (see EFlow Assessment, Artelia and Hydrolab 2024), which will be diverted to the powerhouse and bypass the diversion reach. The EFlow will be supplemented by the flows of the tributaries in this dewatered section. This will achieve a year round minimum depth of at least 30cm, which has been assessed as adequate for the survival and spawning of the common snow trout.
- Downstream from the UAHEP powerhouse – The flows in the section of the Arun River from downstream from the UAHEP powerhouse to the backwater of the Arun-3 HEP reservoir, which is approximately 11.8 km downstream, will vary significantly during the dry season (October to May) as a result of the Project's PRoR operations. The most extreme fluctuation in downstream flows will occur during the periods with the lowest flows in the Arun River (i.e., December through April), when the Project will be operating almost exclusively in a peaking mode. At its most extreme (i.e., during January, which has the lowest mean monthly flow), only about 18 m^3/s of flow from the diversion reach would be reaching the tailrace area when the Project is not peaking. When peaking operations begin, the flow in the Arun River immediately downstream from the tailrace will slowly increase from 18 m^3/s to 155 m^3/s (i.e., 18 m^3/s baseflow + 155 m^3/s powerhouse discharges of four turbines). This increased flow will continue until 24:00 hours (midnight) when peaking operations terminate, and then the powerhouse discharge will cease and the flow in the river will return to the baseflow of 18 m^3/s.

Effects on Local Springs

The Project has the potential to affect flow in at least some springs within the Project's DIA, as a result of the project access road tunnel, headrace tunnel, and powerhouse cavern, and other underground excavation. The construction of these facilities could intercept a fault/fracture zone. As the groundwater pressure head can be quite high for these facilities, as they have in some cases over 1,000 m of overlying rock, there is a risk of encountering high-pressure seepage during excavation. This seepage into the excavation areas could lower the groundwater table, thereby reducing or eliminating flow in some overlying springs or streams within the zone of influence. The construction of these tunnels using drill and blast techniques could also result in some localized fracturing of rock, which could create a preferential groundwater flow path that could also reduce or eliminate flow in some springs and streams.

The Project will implement the following measures to address the risk of diminished flow to springs or effects on streams from construction:

- Apply engineering controls such as grouting and reinforced concrete lining to reduce or eliminate seepage into the excavated area (these will be applied immediately even before any documentation of reduced flows in the springs).
- Provide a permanent alternative source of water to the affected households or villages. The Project already includes two permanent water treatment plants (one each in the powerhouse and headworks areas) with the capacity to meet local water demands. Therefore, the infrastructure will be in place, with only minor extensions required, to provide water to any local village in the event the Project affects local streams. This water will be provided at no cost to affected households.

Sediment Management

The Arun River carries a large sediment load, 95% of which occurs during the high flow monsoon season. The Project has developed a sediment management strategy, which involves shutting down the turbines when flows are above 575 m^3/s and opening the dam's low-level outlets (LLOs) to flush sediment from the reservoir. Sediment transport modelling indicates that sediment deposition will occur rapidly within the reservoir with the initiation of project operations, but after about three years, and applying the proposed sediment management strategy, the silting and scouring of sediment in the reservoir will reach an equilibrium condition, with only about 19% of the reservoir's storage volume lost to sedimentation. The modelling also indicates little sediment deposition within the diversion reach other than in two short sections near the outlet of the sediment bypass tunnel (SBT) and just upstream from the confluence with the Barun River. The model results indicate that the proposed strategy should be effective, although sediment deposition monitoring is recommended for the first five years of project operations and adaptive management measures implemented if sediment deposition is materially degrading aquatic habitat and impacts on the population of the common snow trout have been identified in the diversion reach.

Effects on Water Quality

The Project is not expected to have any meaningful impact on water quality in the Arun River, as there will be no industrial wastewater discharged and the project reservoir is small and not susceptible to stratification or eutrophication. The Project will require up to 4,500 workers, but wastewater treatment facilities will be provided at each workers' camp to treat the domestic wastewater to acceptable Nepali standards before being discharged to the receiving environment. Stormwater management facilities and oil/water separators will also be provided to control erosion from disturbed areas and to manage drainage from facilities such as the crushers, batch plants, fabrications shops, maintenance shops, spoil disposal areas, and the quarry.

Hazardous Materials

Project construction will require the transport, storage and use of relatively large quantities of various hazardous materials, especially diesel fuel, but also various oils, lubricants, paints and other materials. Accidental spills are impossible to completely prevent and, depending on the material and the volume spilled, could pose risks to water quality. The Project will manage this risk as follows:

- Prohibit the disposal of any hazardous material or waste on-site.
- Provide training for staff using hazardous materials regarding proper care, handling, storage, transport, and disposal of hazardous materials and waste. Only trained and authorized personnel will handle hazardous materials and waste.
- Locate fuel/hazardous material storage facilities at least 50 m away from any watercourse and provide an impervious floor, secondary containment with capacity for at least 110% of the largest container, and equipping each fuel dispensing hose with an automatic shut-off nozzle.
- Prepare a Spill Response Plan, which will identify required preventative measures, roles and responsibilities in the event of a spill, the required spill control materials to have available, spill control and clean-up procedures, and notification requirements, for review and approval by UAHEL and the World Bank.

Waste Management

The Project will generate large quantities of both construction debris and domestic waste from the construction workforce. The contractor will construct and operate a sanitary landfill onsite or near the construction sites for the storage of construction waste and hazardous waste, since there is no waste disposal facility in Khandbari. Recyclable materials will be separated on-site for recycling. Effects on Air Quality

During construction, the Project will primarily generate air emissions from the Project's three diesel power plants, construction vehicles, and fugitive dust. All of these impacts will be temporary and limited to the duration of construction. Spraying water onto exposed soil along roads and at construction areas will be used to control fugitive dust during dry periods, and proper maintenance of the power plants and construction vehicles will minimize emissions. Other than vehicle emissions, there are no emissions expected during project operations.

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Noise and Vibration Impacts

Project construction will generate noise, primarily from the power plants, crushers, batch plants, and construction equipment. Night-time construction will be prohibited and all equipment and vehicles will be required to be maintained in accordance with manufacturer's specifications. Noise barriers (e.g., berms, fences, enclosures) will be installed for noise-generating equipment near villages (e.g., road contractor crusher and workers' camp near Namase). Noise modeling indicates that with these mitigation measures, the Project will meet the World Bank EHS guidelines. The use of explosives and helicopters will also contribute noise, but on a sporadic basis. These noise impacts will be managed by prior notification of local residents of their use and again restricting use of helicopters and aboveground explosives to daytime hours. There is potential for the use of explosives and large trucks to cause vibrations, which could damage structures or destabilize slopes. Modelling indicates that the risk of vibration damage is low. Nevertheless, these potential impacts will be managed by limiting the size of the explosive charges, controlling vehicles speeds near residential areas, and documenting with photographs and video the condition of structures that may be exposed to vibration impacts so any damage can be confirmed and compensated.

Effects on Landscape Values and Visual Amenity

The Project will result in permanent on-going impacts on landscape values and visual amenities by introducing large, modern facilities into an otherwise predominantly natural and rural agrarian landscape. Many of the project facilities are underground (e.g., headrace tunnel, powerhouse), which reduces the Project's impacts. The dam, however, must be aboveground and will be a visually prominent feature, but only within a relatively small viewshed, which includes the village of Rukma and short portions of various trails along the Upper Arun River gorge area. Views of the dam elsewhere up and down the river will be limited because of the meandering nature of the river and its location within a gorge. The dam will not be visible from the culturally significant Barun Bazar area, which hosts the Barun Mela, but from this area a person will be able to see Spoil Disposal Areas #3 and #4, which lie across the Arun River. The Contractor will be required to develop a special landscape restoration plan for these two spoil disposal areas.

Biological Environment

This section describes the key findings relative to biodiversity and the application of the mitigation hierarchy to avoid, minimize, mitigate, and offset, in that order, project impacts.

Impacts on Internationally Recognized Protected Areas

The Project will directly impact on 35.55 ha of MBNP Buffer Zone (21.803 ha of government owned forest land and 13.751 ha of private land)of the Buffer Zone of the Makalu Barun National Park (MBNP). Portions of the Buffer Zone will be required for the UAHEP dam, reservoir, access road, and some ancillary facilities.

The Project undertook the following actions to reduce these impacts:

- Avoided impacts by relocating several ancillary facilities to outside the MBNP, including the original proposed borrow areas, which would otherwise have impacted the MBNP core.
- Minimized the facilities located within MBNP Buffer Zone to either permanent facilities that, by their nature, were required to be located along the Arun River, which is partially within the park Buffer Zone (e.g., portions of the dam and reservoir), or temporary ancillary facilities that will be removed after completion of construction and the sites restored. These temporary ancillary facilities were located on sites within the MBNP Buffer Zone only when locations outside of the park were not viable (i.e., would result in greater environmental and social impacts) and were only located on sites within the park Buffer Zone that were already disturbed (e.g., used for agricultural purposes).
- The impacts on the MBNP Buffer Zone will be mitigated by targeting afforestation within the MBNP and its buffer zone and surrounding community and government forests for any direct impacts (i.e., loss of forest) and providing funding to support additional park rangers to address the potential for indirect impacts (e.g., poaching, clearing, collection of animal and plants by UAHEP workers or as a result of improved access to the MBNP lands) and to enhance the capacity of MBNP and division forest office of Sankhuwasabha district.
- Support will be provided to the MBNP and Department of National Parks and Wildlife Conservation for the completion and approval of the MBNP Management Plan.

Loss of Natural Terrestrial Habitat

The Project will result in the loss of approximately 94.58 ha of natural terrestrial habitat as a result of project clearing and grading activities. This clearing of natural habitat has been minimized to the extent possible. The Project will achieve the World Bank's requirement for No Net Loss (NNL) of natural habitat and net gain for critical habitat by providing afforestation on a 1:10 basis, consistent with the requirements of the Forest Rules 2022. As indicated above, this afforestation for clearing within MBNP Buffer Zone will be targeted within the park to the extent that land is available, in consultation with the MBNP and Department of National Parks and Wildlife Conservation. The remaining afforestation will be targeted to create similar habitats using native species.

Fish Passage

The UAHEP dam is located near the upstream limit of most migrating fish. The common snow trout and Dinnawah snow trout, both mid-range migrants, are the only species that are known to migrate upstream past the UAHEP dam site, but even then, are only found in low numbers. The UAHEP dam will serve as a barrier to these two fish species. The other mid-range and long-range migratory species present in the Arun River (i.e., Bengal eel, copper mahseer) are only found downstream from the UAHEP dam site, so the UAHEP dam will not function as a barrier for the migration of these species.

The Project does not propose to provide fish passage for the following reasons:

- The Project's 100 m high dam in a gorge setting will present technical/engineering challenges for constructing an effective fish ladder.
- The downstream Arun-3 HEP, currently under construction, will not provide fish passage upstream from it to the UAHEP affected reach, so will prevent all long-range migratory fish species from reaching the UAHEP dam.
- The Arun-3 HEP will be providing a fish hatchery in lieu of a fish ladder, and it is likely these hatchery fish will come to dominate the fish genetics of the fish in the river segment between the Arun-3 HEP and the UAHEP dams. Provision of fish passage at UAHEP, even if technically feasible, would introduce hatchery fish into the existing native fish population upstream from the dam.
- As indicated above, only a few fish species, with a low numbers of individuals, are found in the Arun River upstream from the UAHEP dam site. The common snow trout, the key migratory species present in the Arun River, will be able to survive upstream from the UAHEP dam without a fish ladder, as suitable spawning habitat is available.

For these reasons, it was determined that provision of fish passage at the UAHEP is not necessary or advisable, in that the UAHEP dam will provide a barrier to the upstream migration of predominately hatchery fish.

Environmental Flow

The Project will divert water from the 16.45 km long diversion reach, so an Environmental Flow (EFlow) of 5.41m^3/s is proposed to mitigate the biodiversity and social impacts associated with this water diversion. This EFlow will be supplemented by the flows of the tributaries in the dewatered section. In accordance with the World Bank Group's *Good Practice Handbook: Environmental Flows for Hydropower Projects* (2018), the UAHEP required a high resolution EFlow Report, involving a fish connectivity, sediment, and social impact assessment (Artelia and Hydrolab 2024). The diversion reach is used as a migratory pathway for common snow trout, and to a much lesser extent for the Dinnawah snow trout. Given the size of these fish in the diversion reach, they require a minimum flow depth of 30 cm of water to enable movement and to support fish migration. The sediment management strategy does not rely on EFlow to transport sediment, but rather will require the Project to shut down the powerhouse and open the low level outlet gates to flush sediment through the diversion reach, so sediment transport will not influence the required EFlow. The Arun River is not used to any significant degree for gravity irrigation, water supply, or transportation purposes, but is used in the dewatered zone of 16.45 km and downstream from the tailrace for some cultural religious practices such as cremation and religious ceremonies (no fixed seasons), fishing, and sand and gravel collection in the dry season. The EFlow required by the fish connectivity study will need to be sufficient to support traditional cremation and other ceremonies. Based on these analyses, an EFlow of 5.41 m^3/s was determined to be adequate to meet national and the World Bank ESF requirements.

Minimum Flow Requirements

The table below was set up during the Building Block Methodology Workshop after discussions between all experts. It describes the required characteristics of hydraulic parameters to reach acceptable conditions to minimize the impacts of flow reduction on environmental and social values:

Table ES.2 Minimum Flow Requirements

Parameter		Component	Constraint Factor	Location	Requirement
Depth	Value	Biological	Fish must be able to migrate laterally and longitudinally. Requirement is based on the size of the largest fish encountered + extra margin	Along dewatered and hydropeaking reaches	30 cm
Depth	Value	Biological	Some pools need to be preserved as distinct habitats	Main existing pools, particular	> 2 m
Depth	Value	Human	Waist deep water is required for performing ceremonies.	At cultural sites	ca. 1 m
Wetted perimeter	Value	Biological	A wide wetted perimeter, particularly in sunlit shallow, low velocity depths, helps support more periphyton (primary productivity) on rocky substrate and higher invertebrate populations on gravel / sand.	Dewatered reach	50% of pre-project
Seasonal pattern		Biological	Hydraulic cues are needed for organisms to trigger their various life cycle phases. This	Dewatered reach	Proportional to natural variation during key

		is particularly important at the start of the monsoon.		spawning period of the common snow-trout

Hydraulic modelling interpretation helped the experts to assess and establish flow requirements corresponding to the different requirements. It appeared during the analysis that maintaining waist deep water at key cultural sites would not be compatible with project concept and additional specific measures were defined to overcome this issue (See Cultural Heritage Management Plan from Eflow Management Plan). Moreover, the proposed concept does not yet allow for variable Eflow and provision of hydraulics cues potentially triggering migration and spawning. Having the design of the Eflow powerplant to allow for an increased Eflow would widen the options to address potential residual impacts.

The table below presents the required environmental flow to minimize the impacts of flow reduction on environmental values. It is noted that this is the minimum flow to be released and that it will be supplemented by the several tributaries located in the dewatered stretch.

Table ES.3 Required Environmental Flow

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
5.41 m^3/s	5.41 m^3/s	5.41 m^3/s	5.41 m^3/s	5.41 m^3/s	5.41 m^3/s or Over-flow/ SBT	Over-flow/ SBT	Over-flow /SBT	Over-flow/ SBT	Over-flow/ SBT or 5.41 m^3/s	5.41 m^3/s	5.41 m^3/s

Downstream Flow Fluctuations

The Project's PRoR operations will result in fluctuations in flows downstream from the powerhouse from November through May when the Project will almost exclusively be operating in a peaking mode. Water levels downstream from the powerhouse are predicted to fluctuate by approximately 1.5 m as a result of peaking. These fluctuations can impact aquatic habitat, as a result of fish stranding and the exposure of the river's margins to alternating flooding and drying, but because of the deeply incised river channel morphology, stranding risk is predicted to be low. These fluctuations can also pose safety risks for river users (discussed in Section 7.3). The Project will monitor the extent of fish stranding during the first year of project operations and put in place adaptive management measures, such as ramping up/down flow releases, if stranding is documented as a significant issue. In order to minimize impacts on juvenile common snow trout the most common fish species in this part of the Arun River a ramping down rate of 1 cm/minute will be required as presented in the table below. This ramping down rate of 1 cm/minute has been adopted as a mitigation measure assessed as adequate in order for the juvenile common snow trout to reach a safe hiding place.

Hydropeaking and SBT Management

The table below was set up during the Building Block Methodology Workshop after discussions between all experts (geomorphology, hydrology, aquatic ecology, hydraulics, environmental and social experts). It describes the required characteristics of hydraulic parameters to reach acceptable conditions to minimize the impacts of hydropeaking on environmental and social values:

Table ES.4 Hydraulic Parameters

Parameter		Component	Constraint Factor	Location	Requirement
Depth	Rate of change (decrease)	Biological	Stranding of fish is expected if depth drops too rapidly for them to find shelter. The effect is amplified for younger life stages that have not reached monsoon size.	Hydropeaking reach, especially near confluences Dewatered reach (end of SBT use)	Max. 1 cm/min on majority of sections, Max. 10 cm/min for all sections
Width of river	Rate of change (decrease)	Biological	Stranding of fish is expected if width narrows too rapidly for them to find shelter. The effect is amplified for younger life stages that have not reached monsoon size.	Hydropeaking reach, especially near confluences Dewatered reach (end of SBT use)	5 m/min
Depth	Rate of change (increase)	Human	A fast rise in water level increases the risk of drowning, particularly considering the poor escape routes in narrow gorges and enhanced opportunities for visiting them.	Hydropeaking reach	20 cm/min
Velocity	Rate of change (increase)	Biology	Sudden increases to un-swimmable conditions for fish do not provide enough time for reaching shelter such as counter currents	All reaches	15 min escape time
Shear Stress	Rate of change (increase)	Biological	Fast rates of change in shear stress may exceed ability of invertebrates to dig in for shelter	Hydropeaking reach	> 10 min for doubling shear stress

Hydraulic modelling interpretation helped the experts to assess and establish the limiting factor. The table below shows the limiting factor and corresponding maximum flowrate variation for bringing the impacts of hydropeaking to acceptable values during a ramp up and a ramp down.

Table ES.5: Limiting Factor and Corresponding Maximum Flow Rate Variation

Parameter		Water Level Variation Constraint	Corresponding Maximum Flowrate Variation	Limiting Factor
Ramp up	First unit	20 cm/min	1.33 m^3/s per min	Human safety Entrainment of macroinvertebrates
	Additional units	*No requirement*	*No requirement*	*Not Applicable*
Ramp down	All units excluding the last one	*No requirement*	*No requirement*	*Not Applicable*
	Last unit	1 cm/min in majority of sections	1 m^3/s per min	Fish stranding

It is noted that these constraints also apply to:

- Opening of the Sediment By Pass Tunnel for the first 50 m^3/s.
- Closing of the Sediment By Pass Tunnel for the last 50 m^3/s.

Loss of Natural Aquatic Habitat

The Project will result in the conversion of free-flowing river habitat to lake habitat, as a result of reservoir formation upstream from the UAHEP dam, reduction in aquatic habitat along the 16.45 km long diversion reach as a result of the diversion of flows through the powerhouse, and modification of aquatic habitat for 11.8 km downstream from the powerhouse to the backwaters of the Arun-3 HEP reservoir due to fluctuations in peaking flow releases. Overall, habitat is not believed to be a limiting factor for fish populations, as the Arun River's very cold, turbid, and high velocity flow limits fish diversity and abundance, so a net reduction in aquatic habitat may not result in a reduction in fish diversity or abundance. In fact, the reduction in flow in the diversion reach is predicted to result in an improvement in habitat conditions for most species found in this segment, as a result of reductions in flow velocity and sediment load for much of the year.

The key factor for achieving no net loss of aquatic biodiversity is the preservation of suitable spawning habitat, as common snow trout spawns mostly in the Arun River itself (Hydrolab 2022). Some of the other fish species breed in the tributaries. Because of the ramping down of no more than 1 cm/minute increase and decrease in water depth, no net loss in the common snow trout population will be achieved. The Project will coordinate with the Government of Nepal to identify and permanently protect one or more clean water tributaries used for the spawning of other fish species, as well as for the common snow trout. Common snow trout spawn between the Arun-3 HEP dam and the UAHEP dam. The adopted mitigation measures of an EFlow of 5.41 m^3/s and the additional of flows provided by the tributaries, will provide a year round minimum depth of 30 cm, which has been assessed sufficient to ensure the survival of a sustainable and naturally reproducing population of the common snow trout in this segment of the Arun River. In the river section downstream from the tailrace the adoption of the ramping down rate of 1 cm/minute has also been assessed as adequate for the survival of the common snow trout in this part of the Arun River. It has been assessed in the high resolution EFlow Report (Artelia and Hydrolab 2024) that these two mitigation measures will achieve no net loss for the common snow trout population. In case monitoring indicates that no net loss is not achieved additional mitigation measures such as catch and release of common snow trout and other fish species affected, local river training by gabions to provide fish swimming lanes and create pools will be implemented.

Potential Residual Impacts and Mitigation Measures: Biodiversity and No Net Loss Approach

The proposed operating rules (EFR and ramping rates) minimize the potential negative impacts of reduced flow and hydropeaking on fish populations and support the overall ecological integrity of the Arun River system. However, residual impacts on aquatic habitats may remain. In this case, restoration and offset measures may be necessary.

This section summarizes the proposed approach and measures developed in the EFMP to achieve no net loss for common snow-trout if residual impacts are confirmed through monitoring after commissioning of the powerplant. Indeed, common snow trout is an umbrella species and protective measures implemented for this species will also safeguard a broader range of other species. Main steps include: i) monitoring and spawning ground protection; ii) fine-turning of operation rules; iii) habitat restoration and river morphology management; iv) offsets.

The proposed approach is a stepped approach based on adaptive management. If monitoring shows that initially proposed measures result in significant residual impacts, the Project should implement additional measures. The commissioning period will be key period for the assessment of the residual impacts and the implementation of the adaptive management. An exhaustive list of all points to check during the commissioning phase will have to be prepared, in conjunction with Contractor and UAHEL E&S teams. For example, the first hydropeaking cycles need to be performed in the daytime, starting with slow ramping rates to ensure a successful monitoring of the impacts. Moreover, staffing arrangements and logistics requirements for the implementation of the different measures must be anticipated so that potential residual impacts can be addressed in due time. More specifically, the team in charge of the measures needs to be trained before they start working so that they can be operational at the time of commissioning.

UAHEL and the Contractor will be responsible for the monitoring and the analysis of monitoring data and the resources of the Contractor may be mobilized if habitat restoration and river morphology management measures appear to be necessary.

Metrics will be developed to assess no net loss of aquatic habitat in more detail as part of a Biodiversity Monitoring and Evaluation Plan. These metrics (e.g., catch per unit effort for native species) will be developed in consultation with a fish expert and guided by the results of the high resolution EFlow study.

Effects on Critical Habitat

As indicated above, a screening of the Project's EAAA and direct observation identified four mammal species that trigger critical habitat. The impacts on these species are evaluated below along with measures to achieve the World Bank requirement for net gain in biodiversity for these species:

- **Red panda** – Red panda have been observed in the project area and it is expected that the Project will have a direct impact on this species. The Project could affect this species through increased risk of poaching, illegal trade, road kills/wildlife strikes, habitat fragmentation and loss, forest fires, increase in feral dogs, increased human pressure and presence, threats of invasive species, barriers to movement/altered use of habitat/altered behavior.
- **Himalayan black bear** – This species is found at a lower and upper elevation limit of 0 m and 4,300 m respectively. Direct impacts on the species and its habitat are expected, while indirect impacts due to human-bear conflict incidents (human casualties, increase in livestock predation, crop-raiding) may occur. The Project could affect this species through increased road kills/wildlife

strikes, increased forest fires, habitat fragmentation and loss, increased poaching and snaring, increased human presence, conduits for invasive alien species, and barriers to movement/altered use of habitat/altered behavior.

- **Clouded leopard** – Clouded leopards have been observed in the project area. It is expected that the Project will have a direct impact on this species. The Project could affect this species through increased road kills/wildlife strikes, habitat fragmentation and loss, increased poaching and snaring, loss of prey species, forest fires, increased livestock predation, increased human presence, conduits for invasive alien species, and barriers to movement/altered use of habitat/altered behavior.
- **Spotted linsang** – Spotted linsang have been observed in the project area. It is expected that the Project will have a direct impact on this species. The Project could affect this species through increased road kills/wildlife strikes, forest fires, habitat fragmentation and loss, increment of retaliatory killings, increased human presence, conduits for invasive alien species, and barriers to movement/altered use of habitat/altered in behavior killings.

Mitigation measures to achieve net gain in biodiversity for these four critical habitat species and net gain for their habitats are as follows:

- The Project will mitigate the risks to these four critical habitat species and achieve net gain by minimizing terrestrial natural habitat loss and reducing natural habitat fragmentation. Without compensation measures, the Project will result in the loss of 94.58 ha of terrestrial natural habitat. The proposed natural habitat offset area should involve a mix of local tree species present in the affected vegetation types; in particular, the planting of bamboo for the red panda is essential. The afforestation areas should be similar to those impacted, with natural and modified habitat within the offset area to be clearly delineated. From this delineation, habitat condition and net gain should be achieved for each vegetation type. This net gain should be achieved after an adequate offset period of several years. The habitat hectares method is suggested for this offset.
- An afforestation program will be implemented. It is estimated that 351,648 trees will be planted to compensate the loss of trees and leasing of forest land. For this 94.58 ha of land will be purchased, as a part of land for land compensation, on which 151,328 trees will be planted, with 1,600 saplings/ha. A further 125.21 ha of government land needs to be obtained, on which 200,340 trees will be planted on a 1:10 basis (i.e., plant 10 saplings for each tree cleared), in accordance with Nepal's Forest Rules 2022. Within Sankhuwasabha, Terhathum, and Taplejung districts, a collective area of 3,932.8 hectares of barren land has been identified, out of which 125.21 ha will be used for the plantation of 200,340 saplings, in consultation with concerned authorities. The planted site will be managed for 5 years and handed over to the concerned authority after designated time.
- The afforestation area needs to be delineated into natural and modified habitat and vegetation types within. This is necessary to assess habitat condition for each vegetation type and likely gains across the afforestation period. For each vegetation type adjusted by its habitat condition, gains needs to be predicted from afforestation after a suitable afforestation period
- Afforestation measures are to achieve net gain of critical habitat in accordance with the World Bank ESF ESS 6, and will target areas of high biodiversity values. The Program is to be led by UAHEL in conjunction with the Department of Forest and Soil Conservation and Department of National Park and Wildlife Conservation. Areas to be targeted for planting are to include areas of degraded forest within the Makalu Barun National Park, its Buffer Zones and community forests within the EAAA. The plantations will need to be fenced to protect them from destruction by free roaming livestock. Dead saplings will be regularly replaced.

Offset metrics for monitoring and evaluation: The monitoring of net gain through improvement of habitat condition in each plantation, e.g., canopy cover, plant species diversity, including bamboo for red panda and fruit plants for other wildlife, will be done. The monitoring objective is to assess satisfactory progress against the net gain objective for critical habitat.

Additional mitigation measures are required to ensure net gain for the four mammal critical habitat species.

- Key measures are proposed, including the development of a number of wildlife crossing infrastructure like underpasses and arboreal bridges to be included in the design of the access road to minimize wildlife road kills. Other measures include the reduction of human-wildlife conflict and support for the preparation of biodiversity profile.
- Natural habitat restoration measures in order to compensate for the losses caused by the UAHEP encompass land acquisition for afforestation, fencing to protect the plantation from damage by livestock, the implementation of forest fire control measures by providing tools to control fires, and the provision of water sources for wildlife, if necessary, when existing water sources are damaged by construction activities. In addition, there is a need to strengthen law enforcement to control poaching and invasive species to protect the four critical habitat species and other wildlife of conservation importance.
- Biodiversity monitoring activities, involving biodiversity surveys and camera trappings, to check the effectiveness of proposed actions, will need to be carried out.
- It is also important to improve the working conditions of the rangers in the MBNP and its Buffer Zone, and the Division Forest Office, by strengthening their financial and management capacity. Actions proposed here are aimed at reducing the impact of UAHEP through multiple approaches by assisting and mobilizing the concerned authorities. These recommended measures collectively aim to conserve the four critical habitat species and their environments, while minimizing project-related impacts and are expected to achieve net gain for these four critical mammal species.

Offset Metric for Monitoring and Evaluation: The quantification of patrolling efforts and number of seizures of illegal wildlife products; improvement of quantity and quality of foraging habitat; and increase in the number of the four critical habitat species, as established through scientifically designed and implemented biodiversity population surveys, including camera trappings and carried out by a qualified mammal ecologist.

Social Environment

Land Acquisition and Physical/Economic Displacement

Project construction will require acquisition of at least 195.8 ha of land for the hydropower and access road, which will affect all or portions of at least 699 privately owned land parcels (totaling 119.47 ha) and 92 publicly owned land parcels (at least 76.33 ha) (***Table ES.6***).[2] A minor amount of additional land acquisition may be required where the parcel residual is too small for economic use and the property owner prefers to have it acquired. The Project will also acquire 1.1 ha for transmission line towers; however, the nature of these lands (private/public) is not yet known as the final tower spotting has not been finalized.

Table ES.6: Land Acquisition by Land Type (Private or Public)

Land Category	# Affected Parcels	Area (m^2)	Area (ha)
Private land	699	1,194,777	119.5
Public land	92	763,206	76.3
Unknown (transmission line towers)	Not available yet	11,250	1.1
Total	**Not available yet**	**1,957,983**	**196.9**

[2] Please note that final information on public vs private land ownership and number of affected parcels for the transmission line is not yet available as the precise location of the towers has not yet been decided. Information pertaining to the transmission line will be included as a supplementary appendix to the Project RAP (which can be found on the Project website).

The Project will also require execution of temporary land access agreements for approximately 76.9 ha of land to allow for temporary construction access and disturbance (e.g., grading, temporary access road). Permanent land use restrictions for the transmission line RoW will be required for 25.5 ha of land . The remainder of this document will deal only with land acquisition associated with the hydropower component and access road. Information pertaining to the transmission line will be addressed in a supplementary appendix to the Project RAP.

Despite the avoidance and minimization measures, the above process of land acquisition will result in the physical and/or economic displacement of **335** households as described below:

- 22 project affected households (PAHs) experiencing physical and economic displacement (approximately 109 project affected people, or PAPs)
- 313 households experiencing economic displacement only (approximately **1,614** PAPs)

Physical displacement is concentrated within the villages of Sibrun (7 PAHs), Limbutar (6 PAHs), and Chongrak (5 PAHs), while economic displacement is concentrated in Chepuwa (125 PAHs), Namase (68 PAHs), and Sibrun (58 PAHs). From a gender perspective, approximately 50.4% of the PAPs are female and 49.6% of the PAPs are male.

These land acquisition and physical/economic displacement impacts will be mitigated by the implementation of a Resettlement Action Plan, which will include a Livelihood Restoration Plan to ensure that all PAPs are no worse off as a result of the Project.

Impacts on Productive Resources due to Displacement

The project will require the acquisition of 78.2 ha of agricultural land. Households will also lose crops and/or trees on land as it is cleared for construction. This includes loss of permanent crops (such as fruit trees), multiannual crops such as cardamom, and seasonal crops if households are not given the opportunity to harvest before the land take. The most prominent crop is, overwhelmingly, cardamom, followed to a much lesser extent by maize and millet.

PAHs reportedly access public community forests to collect wood for energy and furniture making, as well as NTFPs such as medicinal plants and edible forest products (e.g., mushrooms). The impact of the Project on these activities is not expected to be significant as the Project will only affect approximately 1.4% of the community forests upon which these PAHs rely, meaning that PAHs that engage in NTFP extraction will still have access to remaining community forest areas from which to obtain these products.

Impact from Workers' Camps

The number of workers required will vary at different stages of the construction schedule. It is expected that the peak demand for construction workers will be approximately 4,500 workers. The number of workers will also vary seasonally, with the peak workforce occurring during the dry season (October to May) and fewer workers during the monsoon season (June to September). These workers will be housed in four workers' camps located near the villages of Chongrak, Sibrun, Hema, and Rukma. The migrant worker population in all these locations will outnumber the nearby village population. Keeping this in mind, the workers' camps will generate the following potential impacts:

- Migrant workers in these camps could share crucial natural resources such as water.
- Migrant workers' camps will share public infrastructure such as health, road and transportation infrastructure.
- Migrant workers in these camps will have public health concerns due to the following reasons:
  - The camps will generate a large volume of wastewater and solid waste which will impact the local environment and, thereby, affect public health.
  - The migrant workers could spread communicable diseases as they work alongside local workers or come into contact with local community members while sharing public spaces.

- The presence of migrant workers may attract sex workers and facilitate the spread of sexually transmitted diseases.

- Local businesses such as shops, restaurants, and bars are likely to benefit by providing services to migrant workers. However, this may have a negative impact including by increasing alcohol consumption, conflicts, crime, and commodity prices.
- The presence of men and women in the workforce will also have potential gender-based violence and sexual exploitation and harassment issues.
- The migrant workers will have different life-styles and come from different cultures, which will influence the local culture, traditions, and community structure, as well as the relationship between men and women.

These impacts from the workers' camps will be mitigated by:

- Establishing a Workers' Code of Conduct containing requirements that all workers respect local culture and traditions and that address gender-based violence, sexual exploitation, and workplace sexual harassment. Violation of the code will include penalties up to and including termination of employment.
- Establishing a community grievance mechanism to allow local residents to file grievances, as well as an extended SEA/SH GRM at the project level.
- Adopting health and hygiene standards for the workers' camps in accordance with World Bank Group guidelines in the Occupational Health and Safety Plan and IFC/EBRD *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009).
- Providing separate sanitation facilities for women and men working at the sites. At the construction sites mobile toilets will be separated for men and women: one mobile toilet for each 15 workers, which need to be cleaned daily or more if needed. Ensure that facilities like toilets are safe and easily accessible and that there is childcare for women and install 24-hour proper lighting across all campsites and project sites, as per the Labor Act and Labor Good Practice Note.

Impacts of Influx and Labor Management Procedure

The Project can create social issues relating to its hiring practices and the potential for the Project to attract potential laborers, their families, vendors, and sex workers to the project area, which in turn can create social conflict, lead to increases in prices for basic goods and materials, increase crime, overburden community facilities and services, and increase pressure on, and potential for additional exploitation of, natural resources.

The Project will manage these risks by adopting Labor Management Procedures providing the framework for Contractors' Lab or Management Plans and an Influx Management Plan, which will include the following:

- Adopting a hiring policy that explicitly prohibits child labor, forced labor, and discrimination in hiring practices, and abides by all Nepal labor and employment laws
- Establishing a worker grievance mechanism, so that workers can file complaints and have their concerns addressed
- Adopting a Workers' Code of Conduct that establishes strict guidelines for worker interactions with local residents, and fellow workers (both male and female)
- Providing induction training for all workers relating to environmental awareness, cultural sensitivity, and sexual exploitation and harassment
- Providing health and recreation facilities at the workers' camps to avoid placing a burden on public facilities

- Maximizing that hiring of local labor, while recognizing that most of this will likely be for unskilled jobs
- Providing skills training to maximize the potential for local hiring
- Prohibiting “at the gate” hiring; establish employment offices in Kathmandu, Khandbari, and Gola for workforce hiring
- Requiring non-local workers to live in the designated workers’ camps and prohibit foreign workers from bringing their families to the project area

Impact on Community Health, Safety, and Security

The Project may affect community health as a result of the following:

- Changes in the physical, biological, and social conditions may impact on individual health status, especially vulnerable people such as the elderly, children and people with pre-existing health conditions.
- Physical and economic displacement and shock caused by dramatic and rapid changes taking place in local villages may affect the psychology and mental well-being of local residents.
- Potential introduction of communicable and infectious diseases (e.g., COVID-19) due to contact with migrant workers or increases in the vector population
- Increases in non-communicable diseases due to alteration in life-style and consumption pattern
- Introduction of vehicular traffic in an area unfamiliar with traffic safety measures, especially associated with large heavy construction vehicles hard to maneuver and carrying heavy machinery and equipment (e.g. large turbines and cranes)
- Crowding of local health care facilities causing irritation and delays for the local population to meet their health-care requirements and potential shortage of medical supplies
- Unsafe or inappropriate use of explosives and hazardous materials
- Inappropriate use of force by security personnel in controlling access to construction areas and protecting the project workers, equipment, and facilities from vandalism, sabotage, and terrorism
- Sudden and rapid changes in water levels downstream from the powerhouse during peaking operations

The Project will mitigate these impacts by implementing a Community Health and Safety Plan, a Traffic and Logistics Management Plan well-coordinated with contractors and stakeholders, an Emergency Preparedness and Response Plan, and a Security Forces Management Plan, which will include the following key provisions:

- Guidelines for health surveillance system for migrant workers
- Provision of project health facilities to ensure the capacity or availability of existing facilities for local communities
- Awareness campaigns on health and well-being, traffic safety, and project operations risks
- Provision of warning sirens and signage regarding peaking operations
- Provision for education and training on potential emergency/natural disaster events (e.g., glacial lake outburst flood)
- Enquiries to verify previous conduct of contracted security forces; training on appropriate conduct and guidance for security forces regarding use of force and weapons

Occupation Health and Safety

Project construction presents health and safety (H&S) risks to the workforce, and this is especially true in Nepal where few local workers will have any experience with robust H&S programs. These risks will be managed by implementing the following measures:

- Require the Construction Contractor to prepare a detailed Occupational H&S Plan for review and approval by UAHEL and the World Bank.
- Provide H&S training to all employees.
- Provide employees with all necessary personal protective equipment (PPE).
- Monitor and report on construction H&S performance on a monthly basis.
- Require specific plans for the transmission line in remote and steep areas: detailed surveys or lider images to assess risk/terrain, work permits systems and body system, and when required life-lines set by expert climbers for those people climbing up hills, etc.

Effects on Cultural Heritage

Despite efforts to avoid all tangible cultural heritage sites, there are few that the Project was not able to avoid due to technical engineering constraints. The *devithan* near Hema/Namase will be affected by Spoil Disposal Area #2 and a *chhorten* near Limbutar will be impacted by the surge tank, both of which will be physically displaced. The landscape setting of Chepuwa waterfall will be altered by the presence of the dam. The flow of this waterfall will not be changed. In addition, there may be a possible impact on burial grounds as there is no designated area for burial grounds and each community has their own areas, although most of these are located upslope from the villages or along the river, where the potential for project impacts is less. Some cultural heritage resources such as Shree Nekimulung Gumba in Sibrun, a *chautari*, and a *manewall* in Rukuma are close to the project footprint and will be potentially affected during the construction phase due to the increased level of noise and construction activities.

The Project will also potentially impact intangible cultural heritage resources, including: the use of natural resources; traditional knowledge on indigenous crafts (e.g., hand knitting mats, bamboo baskets, and woven woolen carpets); and ethnic or religious traditions, as a result of construction activities, the influx of labor, and increased market linkages potentially displacing indigenous sources of livelihood. In addition, there may be impacts on festival sites during the construction period and increased mobility of people. The adaptable EFlow of 5.41 m^3/s in the dewatered zone will provide enough water for fishing, cremation and religious ceremonies. A warning system will be installed to warn downstream communities of large water releases and the start of the peaking and sediment flushing operations so that they can leave the river banks in time.

The Project will mitigate these impacts by providing funds for the relocation of tangible heritage sites and the preservation/promotion of tangible heritage sites, in coordination with leaders from the local communities; put in place a Chance Finds Procedure to be implemented in the event that any unknown cultural heritage sites are uncovered; provide cultural sensitivity training for all construction workers; implement a Workers' Code of Conduct; and provide funding to support documentation, preservation, and promotion of intangible cultural heritage. Further, a free, prior, and informed consent (FPIC) process has been finalized with affected indigenous people, which has identified other measures to avoid, minimize, and mitigate the potential impacts on tangible and intangible cultural heritage.

Cumulative Impact Assessment

As indicated in Section 1, the Arun River has long been recognized as having significant hydropower potential. A Cumulative Impact Assessment (CIA) has been prepared for the UAHEP, which takes into consideration the entire Arun River Basin (30,041 km^2, of which, 83% is located in China; ***Figure ES.3***). Presently, there are five major hydropower projects in various stages of planning and development along the main stem of the Arun River (***Table ES.7*** and ***Figure ES.3***), plus another one downstream on the Sapta Koshi River, which would form an impoundment that would inundate the lower portion of the Arun River. In total there are 37 hydropower projects proposed within the Arun River Basin in Nepal (none have been identified in the Chinese portion of the basin). Of these, there are 9 operating HEPs, 22 under construction (i.e., obtained construction license), 12 have applied for a construction license, and 17 have obtained a survey license, all of which total approximately 4,763 megawatt (MW).

These hydropower projects also involve access roads and transmission lines. Other planned activities include road improvements, especially the Koshi Highway, which is currently under construction from Num to the Chinese border. Finally, the scope of the CIA also takes into consideration other risks such as climate change and natural disasters (e.g., glacial lake outburst floods, earthquakes).

Table ES.7: Proposed Hydropower Projects along the Arun River

Hydropower Project	Proposed Capacity	Proposed Operations	Current Status
Kimathanka	450 MW	PRoR	Survey license
Upper Arun	1040 MW	PRoR	Survey license
Arun-4	473 MW	RoR	Survey license
Arun-3	900 MW	PRoR	Under Construction
Lower Arun	470 MW	PRoR	Survey License

Figure ES.3: CIA Spatial Boundary – Arun River Basin

Consultations were held with key stakeholders (e.g., local residents, local representatives, ministry officials) to identify the key valued environmental and social components (VECs) within the river basin. These VECs were then screened to identify those with the potential to be cumulatively affected by multiple proposed activities within the basin. Based on this analysis, the following VECs were selected:

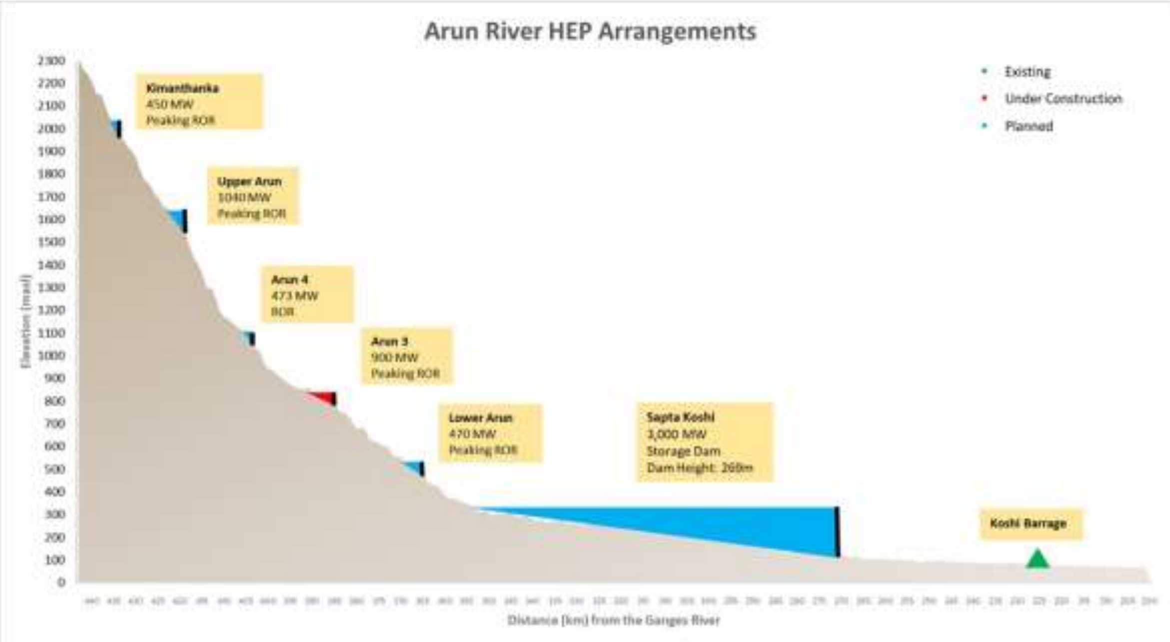
- Forest and agricultural lands
- Makalu Barun National Park
- Fish and aquatic habitat
- Livelihoods, especially those related to river flow
- Social structure and cohesion and cultural heritage

CIA mitigation measures for which UAHEL will seek support from the Government of Nepal include:

- Coordinate proposed linear facilities (e.g., transmission lines, access roads) to minimize impacts on forest and agricultural land covers and the MBNP.
- Maintain naturally reproducing populations of all native fish species in each segment of the Arun River between the main stem hydropower projects. This will require an adequate EFlow in the dewatered sections and protecting key clear, water-water tributaries, which are used by some fish species for spawning, as well as adequate ramping up and down rates to allow juvenile fish to reach a safe location.
- Provide livelihood restoration for residents whose livelihoods are adversely affected by conversion of the Arun River into a series of reservoirs, diversion reaches, and modified flow reaches.

- Develop a strategic plan and provide funding to help local indigenous peoples (especially upstream from Num) to retain their social identify, cohesion, and heritage in response to both significant improvements in access to this area and labor influx.

Figure ES.4: Upper Arun and Koshi HEP Arrangements



Management Measures

In addition to the specific mitigation measures mentioned above, the Project will implement the following measures to manage project environmental and social risks and impacts:

- Environmental and Social Management System (ESMS) – UAHEL will develop, adopt, and implement an ESMS to ensure it has the capacity, staffing, systems and procedures in place to effectively implement the environmental and social management measures recommended in the ESIA.
- Contractor's Environmental and Social Management Plan (CESMP) – The CESMP will identify all of the environmental and social mitigation and management measures and plans that the Construction Contractor(s) are responsible for implementing, so that there is clear designation of requirements and responsibilities.
- Owner's Management Plans – The Owner's (i.e., UAHEL) will ultimately have responsibility for ensuring that the Project is constructed and operated in conformance with World Bank and other lenders' standards and project commitments, as well as Nepal legislation and regulations. In addition to overseeing the Construction Contractor(s) and their effective implementation of the CESMP, UAHEL is responsible for implementing the following plans:
- Resettlement Action Plan – This plan describes the land acquisition process, land and asset compensation framework, and livelihood restoration strategy to ensure all project affected people are at least no worse off as a result of the Project.
- Indigenous Peoples Plan – This plan documents the Project's benefit sharing plan and provides evidence that free, prior, and informed consent (FPIC) has been given by affected indigenous people on their issues related to the project.
- Biodiversity Management Plan – Although some of the biodiversity mitigation measures will be the responsibility of the Construction Contractor, most of the actions in the BMP are the responsibility of UAHEL. The BMP documents the Project's conformance with the World Bank's and other

lenders' requirements for no net loss of natural habitat and net gain for the four critical habitat species. UAHEL has prepared a critical habitat assessment (CHA), including mitigation plans and a budget, which are expected to sufficiently avoid, mitigate, and offset critical habitat loss and achieve net gain.

- Gender Action Plan – This plan addresses gaps and challenges associated with the prevalent gender norms and the subsequent constraints that disproportionately affect women in accessing services, livelihoods, and economic opportunities. The action plan caters to the needs and priorities of indigenous women of Bhotkhola, with a primary focus on strengthening their economic empowerment.
- SEA/SH Action Plan – This action plan aims to create and maintain a safe working and living environment for all individuals in the community or those employed directly/indirectly at the project site. The action plan provides a common understanding among project stakeholders of the SEA/SH and GBV risks associated with the project and the unified strategy to prevent and respond to SEA/SH risks and other GBV risks induced by the project.
- Operations Environmental and Social Management Plan (OESMP) – Although most environmental and social impacts, and their associated mitigation measures will occur during project construction, there are some that will continue into the Project's operation phase and others that will not occur until project commissioning and commencement of operations. This plan will identify the key environmental and social mitigation measures that the project operator will be responsible for implementing. The OESMP will include the EFlow management plan, which includes not only water flow and water quality monitoring but also monitoring of fish/fauna and sediment flows.
- Institutional Strengthening and Capacity Building Plan – This plan describes measures to strengthen and build capacity within UAHEL, as the project sponsor, as well as other Government of Nepal agencies (e.g., Nepal Electricity Authority, Ministry of Energy, Water Resources and Irrigation, Ministry of Forest and Environment) to oversee project implementation. The Institutional Strengthening Plan recommends interventions, such as staffing, capacity building, and budget requirements, to help ensure that UAHEL has the capacity to implement the Project in conformance with the World Bank ESF.

Estimated Budget

The ESMP budget considers the following items:

- General mitigation measures including ES staffing, capacity building, stakeholder engagement and the GRM
- Physical mitigation measures
- Biological mitigation measures, including the budget for BMP implementation
- Social risk mitigation measures and benefits sharing, including the budget for health and safety aspects

Detailed budget table will be agreed upon with stakeholders and presented in this document by project appraisal.

Conclusion

As described above, the construction and operation of the UAHEP, as well as the Project's contributions to cumulative impacts within the Arun River Basin, will result in some significant environmental and social impacts and risks. Some of these unavoidable impacts can be mitigated, but will require effective implementation and monitoring oversight of the ESMP. Residual impacts on legally protected area (i.e., MBNP), natural habitat, and critical habitat will be mitigated and offset through the implementation of the BMP, which will achieve net gain for the four mammal critical habitat species. There will be fundamental changes to social cohesion and cultural heritage in the area as a result of the project and other cumulative impacts.

- Diversion Reach of 16.45 km – Carry out ongoing monitoring and adaptive management to ensure the effectiveness of the Project's sediment management strategy and the effectiveness of the proposed EFlow of 5.41 m^3/s to maintain a viable fish population in the Arun River, especially with regard to the common snow trout population. Also ongoing monitoring and adaptive management will be required to ensure the effectiveness of the ramping down rate of 1 cm/minute with regard to survival of the juveniles of the common snow trout.
- Biodiversity – Coordinate with the Government of Nepal to achieve no net loss of natural habitat and net gain for the four mammal species triggering critical habitat.
- Indigenous Peoples – The Project has finalized an FPIC process that confirms the consent of local indigenous people to the Project.
- Physical and Economic Displacement – Ensure effective implementation of the RAP, especially the livelihood restoration component to address the large number of landowners who will lose valuable cardamom fields.
- Cumulative Impacts – The proposed development activities within the Arun River Basin will likely result in significant impacts on several VECs, especially social cohesion, cultural heritage, and fish and aquatic habitat. The UAHEP or the Government of Nepal needs to provide mitigation measures to minimize these impacts, but significant impacts on these VECs are still likely to occur. A river basin level strategic environmental and social assessment (SESA) is being updated to support the Government of Nepal to incorporate environmental and social considerations into the development of hydropower, irrigation and other developments of water resource in Koshi Basin, which is expected to instrumental in mitigating identified cumulative impacts on VECs.

1. INTRODUCTION

The Upper Arun Hydro-Electric Limited (UAHEL), a subsidiary of the Nepal Electricity Authority (NEA), proposes to construct the Upper Arun Hydroelectric Project (UAHEP, or Project), with an installed capacity of 1,040 mega-watt (MW), on the Arun River in Koshi Province, Sankhuwasabha District, the Bhotkhola and Makalu rural municipalities of eastern Nepal (see ***Figure 1.1***). The project site lies in a straight line about 200 kilometers (km) east of Kathmandu, the capital of Nepal, approximately 140 km north of the provincial capital, Biratnagar, about 40 km north of the district headquarters at Khandbari, and about 10 km south of the China border. This chapter provides some background to the Project, describes the purpose and need for the Project, identifies the Project Proponent and its consultants, and describes the relevancy, scope, objectives, limitations, and structure of this Environmental and Social Impact Assessment (ESIA).

1.1 Project Background

The hydropower potential of the UAHEP site was first identified during a Master Plan Study of the Koshi River Water Resources Development carried out by the Japan International Cooperation Agency (JICA) in 1985. The Master Plan Study proposed a cascade run-of-river (RoR) scheme with a potential installed capacity of 335 MW. A reconnaissance study of the project site was conducted by the NEA in the summer of 1986 and, in view of the high energy potential of the UAHEP and with an attractive investment to energy ratio, the Project was recommended to proceed to a feasibility study.

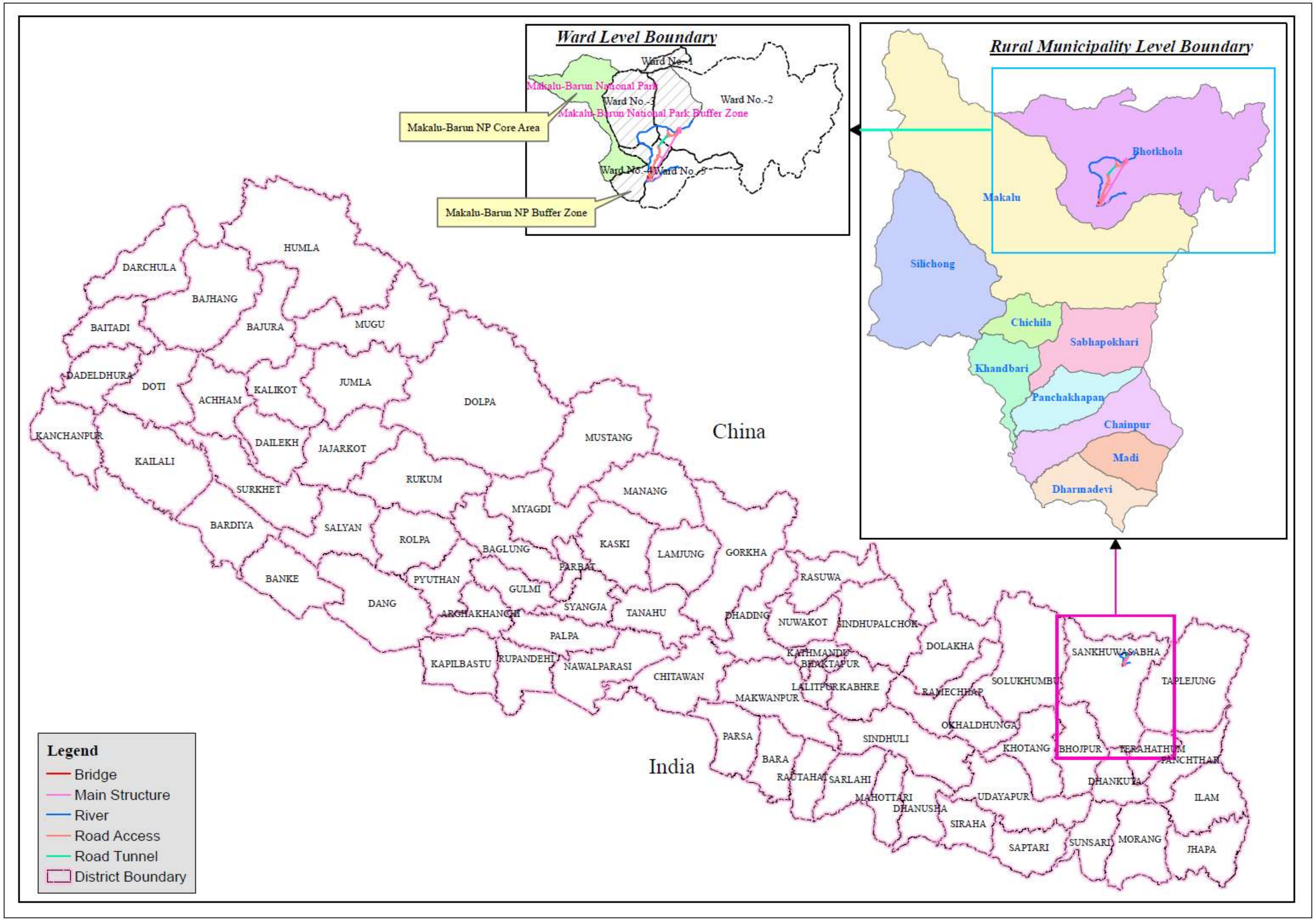
In 1987, the Feasibility Study Phase I was carried out by Morrison Knudsen Engineers. This study proposed an integrated development of the total head available incorporating a single power plant with an installed capacity of 350 MW, with an annual energy production of almost 3,000 giga-watt hours (GWh). The estimated project development cost was US$371 million, and it was recommended to proceed to a Phase II feasibility study, based on its economic and technical attractiveness.

A joint venture by Morrison Knudsen Corporation, Lahmeyer International, Tokyo Electric Power Services Co. and NEPECON completed the Feasibility Study Phase II in December 1991 (Morrison Knudsen Corporation *et al.* 1991). Phase II conceptualized the development of the Project as a Peaking RoR project (PRoR) with an installed capacity of 335 MW, generating 2,050 GWh of annual firm energy. The estimated cost of project development was US$479 million. For future development and planning, the study proposed an underground power plant arrangement with two additional turbine units to increase the total installed capacity to 500 MW, with annual power generation of approximately 3,200 GWh.

In 2011, the Project Development Department of the NEA reviewed the UAHEP Feasibility Study Phase II, focusing on project costs and the economic and financial analysis. The estimated cost for project development in the review report was US$750 million. The study pointed out the need for additional geological investigations, topography survey, and sediment studies to update project information. As the Project was found to be technically and financially viable, the review study recommended it for implementation.

In 2018, the NEA contracted a joint venture of the Changjiang Survey, Planning, Design and Research Co. Ltd. (CSPDR) and Sinotech Engineering Consultants Ltd. To further evaluate the Project. They conducted additional field investigations in order to optimize project design. Their Project Optimization Report was submitted in April 2019 and supplemented in July 2019. This report ultimately recommended a PRoR scheme with a nominal installed capacity of 1,040 MW, with a peaking operation of up to six hours daily. Based on this optimized scheme, CSPDR prepared an Updated Feasibility Study Report in July 2019, with input from the NEA's environmental and social consultant, which was reviewed by the Project's Dam Safety Panel of Experts, and ultimately finalized in November 2019. The objective of the Updated Feasibility Study Report was to prepare the Project for implementation by carrying out detailed engineering design.

Figure 1.1: Project Location Map



The UAHEP dam site will be located on the Arun River close to Chepuwa Village on the right bank and Rukma Village on the left bank at a narrow gorge about 350 m upstream from the Arun River's confluence with Chepuwa Khola waterfall (***Figure 1.2***). The proposed UAHEP underground power plant site would be located on the left bank of the Arun River, close to the Village of Sibrun, about 750 m upstream from the confluence of the Arun River with Leksuwa Khola (***Figure 1.3***). This final design provides for an installed capacity of up to 1,040 MW, a 100 m high dam with a reservoir at elevation 1,640 m above sea level[3] and annual average energy generation of 4,549.57 GWh. In conjunction with the Updated Feasibility Study, the NEA also contracted with Kyongdong Engineering Co., Ltd (KEC) from South Korea to prepare the project access road design. KEC produced Draft Road, Tunnel, and Bridge reports in November 2018, which were finalized in January 2019. Based on a decision by NEA in December 2019, the transmission line alignment was modified to connect to the proposed Arun Hub substation. CSPDR prepared a revised conceptual design report for the transmission line, with input from Environmental Resource Management (ERM), in February and June 2020, which was ultimately approved by the NEA in July 2020. The NEA obtained a study license from the Nepal Department of Electricity Development in August 2020. ***Figure 1.4*** provides the overall project layout.

As discussed above, the Arun River offers significant hydropower potential. As a result, there are several (5) other large hydropower projects proposed along the main stem of the Arun River and one additional project proposed farther downstream on the Sapta Koshi River (***Figure 1.5***). These projects include the Arun-3 Hydroelectric Project (HEP), which is located approximately 15.5 km downstream from the UAHEP powerhouse and is currently under construction, and the proposed Kimathanka HEP, the tailwaters of which would be about 3 km upstream from the UAHEP dam. There are other existing and proposed hydropower projects on tributaries of the Arun River; for a full list of existing and proposed mainstem and tributary hydropower projects within the Arun River Basin please refer to Chapter 6 – Table 6.3.

[3] All elevations in this ESIA reference meters above sea level.

Figure 1.2: UAHEP Dam Site Area Photograph

Figure 1.3: UAHEP Powerhouse Site Area (looking upstream)

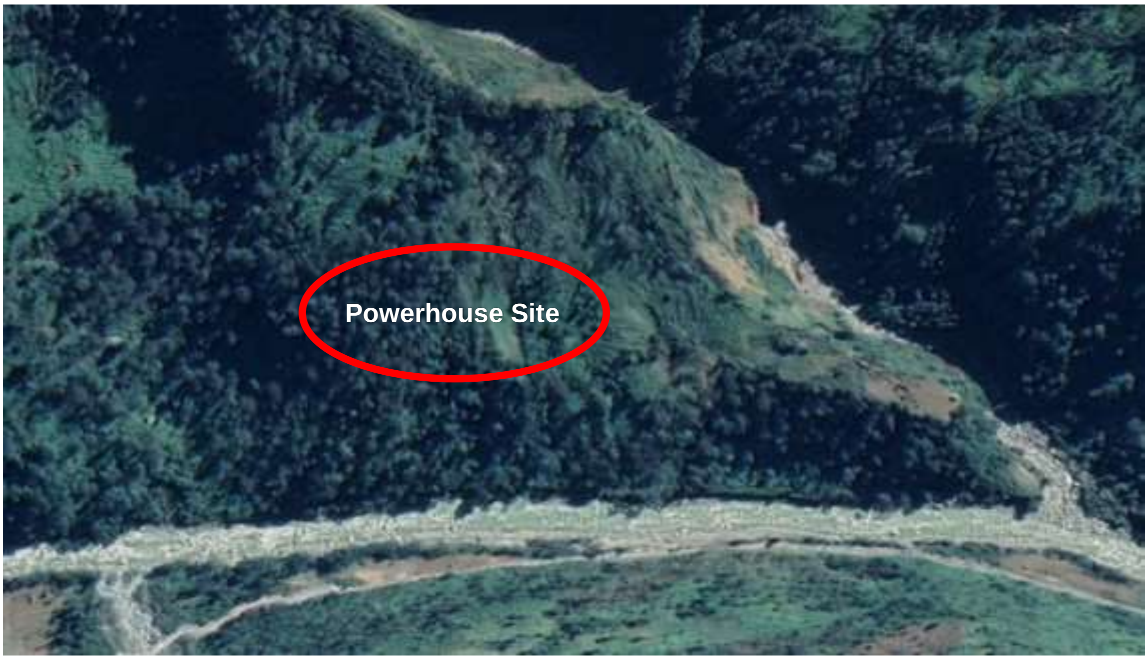


Figure 1.4: Project Layout

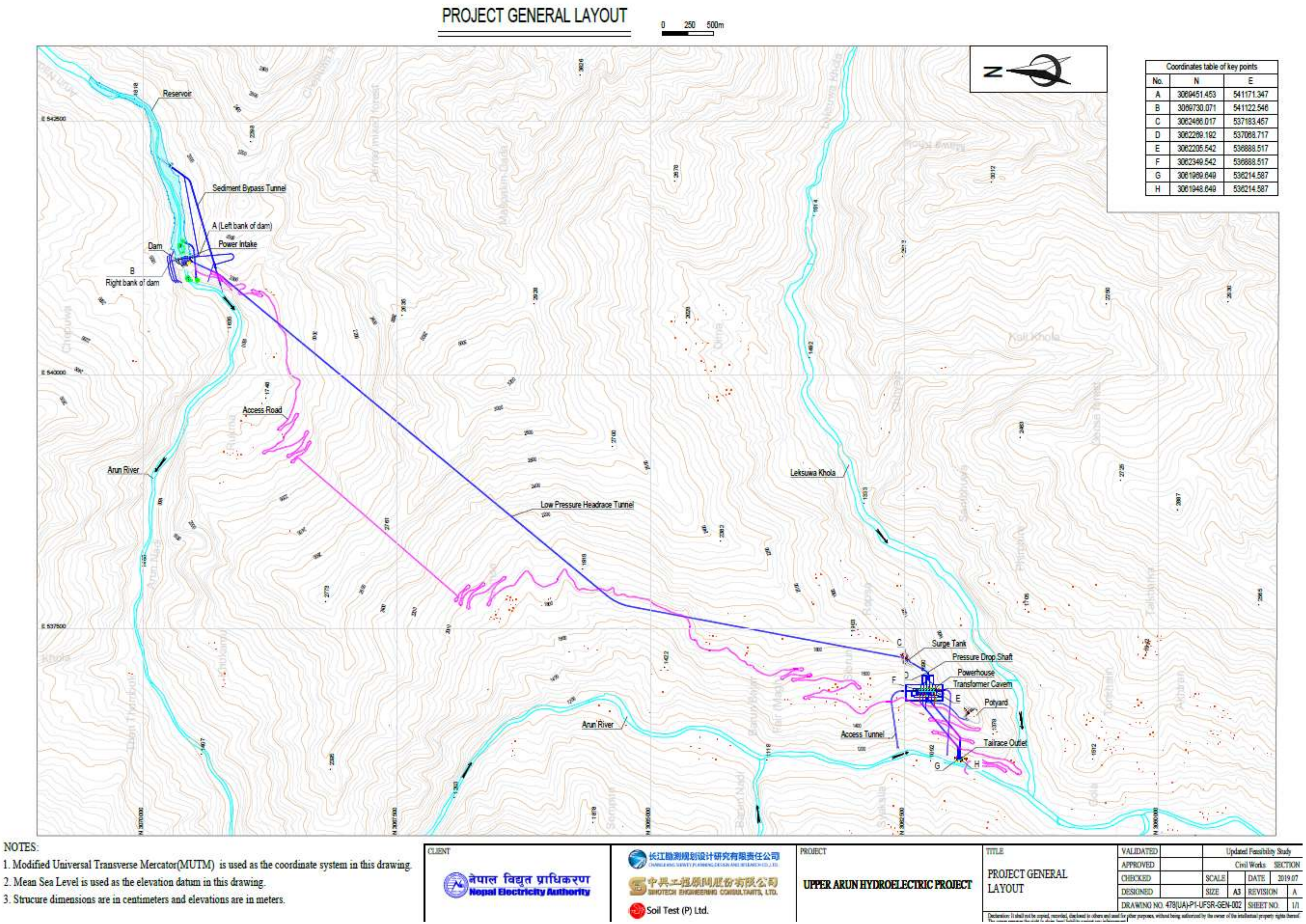
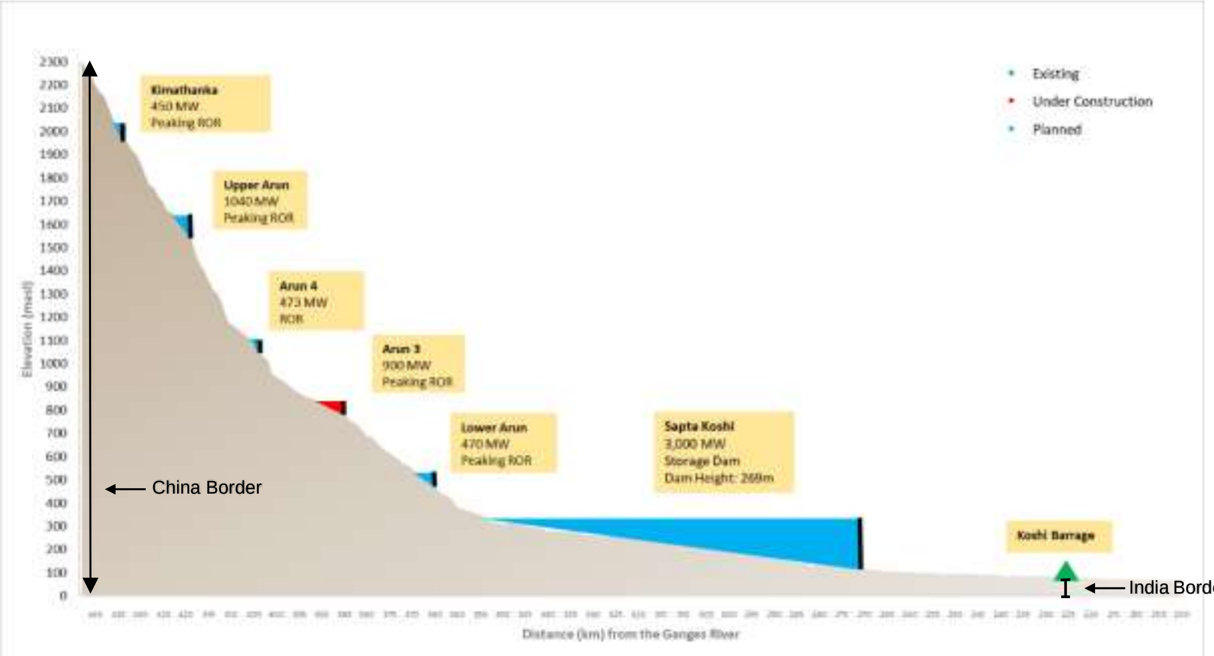


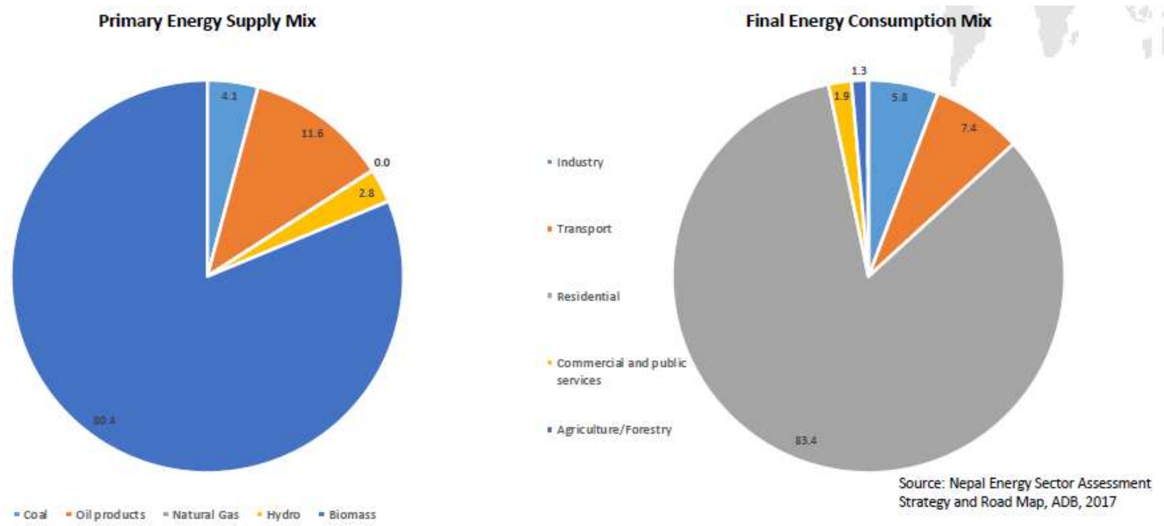
Figure 1.5: Arun River Hydropower Projects



1.2 Project Purpose and Need

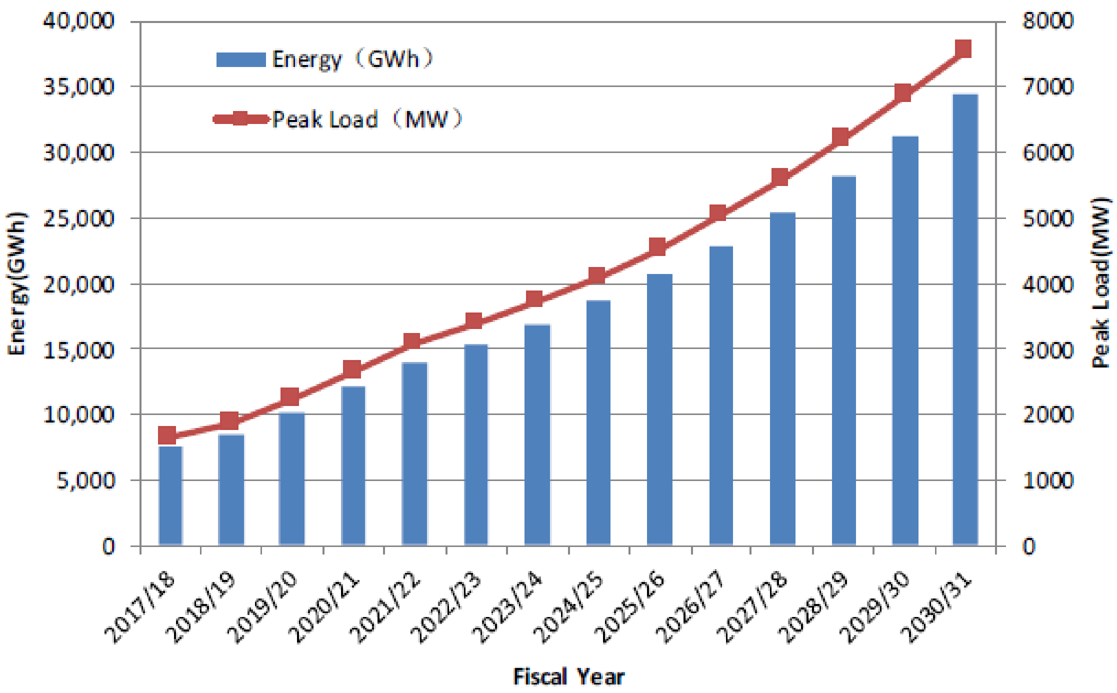
Nepal's economic and social development is being hampered by its inadequate energy supply. The country does not have its own reserves of gas, coal or oil. As ***Figure 1.6*** shows, biofuels (e.g., firewood) and waste (e.g., dung) are the predominant energy sources in Nepal, accounting for more than 80% of consumption (ADB 2017; IEA 2020). Present capacity and energy generation is less than Nepal's current electricity demand, for both base and peak load. Until recently, Nepal suffered severe electricity shortages, especially during the winter season when river flows are low, although recent increases in domestic hydropower production and imports from India have significantly reduced the frequency and duration of load shedding programs. Nevertheless, the country's low electricity reliability has severe negative implications for its economic development.

Figure 1.6: Nepal Energy Supply and Consumption Mix – 2014 (ADB 2017)



The largest share of energy consumption goes to the residential sector (***Figure 1.7***). About 95% of households in Nepal have access to electricity, of which about 60% are connected to the grid, 10% to community rural electrification schemes, 18% to off-grid electrification schemes, and 7% have stand-alone solar systems (Bhattarai 2019). Many of these households use biofuels for cooking and heating. The demand for electricity by industry and other sectors is increasing, but is still small relative to the residential sector and most still rely on diesel generators as primary or backup source of power.

Figure 1.7: Nepal Electricity Load Forecast



Source: NEA 2018

Nepal is rich in hydropower resources. The high elevation, rainfall, and river flows from the Himalayas (i.e., the so called “water tower” effect) provide excellent conditions for hydropower development, giving Nepal a theoretical hydropower generation potential of about 83,000 MW, of which 43,000 MW is considered to be economically feasible. Despite this potential, Nepal has developed only about 1,332 MW of that potential (NEA 2020). The one weakness with hydropower development in Nepal is the country’s strong seasonal climate, with long dry seasons that result in declining river flows in late winter (December to March) and associated decreases in power generation. This emphasizes the importance of the Government of Nepal (GoN) strategically selecting at least a few large hydropower projects to operate in a peaking mode to meet daily peak electricity demand and improve system reliability during the dry season.

Electricity demand in Nepal is projected to grow by about an average of 11% annually from fiscal year (FY) 2018/19 through to FY2030/31, with a net increase in power demand of nearly 26,000 GWh and peak load of 5,700 MW (NEA 2018). This increase in demand is larger than the current pace of energy development, indicating that the energy supply and reliability situation could worsen. According to the NEA (2018), there are a large number of hydropower and solar projects proposed (over 7,000 MW), which would be more than adequate to meet these future demand projections, but many of these projects lack financing and may never be constructed. Further, CSPDR’s analysis of the power market indicates that while there could be a surplus of capacity during the wet season with these projects, there would still be a deficit in power production during the dry season, which is predicted to grow from about 1,025 MW in FY2020/21 to 4,870 MW in FY2030/31 (CSPDR 2020) (***Table 1.1***).

The GoN recognizes that It must accelerate the development of its hydropower potential as an important step forward in its efforts to reduce poverty and stimulate economic growth, as articulated in its *White Paper on Energy, Water Resources, and Irrigation Sector's Status and Roadmap for the Future* (MoEWRI 2018). This White Paper sets key sector goals of reaching 5,000 MW of installed capacity in five years, and 15,000 MW of installed capacity in ten years. Hydropower taps a domestic, clean, and renewable energy source, which will ultimately eliminate electricity inputs and reduce carbon emissions, enabling Nepal to generate revenue from the export of excess energy to neighboring countries (ADB 2017).

The UAHEP includes one of the more promising hydroelectric projects in the country, with a very high head (508 m) and relatively firm river flow, resulting in 1,063.36 MW of licensed capacity (1,040 MW an installed capacity) and 4,549.57 GWh of average annual energy generation. With its proposed PRoR operations, the Project would generate nearly 1,250 GWh of critical dry season energy, with 67% of that energy coming during peak demand periods. Given its large capacity and energy production potential, the UAHEP is a project of national importance. It is expected to play a crucial role in fulfilling the power demand of load centers in eastern Nepal and reducing transmission losses. Koshi Province, where the Project is located, had a total of only 162.3 MW of hydropower capacity in 2019, with about 76% of the population having access to electricity. The Project can help meet future increases in electricity demand from eastern Nepal, which will result from both economic development and connecting more of the population to the electricity grid. The Arun-3 HEP, which is located about 15 km downstream on the Arun River, has a capacity of 900 MW, but this energy is primarily targeted for export to India, which limits its ability to meet Nepal's domestic peak energy demands. Based on CSPDR's analysis of Nepal's power market, and assuming the UAHEP begins operations in 2029, the power generated from the Project during the dry season can be completely consumed by predicted domestic demand, while the excess power generated during the wet season could be exported (CSPDR 2020). The Nepal Ministry of Energy, Water Resources, and Irrigation (MoEWRI) has indicated an interest is potentially exporting some of the electricity generated by the UAHEP, possibly to Bangladesh via existing transmission lines (Kathmandu Post September 23, 2018).

Table 1.1: Analysis of Nepal's Power Market During Dry Season

Power Criteria	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Peaking capacity (MW)	863.9	1,489.6	1,876.8	2,061.8	2,097.8	2,309.8	2,592.3	3,040.3	3,340.3	3,850.3	4,030.3	4,180.3	4,180.3
Peak capacity requirement (MW)	1,989.5	2,426	2,902.1	3,399.8	3,769,9	4,184.7	46,49.8	5,196.9	5,812.9	6,506.6	7,282.1	8,149.7	9,050.4
Peak load (MW)	1,842.1	2,225.7	2,638.3	3,062.9	3,366	3,703.3	4,078.8	4,519.1	5,011.1	5,561.2	6,171.3	6,848.5	7,542
Spare capacity (MW)	147.4	200.3	263.8	336.9	403.9	481.4	571	677.9	801.8	945.4	1,110.8	1,301.2	1,508.4
Surplus (+) / deficit (-)	-1,125.6	-936.4	-1,025.3	-1,338	-1,672.1	-1,874.9	-2,057.5	-2,156.6	-2,472.6	-2,656.3	-3,251.8	-3,969.4	-4,870.1

Source: CSPDR 2020

1.3 Name of Project Proponent and Consultants

The Government of Nepal, through a cabinet decision dated 21 September 2018 (BS 2075/06/05), decided to develop the Project under a subsidiary company of the NEA, namely, the Upper Arun Hydro-Electric Limited (see Appendix B), which will be the Project Proponent. The contact details of the Proponent are as follows:

Upper Arun Hydro-Electric Company Limited
Contact: Mr. Fanendra Joshi, UAHEP Project Director
Shanti Priya Marg, Maharajgunj, Kathmandu, Nepal
Telephone: +977-1-4720553, 4720543
E-mail address: uahepnea@gmail.com or upperarun@nea.org.np
Website: www.nea.org.np www.ppmo.gov.np

Appendix A provides a list of contributors to this ESIA and their position.

In preparing the ESIA, ERM coordinated closely with the following project engineering firms:

- Hydropower and transmission line components – Changjiang Survey, Planning, Design and Research Co., Ltd (CSPDR) from China, which was supported by Sinotech Engineering Consultants, Ltd. And Soil Test Ltd
- Project access road component – Kyongdong Engineering Co., Ltd (KEC) from South Korea, which was supported by Nepal Consult Ltd

-

1.4 Purpose and Scope of ESIA

The World Bank (WB, or Bank), potentially the European Investment Bank (EIB)[4], and other Lenders are considering financing the construction of the UAHEP. Therefore, the Project needs to document conformance with their respective environmental and social policies. The WB requires borrowers to conduct an environmental and social assessment of projects proposed for Bank support, pursuant to its Environmental and Social Framework (ESF) (World Bank 2017). All investment projects supported by the EIB must meet its Environmental and Social Principles and Standards. This ESIA has been prepared to support the management of social and environmental risks in accordance with international good practice, including the WB's ESF and the EIB's Environmental and Social Principles and Standards.

The scope of this ESIA includes the entire UAHEP and associated facilities under consideration for financing by the World Bank. The UAHEP has the following components:

- Project Access Road – The project area does not currently have vehicular access, so will require construction of a project access road. The project access road will be 21.6 km long, providing access to both the project powerhouse and headworks, and will include a 2.03 km long tunnel and two bridges.
- Hydropower Facility – The hydropower facility includes a 100 m high dam and associated reservoir, a water conveyance system, and a powerhouse with a licensed capacity of 1,063.36 MW.
- Transmission Line – The UAHEP will require construction of a transmission line to evacuate the electricity generated at the powerhouse and connect it to the Nepal electricity grid. UAHEL proposes to construct a 5.8 km long, 400 kV transmission line extending from the UAHEP switchyard to the proposed Arun Hub substation at Hitar.
- Ancillary Facilities – There are a variety of temporary and permanent ancillary facilities required to construct and operate the project components listed above, including contractor's camps, owner's camps, construction roads, spoil disposal areas, quarry, borrow areas, crusher, batch plants, maintenance yards, fabrication shops, fuel depots, and explosives magazine.
- Associated Facilities – These include facilities or activities that are not funded by the World Bank, but are directly and significantly related to the Project; carried out or planned to be carried out contemporaneously with the Project; and necessary for the Project to be viable and would not have been constructed, expanded, or conducted if the Project did not exist (World Bank 2017). The WB ESF requires associated facilities to meet the requirements of the Environmental and Social Standards (ESSs). The project access road meets the definition of an associated facility and is evaluated in this ESIA as part of the overall project (see Section 3.3.4).

All of these components are addressed in this ESIA.

1.5 Objectives

The objectives of the ESIA process are to:

- Introduce the Project and provide an opportunity for stakeholders to provide suggestions and identify concerns about the Project
- Establish the existing status of the physical, biological, socio-economic, and cultural environments of the project area

[4] The ESIA was developed to meet primarily the World Bank ESF and Nepal national regulatory requirements. Examination of its conformance with EIB's Environmental and Social Principles and Standards have also been conducted and documented in this ESIA.

-
- Identify, evaluate, and manage the environmental and social risks and impacts of the Project in a manner consistent with the ESS
- Adopt a mitigation hierarchy approach to anticipate and avoid risks and impacts and, where avoidance is not possible, to minimize or reduce risks and impacts to acceptable levels; once risks and impacts have been minimized/reduced and mitigated, if significant residual impacts remain, to compensate for or offset them, where technically and financially feasible
- Optimize the project design for sustainability
- Adopt differentiated measures so that adverse impacts do not fall disproportionately on disadvantaged or vulnerable people, and these people are not disadvantaged in sharing development benefits and opportunities resulting from the Project
- Use national environmental and social institutions, systems, laws, regulations, and procedures in the assessment, development, and implementation of the Project
- Promote improved environmental and social performance in ways that recognize and enhance the NEA's capacity
- Document project conformance with the WB ESF and ESS, and the general Environmental, Health and Safety Guidelines (EHSG)

In order to document conformance with the GoN's requirements and to obtain government authorization for the UAHEP, several separate environmental documents have been submitted or are in the process of being prepared for submission to the GoN, including:

- Limbutar Camp Initial Environmental Examination (IEE) – This was submitted by the NEA to the Ministry of Urban Development in 2018 for a workers' camp facility that needed early approval to support the UAHEP access road construction.
- UAHEP Access Road Environmental Impact Assessment (EIA) – This was prepared by the NEA's Environment and Social Studies Department with the most recent submission to the Ministry of Forests and Environment (MoFE) through the Nepal Department of Electricity Development (DoED) in March 2021, again to obtain approval for early initiation of access road construction.
- UAHEP Transmission Line IEE – This is being prepared by ERM for submission to the Nepal DoED for approval of the electricity transmission component of the UAHEP and is expected to be submitted in fall 2021. This IEE will reflect the findings and recommendations of this ESIA.
- UAHEP EIA – This is being prepared by ERM for submission to MoFE through the Nepal DoED by fall 2021, for approval of the hydropower facility of the UAHEP. This EIA will reflect the findings and recommendations of this ESIA.

All of these documents have been prepared separately to meet Nepal's permitting requirements, but the impacts addressed are incorporated into this ESIA to document overall Project conformance with the WB ESF.

1.6 Limitations

The following limitations are applicable to this ESIA study:

- Community forest boundaries – Most community forests have not had their boundaries surveyed, so, for purposes of this ESIA, the boundaries of these forests were mapped in consultation with the associated forest user groups and represent approximate boundaries.

- Arun Hub substation – The UAHEP proposes to evacuate its power via an approximately 5.8 km long transmission line connecting with the proposed Arun Hub substation in Hitar. The Arun Hub substation is currently undergoing a detailed feasibility study by the NEA. The current UAHEP transmission line shows a connection to the proposed Arun Hub substation location, but it is understood that at least the terminal tower location shown in the current transmission line design may need to be adjusted to properly align with the substation electrical bay orientation.

1.7 Report Structure

This ESIA report is structured as follows, in general accordance with the WB ESS 1, Annex 1:

Executive Summary

1. Introduction – provides background on the proposed project and its purpose and need
2. Legal and Institutional Framework – summarizes the legal and institutional context and requirements with which the Project must comply
3. Project Description and Design Measures – provides a description of the proposed Project, including all project components (i.e., access road, hydropower project, transmission line, ancillary facilities, and associated facilities)
4. Analysis of Alternatives and Environmental and Social – describes the alternatives considered in ultimately selecting the proposed Project
5. Methodology – describes the methodology used for conducting the study
6. Baseline Conditions – describes the existing physical, environmental, and social baseline conditions
7. Environmental and Social Risks, Impacts, and Mitigation – identifies and evaluates the significance of all relevant direct, indirect, and cumulative environmental and social risks and impacts, applies the mitigation hierarchy, and for impacts that cannot be avoided or further minimized, proposes mitigation measures to reduce any residual risk to an acceptable level
8. Conclusions – summarizes the key findings and overall conclusions of the ESIA
9. References – provides details on the information sources relied on in preparing this ESIA

Appendices – includes records of meetings, consultations, and surveys with stakeholders

2. LEGAL AND INSTITUTIONAL FRAMEWORK

This ESIA has been undertaken with reference to the provisions of the various requirements, standards, policies, laws, rules, guidelines, manuals, and international conventions and treaties. For this, ERM reviewed various national acts and regulations to ensure compliance with the prevailing law. In addition, international standards and best practices on social and environmental safeguards were reviewed to develop an ESIA that identifies all possible risks and impacts from project development and to identify appropriate measures to minimize and mitigate the risks to the extent possible.

2.1 World Bank Standards and Guidelines

The World Bank is considering providing financial support for the UAHEP, in which case the Project would need to comply with the World Bank requirements described below.

2.1.1 Environmental and Social Framework

The World Bank adopted a new Environmental and Social Framework (ESF), which applies to all new WB investment project financing as of October 1, 2018. The ESF offers broad and systematic coverage of environmental and social risks. The ESF describes the Environmental and Social Standards (ESSs) and provides a comparison of these and the Nepalese legal framework, along with a gap analysis and gap-bridging measures applicable to this project.

Table 2.1: Comparison of World Bank Environmental and Social Standards with Relevant National Laws

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	**Requirements**			
ESS 1: Assessment and Management of Environmental and Social Risks and Impacts	ESS 1 requires the Borrower to assess, manage and monitor the environmental and social risks and impacts of the project throughout the project life cycle so as to meet the requirements of the ESSs in a manner and within a timeframe acceptable to the World Bank. The Borrower will: (a) conduct an environmental and social assessment of the proposed project, including stakeholder engagement; (b) undertake stakeholder engagement and disclose appropriate information in accordance with ESS 10;	The Environment Protection Act (EPA), 2019; Environment Protection Rules (EPR), 2020; and National Environmental Impact Assessment Guidelines, 1993 are the legal instruments containing requirements for the environmental and social assessment of any development project.	The Schedules in the EPA/EPR are based on activity type, threshold/size, as well as location. The potential risks associated with the project are omitted from GoN policy. There is no provision for associate projects/ activities; large projects can be split into smaller projects to avoid conducting a full ESIA study. The Environmental Assessment (EA) requirement in Nepal is primarily based on the project's size, location and financial threshold, irrespective of the level of potential risks. This	• An Environmental and Social Systems Assessment (ESSA is prepared in compliance, for government clearance; a separate IEE or EIA will be prepared as per the standard. • The preparation of an Environmental and Social Management Plan (ESMP) shall be made an integral part of the bidding document so that the Contractor (as for the provision of services) shall adhere to the provisions prescribed in the ESMP during the

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	Requirements			
	(c) develop an environmental and social commitment plan (ESCP), and implement all measures and actions set out in the legal agreement including the ESCP; and (d) conduct monitoring and reporting on the environmental and social performance.		gives total freedom to the proponent to design and implement EA on their own (for example, all documents including scoping, terms of reference [ToR], EIA reports are prepared by the proponent and approved by concerned government offices. Experience has shown that not all projects' need for EA is justified based on size, location, and thresholds. The scope of EIA may not cover all WB ESS. The EPA/EPR do not allow use of other types/forms of assessment. The EPA/EPR do not emphasize a hierarchy of measures in environmental and social (ES) risk management planning.	execution of the project.
ESS 2: Labor and Working Conditions	There are a number of requirements in ESS 2, under the following headings: • Working conditions and management of worker relationships • Protecting the work force including SEA/SH code of code • Grievance mechanism including SEA/SH responsive procedure	The Labour Act (2017), Labour Rules 2018, and Child Labor Act (2001) are the relevant legal instruments.	Current OHS legislation is not adequate (there is no separate legislation on OHS). The current OHS mandate is provided only in Chapter 12 of the Labour Act) The is a lack of industry-specific standards (so far, the Department of Labour and Occupational Safety has issued only one directive: OHS Directive for Brick Workers)	• Labour Management Procedures (LMPs) will be implemented in the project implementation. • A sub-project specific OHS plans will be developed by the Contractors.

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	Requirements			
	• Occupational health and safety (OHS) • Contracted workers • Community workers • Primary supply workers			
ESS 3: Resource Efficiency and Pollution Prevention and Management	The Borrower shall consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention.	The relevant legal instruments are: EPA (2019), EPR (2020), National Ambient Air Quality Standards (2003), Nepal Vehicle Mass Emission Standard (2012), National Ambient Sound Quality Standard (2012), Standard on Emission of Smoke in Air by New and Existing Diesel Generator (2012), National Water Quality Standard (2008), Tolerance Limits for Industrial Effluents to be discharged into Inland Surface Waters (2003), Solid Waste Management Act (2011), Solid Waste Management Rule (2013), Water Resources Act (1992), Water Resources Rules (1993), Drinking Water Regulation (1998), and Drinking Water Quality Standards.	There are a lack of suitable enforcement mechanisms for legislation on resource use efficiency in projects.	• Resource efficiency and pollution prevention in any project activity will be captured in ESIA/ESMP preparation. • World Bank Environmental Health and Safety Guidelines (EHSG) or/national standards (depending on which are stricter) related to environmental protection and resource efficiency will be complied with by the project.
ESS 4: Community Health and Safety	There are a number of requirements in ESS 4, under the following headings: • Community health and safety • Security personnel	The EPA identifies the direct and indirect human health impact as one of the components in assessing the effect of development projects.	There is limited coverage as scope of ESIA does not necessarily include community safety issues. Public health legislation does not specifically	• ESIA/ESMPs developed under the project will address all community health and safety issues that arise during the execution and

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	Requirements			
		EPA Section 7: Nobody shall create pollution in such a manner as to cause significant adverse impacts on the environment or likely to be hazardous to public life and people's health.	impose requirements on development and infrastructure projects.	operation of the project.
ESS 5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	There are a number of requirements in ESS 5, under following headings: • General (eligibility classification; project design; compensation and benefits for affected persons; community engagement; grievance mechanism; planning and implementation) • Displacement (physical displacement; economic displacement) • Collaboration with other responsible agencies or subnational jurisdictions • Technical and financial assistance	The relevant legal instruments are: Land Acquisition Act (1977), Guthi Corporation Act (1976), Land Acquisition Guidelines (1989), and Land Reform Act (1964). Clause 3 of the Land Acquisition Act states that any asset that is required for public purposes shall be acquired by providing compensation. The Compensation Fixation Committee shall establish the compensation rates. Section 42 of the Guthi Corporation Act states that Guthi land (religious trust land) acquired for the purpose of the development shall be replaced with other land, than compensated in cash. Compensation shall be provided for loss of crop damaged and income source.	• Does not require preparation of Resettlement Action Plan (RAP) • Does not allow for consultation of project affected people (PAP) in the compensation options • Does not allow for non-cash compensation options, such as land-for-land and replacement homes, only "arrangements for rehabilitation" and "priority in employment" • Valuation of lost assets considers depreciation and, hence, is not at replacement cost • Does not make mention of compensating non-titleholders (tenants, long-term land users, encroachers and squatters)	• The project shall be required to prepare a vulnerability assessment and mitigation plan for project affected people who experience impacts on their livelihood after losing their land. • A Resettlement Framework is being prepared to provide guidance for any resettlement activities. • The project shall assist those who experience impacts on their livelihoods due to land acquisition by the project, including tenants. • The lost assets need to be fully replaced and affected livelihoods restored. • A pragmatic livelihood assistance program shall be designed by the project. • The project shall develop

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	**Requirements**			
				alternative forms of compensation or assistance for adversely affected non-title holders, encroachers and squatters.
ESS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	There are number of requirements in ESS 6, under the following headings: • General (assessment of risks and impacts following a precautionary approach) • Conservation of biodiversity and habitats • Habitats are classified as the modified habitat; natural habitat; and critical habitat • No net loss is achieved to mitigate the loss of natural habitats; where critical habitats are impacted, Net Gain will be demonstrated for the biodiversity values for which the critical habitat is designated • Legally protected and internationally recognized areas of high biodiversity value invasive alien species • Sustainable management of living natural	The relevant legal instruments are: Aquatic Animal Protection Act (1961), National Park and Wildlife Conservation Act (1973), National Park and Wildlife Conservation Regulations (1974), Soil and Watershed Conservation Act (1982), Himalayan National Park Regulation (1979), National Trust for Nature Conservation Act (1983), Forest Act (2019), Conservation Area Management Rules (1996), Buffer Zone Management Rules (1996), and Plant Protection Act (2007).	• Natural habitats are not specifically required to be assessed in the EIA • Does not specifically require a Biodiversity Management Plan even where biodiversity impact is found to be significant in the EIA	• All the provisions of relevant laws will be complied with by the project. • A separate Biodiversity Management Plan needs to be developed for project activities that have potential impacts on biodiversity and critical/natural habitats.

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	Requirements			
	resources and primary suppliers			
ESS 7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	There are a number of requirements in ESS 7, under the following headings: • General (projects designed solely to benefit indigenous peoples/Sub-Saharan African historically underserved traditional local communities; projects where indigenous peoples/Sub-Saharan African historically underserved traditional local communities are not the sole beneficiaries; avoidance of adverse impacts; mitigation and development benefits; meaningful consultation tailored to indigenous peoples/Sub-Saharan African historically underserved traditional local communities • Circumstances requiring free, prior and informed consent (FPIC) (impacts on lands and natural resources subject to traditional ownership or under customary	The relevant legal instruments are: National Foundation for the Development of Indigenous Nationalities Act (2002), Local Self-Governance Act (1999), and ILO Convention 169 (2007). The GoN encourages the inclusion and consideration of the concerns of indigenous peoples and local communities (IPLC) in development and infrastructure programs and the formulation of a plan or mechanism to incorporate income generation programs targeted to IPLC.	• The GoN encourages development programs to incorporate income generation schemes for indigenous peoples (IPs). • The provision of FPIC and broad community support in relation to IPs is absent. Nonetheless, the GoN has ratified ILO 169 and the United Nations Declaration of Rights of Indigenous People (UNDRIP). • The GoN is in the process of preparing a National Action Plan to implement these international commitments.	• An Indigenous People Development Framework (IPDF) is being prepared to provide guidance to mitigate any impacts on IPs. • The project shall seek to maximize the ability of aadibasi/janajati to benefit from the project by: (1) creating an environment for social inclusion; and (2) enabling their participation in policy discussions and decision making. • The project shall promote the culture, language and knowledge of Ips through different project activities.

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	Requirements			
	use or occupation; relocation of indigenous peoples/ Sub-Saharan African historically underserved traditional local communities from lands and natural resources subject to traditional ownership or under customary use or occupation; cultural heritage); grievance mechanism; and indigenous peoples/Sub-Saharan African historically underserved traditional local communities and broader development planning			
ESS 8: Cultural Heritage	There are a number of requirements in ESS 8, under the following headings: • General • Stakeholder consultation and identification of cultural heritage (confidentiality; stakeholders' access) • Legally protected cultural heritage areas • Provisions for specific types of cultural heritage (archaeological sites and material; built heritage;	• The EPA (2019) and EPR (2020) provide that physical and cultural resources shall not be disturbed or damaged without the prior approval of the concerned authority. • The Ancient Monument Act (1956) contains provisions on cultural heritage.	• Does not include intangible cultural heritage • Does not provide for the development of a Cultural Heritage Plan • Does not provide for the application of globally recognized practices in the study, or for the documentation and protection of cultural heritage • Does not provide for adoption of "chance find" procedures	• The ESMF has incorporated "chance find" provisions and requirements. • ESMPs developed under the project will aim to address any issues of cultural heritage that may be affected by the execution and operation of the project. • During the drafting stage of this ESMF, not all cultural heritage is identified and documented. However, through

World Bank ESS Requirements		Nepal's Policy Framework and Requirements	Gaps Between ESSs and GoN Legal and Policy Requirements	Gap-Bridging Measures
ESS	Requirements			
	natural features with cultural significance; movable cultural heritage); and commercial use of cultural heritage			a collaborative approach, the community will be consulted in identifying cultural heritage sites of local significance/ importance and these sites will be documented and follow Culture Heritage Protection-Chance Finds Procedure (CHP-CFP).
ESS 10: Stakeholder Engagement and Information Disclosure	There are a number of requirements in ESS 10, under the following headings: • Engagement during project preparation (stakeholder identification and analysis; stakeholder engagement plan; information disclosure; meaningful consultation) • Engagement during project implementation and external reporting; grievance mechanism; and organizational capacity and commitment	Prevailing national polices including EPA 2019 and EPR 2020 envisage stakeholder engagement at different stages of project design and implementation. Stakeholder consultation, disclosure and a grievance hearing system are provided for.	• Does not require stakeholder analysis and preparation of stakeholder engagement plan • Does not provide for continuous stakeholder engagement/ consultations beyond EIA process during construction and operation phase	• The project has prepared a stakeholder engagement plan (SEP) to ensure that stakeholder engagement activities are effective and meaningful consultation is carried out including guideline for establishing a comprehensive grievance redressal mechanism (GRM) with clear, safe and accessible procedures to identify and respond to grievances, including Sexual Exploitation and Abuse and Sexual Harassment (SEA/SH) cases.

2.1.2 World Bank Good Practice Notes, Templates, and Checklists

Good practice notes, templates, and checklists have been produced by the World Bank to guide their clients and staff in the use of the ESF. The notes, templates, and checklists most relevant to the UAHEP are identified below.

- Good practice notes:

Assessing and Managing the Risks and Impacts of the Use of Security Personnel

SEA/SH for Large Civil Works

Road Safety

- Templates and checklists:

Environmental and Social Commitment Plan

Labor Management Procedures Template

Stakeholder Engagement and Information Disclosure – Stakeholder Engagement Plan (SEP) and Stakeholder Engagement Framework (Template for ESS 10) – June 2018

2.1.3 EHS Guidelines

The World Bank has prepared several Environmental, Health, and Safety (EHS) Guidelines, which are technical reference documents with general and industry-specific examples of good international industry practices and are referred to in the ESF. The EHS Guidelines contain the performance levels and measures that are usually acceptable to the World Bank Group and that are generally considered to be achievable in new facilities at a reasonable cost with existing technology. The WB requires borrowers/clients to apply the relevant levels or measures to their projects. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent. The EHS Guidelines most relevant to the UAHEP are identified below:

- General EHS Guidelines
- EHS Approaches for Hydropower Projects
- Electric Power Transmission and Distribution

2.1.4 World Bank Operational Policies

The World Bank has adopted various Operational Policies that require borrowers to address certain environmental and social risks to receive World Bank support for investment projects. Many of these policies are now incorporated into the ESF, but the following policy is relevant and addressed in this ESIA.

- OP 7.50 – Projects on International Waterways

2.1.5 Good Practice Handbook on Cumulative Impact Assessment and Management

The International Finance Corporation, a part of the World Bank Group, issued their *Good Practice Handbook on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets* in 2013. The purpose of this handbook is to provide practical guidance to companies investing in emerging markets to improve their understanding, assessment, and management of cumulative environmental and social impacts associated with their developments. A Cumulative Impact Assessment (CIA) is required for the UAHEP, as part of complying with ESS 1.

2.2 European Investment Bank

The European Investment Bank (EIB) is the lending arm of the European Union. The mission of the EIB is to foster sustainable growth within the European Union and abroad. The promotion of sustainable development – in particular the preservation of environmental and social capital that exists today for future generations – underpins the EIB's lending strategy and objectives. All investment projects supported by the EIB have to meet the EIB Environmental and Social Principles and Standards, which are grouped across 10 thematic areas:

- Assessment and Management of Environmental and Social Impacts and Risks
- Pollution Prevention and Abatement
- Biodiversity and Ecosystems
- Climate-related Standards
- Cultural Heritage
- Involuntary Resettlement
- Rights and Interests of Vulnerable Groups
- Labor Standards
- Occupational and Public Health, Safety, and Security
- Stakeholder Engagement

2.3 Nepal Legal and Institutional Framework

This section provides an overview of the applicable legal and administrative framework in Nepal.

2.3.1 Constitution of Nepal 2072 BS (2015)

The Constitution of Nepal mandates environmental protection as state policy. It provides that the State shall give priority to the protection of the environment and to prevent further damage due to physical development activities by increasing the awareness of the public about environmental cleanliness. It also provides that the State shall arrange for the special protection of the forest, vegetation and biodiversity, its sustainable use and ensure equitable distribution of the benefit derived from it.

Article 30 of the Constitution provides that Nepali citizens shall have the right to live in a clean and healthy environment, and the right to obtain compensation, in accordance with the law, for any injury caused by environmental pollution or degradation.

Article 18 provides for the equality of women, Dalits, and indigenous people (aadibasi/janajati) and Article 261 requires an Indigenous and Nationalities Commission (INC) of Nepal to be created to look into the matters of aadibasi/janajati people of Nepal. The INC was established in 2018.

Article 24 provides for rights against untouchability and discrimination.

Article 34 provides for the right to fair labor practices.

Article 38 provides for the right to equality of women, protection for women from physical, mental, sexual, and psychological abuse, or other forms of violence or exploitation based on any grounds.

Article 51(g) of the constitution relates to protection, promotion, and the use of natural resources, including:

- Protection, promotion and sustainable use of natural resources
- Conservation, promotion, and sustainable use of forests by mitigating possible risks to the environment from industrial and physical development by raising awareness about environmental protection measures

- Maintenance of forest area for ecological balance
- Advance warning and disaster preparedness measures to mitigate risks from disasters
- Minimization/avoidance of the impact of physical development works on the environment and rare species with due emphasis of conservation
- Development of renewable energy to ensure reliable and affordable source of energy

Article 51 (j) requires consent of indigenous nationalities to be obtained while making any decisions concerning these people. The essence of this provision is to ensure participation of indigenous nationalities in the decisions concerning their community.

2.3.2 Acts

Forest Act, 2076 BS (2019 AD)

This Act classifies national forest into government-managed forests, forest conservation areas, community forests, collaborative forests, and religious forests. The Act also aims to promote private, public, and urban forests. As per Article 42(2), the project needs to make available the equivalent amount of land to the government for forest development. Such land should be in similar ecological and geographical area and near the impacted national forest as far as possible. If the project is not able to buy land, it could deposit the money needed to buy such land in the Forest Development Fund established, as per Article 45 of the Act. Article 42 (5) requires the project developers to pay the expenses needed to reforest and maintain reforested area for five years.

Environment Protection Act (EPA), 2076 BS (2019 AD)

This is the main Act guiding environmental assessments and the permitting process of development projects in Nepal. Section 2 of the Act discusses different aspects of conducting a brief environmental study (BES), IEE, and EIA. Article 3 of the Act mandates a BES/IEE/EIA study for development projects. Article 4 requires a detailed analysis of alternatives and preparation of alternative measures for minimizing the adverse impacts of the project on the environment. Article 5 requires approval of terms of reference for an IEE, and a scoping document and terms of reference for an EIA by appropriate regulatory agencies before the preparation of environmental study report. Article 6 requires project developers to follow quality standards specified by the GoN while preparing environmental study reports. Article 7 discusses approval procedures for environmental study reports. Article 8 prohibits the implementation of the project without an approved environmental study report. Article 9 discusses strategic environmental analysis and Article 10 deals with the preparation of an Environment Management Plan prior to implementation of the proposal. Article 11 specifies the conditions under which a supplementary EIA is needed. Article 17 discuss the responsibility of the proponent for the management of hazardous substances.

National Civil Code and Criminal Code (Muluki Debani Samhita, 2074 BS [2017 AD], Muluki Aparadh Samhita, 2074 BS [2017 AD])

This Act refers to land acquisition/utilization of land, restriction on illegal encroachment of land, non-obstruction in public places like road, river, or any other public places, and protection of governmental and public property. Chapter 5 elaborates provisions relating to government, public, and community properties. Chapter 14 explains provisions relating to wages, labor, and employment. This Act is applicable because the Project will involve land acquisition and will cross public spaces like roads, rivers, and other government property (e.g., national forest land), and will also involve hiring employees.

Contribution Based Social Security Act, 2074 BS (2017 AD)

This Act is enacted per the social welfare concept in accordance with which the people have the right to welfare of various kinds as a fundamental right, as enshrined in the Constitution. The Act is applicable to industries, businesses, and the service sector, as prescribed by the government. Even those who are self-employed can take part in the Social Security Fund. The Fund will operate various schemes, as per the Act: medical and health protection, maternity protection, accidental protection, old age protection, dependent family protection, and unemployment protection.

Labour Act, 2074 BS (2017 AD)

This Act provides guidance on the classification of job postings and prohibition on child labor. It also provides restriction on minors and women, job security, retrenchment and re-employment, working hours, occupational health and safety, welfare arrangements, special arrangements for construction sites, conduct and penalties, and settlements of labor disputes. This Act is applicable to the Project because the Project will involve advertising and hiring employees and occupational health and safety issues.

Local Government Operation Act, 2074 BS (2017 AD)

This Act provides guidance on the jurisdiction, roles, and responsibilities of personnel appointed to local bodies in Nepal. This Act is applicable to the Project because the Project will involve interactions with local government personnel.

Guthi Corporation Act, 2033 BS (1976 AD), as amended 2066 BS (2010 AD))

This Act empowers the corporation to manage and operate Guthi lands and properties, and stipulates the roles and responsibilities of the corporation. This Act is applicable to the Project because the Project may affect Guthi lands and properties.

Control of International Trade of Endangered Wild Fauna and Flora, 2073 (2017AD)

This Act enforces the adoption of the Convention on International Trade in Endangered Species (CITES) of wild fauna and flora, to which the GoN is a signatory state. The main objective of this Act is to implement CITES through the protection of endangered species and controlling and regulating the wildlife trade. This Act provides a framework to be respected by each Party, which must adopt its own domestic legislation to ensure that CITES is implemented at the national level. This Act is applicable to the Project because the Project will employ workers who, if not properly managed, could engage in activities prohibited by CITES.

Solid Waste Management Act, 2068 BS (2011 AD)

This Act aims to manage solid waste, mobilize resources, and ensure the health of the public by controlling the adverse impact on pollution from solid waste. This Act is applicable to the Project because the Project will generate solid waste during both the construction and operation phases.

Right to Information Act, 2064 BS (2007 AD)

The aim of this Act is to make the functions of the state open and transparent in accordance with the democratic system and to make it responsible and accountable to the citizens. It intends to protect the rights of the citizens to be well informed by providing citizens with simple and easy access to information of public importance that is held in public bodies while protecting sensitive information that could have an adverse impact on the interests of the nation and citizens. This Act is applicable to the Project because the Project will involve construction of a large capital facility for which affected stakeholders have the right to information.

Plant Protection Act, 2064 BS (2007AD)

This Act aims to prevent or control harmful epidemic insect or disease spread in plant or plant products while importing or exporting. By notification in the Nepal Gazette, the GoN may impose restrictions or conditions for the import of plant or plant products. This Act is applicable to the Project because the Project will employ foreign workers who will need to comply with these requirements.

National Foundation for Upliftment of Aadibasi/Janajati Act, 2058 BS (2002 AD)

This Act prescribes a number of provisions for overall improvement of the aadibasi/janajati by formulating and implementing programs related to social, educational, economic, and cultural development. This Act is applicable to the Project because the Project will affect aadibasi/janajati people and will involve an Indigenous Peoples Plan with benefit sharing elements.

Child Labour (Prohibition and Regulation) Act, 2056 BS (2000 AD)

This Act prohibits engaging children in factories, mines, or similar risky activities, and makes necessary provisions regarding their health, security, services, and facilities while engaging them in other activities. Article 3 sets the minimum age to work at 14 years of age, and Article 4 prohibits child labor by way of persuasion, misinterpretation, or coercion. This Act is applicable to the Project because the Project will be hiring local workers and needs to prevent use of child labor.

Human Trafficking (Control) Act, 2007

This Act provides several legal safeguards against human trafficking, including provisions for the rehabilitation and integration of survivors, as well as their protection and compensation.

Domestic Violence (Crime and Control) Act, 2009

This Act defines domestic violence as any form of physical, mental, sexual, and economic harm perpetrated by a person to a person with whom he/she has a family relationship.

Sexual Harassment at the Workplace (Elimination) Act, 2015

This Act prohibits sexual harassment at both public and private workplaces. It defines sexual harassment as any unsolicited acts committed by, or caused to be committed by, any person in abuse of his/her position or power, or by the imposition of any type of coercion, undue influence, or enticement.

Caste-based Discrimination and Untouchability Act, 2011

This Act contains provisions to end discriminatory practices aimed at those considered to be members of the lowest castes in the public and private sphere.

Building Act, 2055 BS (199 AD) and Amendment 2066 BS (2010 AD)

Building Act, 2055 BS contains the necessary provisions for the regulation of building construction to protect buildings against earthquake, fire, and other natural calamities, to the extent possible. It contains provisions relating to the design and approval of the design/map of building, and states, “Any person body or government body shall, in making a building, build it in consonance with the standards set forth in the building code.” This Act is applicable to the Project because the Project will involve the construction of several permanent buildings at the headworks and powerhouse sites.

Water Resources Act, 2049 BS (1992 AD)

This Act ensures the rational utilization, conservation, management, and development of water resources in Nepal. The main objectives of the Act are to define legally the process for determining beneficial uses of water resources, to prevent environmental and other hazardous effects thereof, and to keep water resources free from pollution. The Act strives to minimize the environmental damage to water bodies, especially lakes and rivers. The Act specifies that soil erosion, flooding, landslides, or any significant impact on the environment should be avoided in all uses of water resources. Article 3 of this Act provides ownership of water resources to the GoN. Article 7 stipulates the priority order of the use of water resources as drinking and domestic use (first), irrigation (second), agricultural usage such as animal husbandry and fisheries (third), and hydroelectricity (fourth). Article 8 makes provision for the licensing of water use and Article 9 for the utilization of water resources for hydroelectricity. This Act is applicable to the Project because the Project will involve the generation and transmission of hydroelectricity, as well as construction activities that may potential affect water quality (e.g., disturbance of slopes, use of hazardous materials).

Electricity Act, 2049 BS (1992 AD)

This Act was enacted to manage the survey, generation, transmission, and distribution of electricity in such a manner that there is no substantial adverse effect on the environment, such as soil erosion, flood, landslide, or air pollution, and to standardize and safeguard electricity services. Articles 3–9 make provision for the survey, generation, transmission, and distribution of electricity based on government license and its terms and related conditions. Article 10 contains provision for project ownership by the government after the agreed term of the license expires. Article 11 contains provisions for royalties to be paid to the GoN, based on its capacity. Articles 12–13 contain provisions on the facilities provided by the government for the hydropower developer. Article 16 is about electricity charges and Article 17 deals with tariff. Article 20 contains provisions about the national transmission line of grid and Article 22 governs the import and expert of electricity. Article 24 provides that there shall be no adverse effect on the environment due to hydropower projects. This Act is applicable to the Project because the Project will involve the generation and transmission of electricity.

Electricity Regulatory Commission Act, 2074 BS (2017 AD)

Section 3(1) of this Act regulates the generation, transmission, distribution, and trade of electricity. Section 12 contains provisions for the management of technical aspects for generation, transmission, distribution and trading of electricity. Section 13 has provisions for fixing rate of electricity and monitoring trade. Section 16 contains provisions to advise the government on policy formulation. Section 17(1) deals with the compliance of licenses with the Act, sub-legislation (e.g., rules, order), or other prevailing laws. Section 37 has the power to issue directions to licensees under the Act, and it is the duty of all licensees to comply with such directions. Section 19(1) grants the power to fine licensees not complying with orders or directions. This Act is applicable to the Project because the Project will involve the generation and transmission of electricity.

Soil and Watershed Conservation Act, 2039 BS (1982 AD) and Amendment 2066 BS (2010 AD)

This Act guides watershed conservation during project implementation; it contains provisions to prohibit actions within any protected watershed area. This Act is applicable to the Project because the Project could affect protected watershed areas, although the Project avoids all protected watersheds.

National Trust for Nature Conservation Act, 2039 BS (1982 AD)

The Act guides the conservation and management of nature and natural heritage. It forms a trust under the guidance of the GoN to conserve, promote, and manage wildlife and other natural resources. Most importantly, the trust aims to manage necessary arrangements related to the development of national parks. This Act is applicable to the Project because the Project may affect wildlife and other natural resources, and will affect the Makalu Barun National Park and its Buffer Zone (BZ).

Land Acquisition Act, 2034 BS (1977 AD)

The Act covers all aspects of land acquisition and compensation to private landowners for land and other assets. Article 3 of the Act empowers the GoN to acquire any land at any place for any public purpose, subject to compensation under this Act. As per Article 4, the GoN may also decide to acquire land for other institutions to implement projects in the interest of the general public. The institution requesting land acquisition is required to pay all costs associated with such acquisition. Article 5 makes provision for appointing an Officer for Preliminary Action. Article 6 outlines procedures for preliminary action relating to acquisition of land, and Article 7 contains provisions for the compensation of losses incurred during preliminary action. Article 9 of the Act relates to the notification of land acquisition. Article

13 deals with the compensation rate. Compensation is to be paid in cash, as per this Act; there is no provision for land-for-land compensation. Article 18 of this Act requires the chief district officer to prepare a list of persons to compensation and issue a notice accordingly for the information of the concerned persons. This Article also makes provision for the lodging of complaints by unsatisfied persons and a grievance redressal mechanism. As per Article 27 of the Act, land could also be acquired through negotiation.

Public Roads Act, 2031 BS (1974 AD)

The major provisions of the *Public Roads Act,* 1974 include prescribing rules for planned road construction; regulating road width and boundaries within which no house can be built; and maintaining the road environment through plantation along public roads. GoN agencies and the public need to obtain prior approval from the Department of Roads to carry out work on roads and road boundaries. This Act is applicable to the Project because the Project will involve carrying out work on roads (e.g., potential for temporary road closures when stringing crosses on a public road).

National Parks and Wildlife Conservation Act, 2029 BS (1973 AD) and Amendment 2049 BS (1992 AD)

This Act includes provisions to restrict damage to forest products and to block or divert any river or stream flowing through a national park or reserve or any other source of water. It also states that, without permission, no one shall cut, fell, remove, or overshadow any tree, plant, or any forest produce or do anything by which the forest produce may die, burn, or get damaged. This Act is applicable to the Project because the Project will involve some clearing of forest and trees.

Lands Act, 2021 BS (1964 AD) and Amendment 2075 BS (2018 AD)

This Act provides guidance on land and/or asset acquisition, land ceiling, rights of tenant, exemption from upper ceiling, land use, control of land fragmentation, and plotting. This Act is applicable to the Project because the Project will involve land acquisition and may affect tenants.

Land Use Act, 2076 BS (2019 AD)

This Act is classified land into 10 categories: agricultural; residential; commercial; industrial; mining and mineral; forest; river, stream, pond and wetland; public use; cultural and archaeological; and others. The land classification is based on the composition and use of the land. The classification has not clearly pinpointed Guthi land, which is religious land in the name of temples or shrines, from the revenue of which the religious ceremonies or festivals associated with the temples or shrines are celebrated and the repairs and maintenance of the temples or shrines are carried out. The Act is introduced based on the condition of land, population growth, requirements of land for various purposes, such as food and habitation and the need for economic development and infrastructure building, among other things. The main aim of the Act is to ensure that land is properly used and managed and that land set aside for one purpose is not used for another. The provincial and local governments are also required to formulate their own land use laws based on the Act. This Act is applicable to the Project because the Project will involve use of land other than the existing use.

Explosive Act, 2018 BS (1961 AD)

This Act emphasizes the need for permission for the use, sale, transportation, import, and use of explosives. This Act is applicable to the Project because the Project will require the use, transportation, and import of explosives for rock excavation and tunnelling.

Aquatic Animals Protection Act, 2017 BS (1960 AD)

This Act empowers the government to prohibit the catching, killing, and harming of aquatic animals. According to this Act, aquatic animal means any animal living in water. Section 3 restricts the methods of catching and killing aquatic animals by using electric current, explosive substance, or poisonous substance with the intent of catching and killing any aquatic animals in any water. Section 4 empowers the GoN to prohibit the catching, killing, and wounding of certain kinds of aquatic animals. This Act is applicable to the Project because the Project could affect aquatic animals such as fish and otters.

Ancient Monument Preservation Act, 2013 BS (1956 AD)

This Act refers to ancient monuments and empowers the government to declare any place or area as a monument site/area. It also restricts the transfer, transaction, export, or collection of ancient monuments and archaeological objects or curios without the prior approval of the government. Although the Project will avoid all known ancient monuments, archaeological sites, and other cultural heritage sites, this Act is applicable to the Project because the Project may uncover previously unknown archaeological sites, objects, or curios during construction.

2.3.3 Rules and Regulations

Labour Rules, 2075 BS (2018 AD)

These Rules stipulate the circumstances in which Nepali and foreign workers may be engaged in work and contain guidance on deploying minors and women at work. They also stipulate that there should be no discrimination in remuneration and provide for compensation in the case of injury, grievous harm resulting in physical disability, and death. These Rules are applicable to the Project because the Project will employ Nepali and foreign workers.

Child Labour (Prohibition & Regulation) Rules, 2062 BS (2006 AD)

In an exercise of the powers conferred by Section 27 of the Child Labour (Prohibition and Regulation) Act, 2056 (1999 AD), the GoN has framed several Rules. These Rules are applicable to Project because child (above designated ages) labor requires a certificate of eligibility.

Solid Waste Management Rules, 2070 BS (2013 AD)

These Rules specify the procedures for the management of solid waste. These Rules are applicable to the Project because the Project will generate and require the proper management of solid waste during both the construction and operation phases.

Environment Protection Rules (EPR), 2077 BS (2020 AD)

The EPR establishes the process to be followed during the preparation and approval of scoping determination, the preparation of terms of reference for EIAs, and the preparation of IEE or EIA reports for proposed projects. Section 3 of the EPR make provision for BES, IEE, and EIA, depending on the type of proposal. It is apparent from this provision that any private or government agency that wishes to implement any of the proposals defined in the regulations must prepare either a BES, IEE, or EIA, as the case may be. Rules 3 to 8 of the EPR are directly related to the study and have been duly considered during the preparation of the report. The EPR contains provisions to prepare and submit the Scoping Report (Rule 4), Terms of Reference (Rule 5), and BES/IEE/EIA Report (Rule 7) for approval, and includes the public hearing process (Rule 6). Rule 7(3) mentions the publication of notice in a national level daily newspaper for EIA and in local newspaper for BES/IEE regarding the collection of the concerns of local people and institutions within 7 days. Rule 8(8) deals with the collection of recommendation letters from the municipalities/rural municipalities and concerned government offices. The rule provides the content to be covered while preparing the report, as per schedules 10, 11, and 12, and specifies that the report should be prepared in Nepali language (Rule 7[7]).

Conservation Area Management Rules, 2053 BS (1996 AD)

These Rules implement the conservation efforts of the conservation area by dividing the area into multiple sub-areas (*ilakas*), according to need, and establishes unit conservation officers and other staff, as necessary.

- Section 2 describes the boundaries and management modalities of the conservation area.
- Section 4 depicts the management plan and implementation of the conservation area, stressing the management and operation of the development works and the management and implementation of the work plan.
- Section 5 focuses on the forbidden works that must be considered during the development works.

These Rules are applicable to the Project because the Project will traverse a conservation area (i.e., Makalu Barun National Park [MBNP]).

Forest Rules, 2079 BS (2020 AD)

Rule 91 makes provision for land for land compensation for the forest land leased by the development projects. The rule states that such land shall be provided in a similar topography. Rule 93 defines the provision of deposition of required costs for land in a forest development fund, as per the rates mentioned in Schedule 51. Section 5, Rule 93 highlights the plantation of trees at the rate of 10 samplings for the loss of one tree, and requires that the plantation be managed for 5 years. Section 6 of the rules deals with estimating the production cost of saplings, transportation, and plantation on 1,600/ha, fencing, and the manpower required for 5 years management. Rule 94(3) make provision for monitoring the conditions, set forth by the Department of Forests and Soil Conservation, while providing forest land to development projects. Rule 96(1) highlights that projects shall implement the mitigation measures specified in the EIA report at its own cost. Rule 96(2) mentions that such mitigation measures shall be implemented in coordination with community forest users groups. Rule 96(3) highlights the need for the construction of wildlife friendly infrastructure. Rule 97(1) makes provision for compensation for the loss of private trees due to a project. Rule 103(1) states that the cost required for cutting and transporting forest products from the felled site to the designed site shall be provided by the project developer/proponent.

Water Resources Rules, 2050 BS (1993 AD)

These Rules provide guidance and mitigation measures for aquatic life and the water environment. They are applicable to the Project because the Project could potentially affect aquatic life and the water environment.

The Water Resources Rules basically deal with the formation of consumer associations and licensing for the utilization of water resources for all purposes (e.g., drinking water and domestic use, irrigation, hydropower, animal husbandry and fishery cottage industry, water transport). The Rules also contain provisions for environmental matters to be included in the application for a license for the utilization of water resources. Rule 1include) states that the application (to obtain a license for the utilization of water resources) must include “analysis of environmental affect”. According to this Rule, the analysis should include measures to be taken to minimize adverse impacts due to project on environment (natural as well as socioeconomic and cultural), provisions for sharing the project benefits with the local community during the construction and operation period, provisions for safety arrangements, details on people to be evacuated, and necessary plans for their rehabilitation. Matters relating to acquisition of land and houses and their compensation are dealt with in Rules 32, 33, 34 and 35.

Contribution Based Social Security Regulation, 2075 BS (2018 AD)

These regulations are framed under Section 69 of the Contribution Based Social Security Act, 2017. Several of the protections provided by the Regulations (e.g., accidental and illness) are applicable to the Project, as the Project will employ labor.

Electricity Rule, 2050 BS (1993 AD)

Article 13(g) of this rule emphasizes that the environmental study report should include the measures to be taken to minimize the adverse effects of the project on the physical, biological, and social environments. It should also elaborate on the utilization of local labor, source of materials, benefits to the local people after the completion of the project, training to local people in relation to construction, maintenance and operation, facilities required for the construction site, and safety arrangements. Article 66(2) of this rule prohibits the construction of houses or growing of tall trees within a transmission line right-of-way (RoW). Article 87(1) requires project proponents to compensate landowners for the restriction imposed on RoW land. Article 88 makes provision for the Compensation Fixation Committee for transmission line RoW land.

Electricity Regulatory Commission Rules, 2075 BS (2018 AD)

These Rules are formulated under Section 41 of the Electricity Regulatory Commission Act, 2017. They deal with issues relevant to development of standards. They stipulate that the Electricity Regulatory Commission may develop standards regarding the performance to be abided by the licensee, the quality and safety level of the National Grid System, and the determination of responsibilities of electricity system operators. While developing the standards pursuant to Sub-Rule (1), the Commission may consult the stakeholders and experts in the concerned area.

Ancient Monuments Preservation Rules, 2046 BS (1989 AD) with amendments

These Rules aim to protect and limit the acquisition of ancient monuments and archaeological, historical, or artistic objects and require approval from the GoN, Department of Archaeology for any construction work. Although the Project will avoid all known ancient monuments, archaeological sites, and other cultural heritage sites, these Rules are applicable to the Project because the Project may uncover previously unknown archaeological, historical, or artistic sites, objects, or curios during construction, which would trigger the need to obtain approval from the GoN, Department of Archaeology.

2.3.4 Policies

National Environment Policy, 2076 BS (2019 AD)

This Policy has the following objectives:

- Prevent, avoid, control, minimize, and mitigate pollution in these sectors: noise, air, water, soil, electromagnetic waves, and chemicals, including radioactive substances.
- Manage solid waste originating from domestic, industrial, and service sectors.
- Mainstream environmental issues in all development activities.
- Conduct research and capacity development in the field of environmental protection and management.

This Policy proposes a punishment, of a fine up to Nepali rupees (NPR) 500,000, NPR 1,000,000, and NPR 5,000,000, for the implementation of any proposal without approval of the brief environmental study, IEE, and EIA reports or any act contrary to these approved reports. The concerned agency shall issue directives to comply with the approved reports. This Policy is applicable to the Project because the Project may cause noise, air, water, soil, and electromagnetic pollution and generate solid waste.

National Climate Change Policy, 2076 BS (2019 AD)

The main goal of this Policy is to improve livelihoods by mitigating and adapting to the adverse impacts of climate change, adopting a low-carbon emissions socioeconomic development path, and supporting and collaborating in the spirit of the country's commitments to national and international agreements related to climate change. The Policy includes the following objectives:

- Focus on increasing capacity on climate change adaptation
- Promote green economy by adopting low-carbon economic development
- Develop economic resilience
- Mobilize national and international financial resources to combat climate change
- Mainstream climate change into relevant policies, plans, and strategies
- Incorporate gender and social inclusion in climate change mitigation and adaptation programs

This Policy is applicable to the Project because the Project may affect the magnitude of greenhouse gas emissions during both Project construction and operation.

National Forest Policy, 2075 BS (2018 AD)

This Policy aims to strengthen the forest resources of Nepal, as follows:

- Manage forest resources sustainably and increase productivity.
- Conserve biodiversity, conservation of sources, and equal sharing and distribution of environmental services gained from conservation.
- Encourage the private sector for the development and conservation of the forest sector. The Policy also aims to promote forest-based entrepreneurships, diversification, and value addition through marketing, creation, and promotion of green employment.
- Reduce and mitigate the adverse impacts of climate-related hazards and enhance climate change adaptation measures and resilience in Nepal. The Policy also promotes good governance, inclusion, and social justice for the conservation of forest resources.
- Enhance the conservation policy, which aims to encourage forest conservation groups to manage the forest in a scientific way to strengthen ecosystems and other environmental services.
- Protect forests, conservation areas, watersheds, biodiversity, and wildlife through sustainable and participatory management and their equitable distribution.
- Provide ownership of the forest area to the federal government, whereas the ownership of non-timber forest products (NTFPs) is vested in the management group or community.

It also provides the following:

- For national priority projects and national pride projects that have no alternative to forest land use, the federal government will provide forestland use based on the laws, directives, and procedures, as well as compensatory afforestation and restoration of the used forest area.
- Recognize forest area outside of the national forest is to include private forest, forest in community areas, forest in institutional land, urban forest, agricultural forest, and emphasize assistance to increase and promote these forest lands through subsidized interest rates and through awareness programs, technology transfer, and capacity building.

This Policy is applicable to the Project because the Project will affect the forest resources of Nepal.

Electricity Development Decade, 2072 BS (2016 AD)

The overall objectives of this Concept Paper are as follows:

- Ensure energy security by reducing power outages within a prescribed timeframe
- Recognize earthquake, flood, and landslides as a force majeure event and have a provision for the extension of commercial operation date in cases where force majeure is triggered

- Provision appropriate concessions to projects that had to halt their operation due to damaged caused by the earthquake, flood, or landslides

This Concept Paper is applicable to the Project because the Project will help improve energy security and its construction and operation are subject to force majeure events.

Land Use Policy, 2072 BS (2015 AD)

This Policy envisions optimum use of the available land based on its capability for sustainable social, economic, and environmental development. The goal of the policy is to:

- Classify land according to its capability for optimum use
- Manage land fragmentation and urbanization
- Balance development with the environment
- Conserve geographic, cultural, religious, historical, and touristic areas

This Policy is applicable to the Project because the Project will affect land use and must take into consideration and mitigate to the extent possible land fragmentation.

National Conservation Strategy, 2071 BS (2014 AD)

The key strategies included are to:

- Ensure the sustainable use of Nepal's land and renewable resources
- Preserve the biological diversity of Nepal to maintain and improve the variety and quality of crops and livestock and maintain the variety of wild species, both plant and animal
- Maintain the essential ecological and life-support systems, such as soil regeneration, nutrient recycling, and the protection and cleansing of water and air

In addition, the Strategy has made various provisions for resource conservation and its utilization in an environmental-friendly manner. It has provisions dealing with biological diversity, soil conservation, watershed management, national parks, protected areas, wildlife conservation, and natural heritage. This Strategy is applicable to the Project because the Project will affect Nepal's land and renewable resources.

Policy on Land Acquisition, Resettlement, and Rehabilitation for Infrastructure Development Projects, 2071 BS (2015 AD)

This Policy emphasizes that project development agencies will conduct meaningful consultation with project-affected persons, communities, and sensitive groups, particularly:

- Economically vulnerable groups
- Landless citizens
- Senior citizens
- Women and children
- Indigenous/janajati groups
- Differently abled and helpless persons
- Persons having no legal rights on the operated land

Consultations will be held while preparing for land acquisition or for resettlement or rehabilitation planning. This requires completing all the processes, including compensation, resettlement, rehabilitation, and other benefits to the project-affected persons/households prior to physical and economic displacement by the Project. The land acquisition process, as far as possible, will be undertaken through the process of negotiation with project-affected persons/households in a transparent, free, fair, and justifiable manner.

This Policy is applicable to the Project because the Project is an infrastructure project and will be subject to the Policy's consultation requirements, especially for the sensitive and disadvantaged groups identified in the Policy, and will involve land acquisition.

Rangeland Policy, 2068 BS (2012 AD)

The primary objective of this Policy is to help maintain ecological balance by conserving, promoting, and sustainably using rangeland biodiversity and natural resources. This Policy is applicable to the Project because the Project may affect some rangeland.

National Wetlands Policy, 2069 BS (2012 AD)

The primary goal of the National Wetlands Policy is to conserve and manage wetland resources wisely and in a sustainable way with participation from the local people. The major objectives of the Policy are to:

- Identify wetlands and prepare detailed management plans for each of them
- Identify local people's knowledge, skill, and practice regarding wetlands
- Conserve and manage wetlands

This Policy is applicable to the Project because the Project will affect some wetlands.

Rural Energy Policy, 2063 BS (2006 AD)

This Policy has been designed to:

- Address the energy needs of the rural population and incorporate rural energy policies of the ministries and institutions related to rural development
- Provide adequate information campaigns and education programs
- Promote broad stakeholder involvement to ensure success

This Policy is applicable to the Project because the Project will help provide energy to rural populations.

Water Induced Disaster Management Policy, 2062 BS (2006 AD)

The Policy includes the following provisions:

- Mitigate water-induced disasters and reduce loss of lives and property
- Enhance institutional strengthening of Department of Water Induced Disaster Prevention
- Establish a network with the associated institutions and agencies to cope with potential disasters

This Policy is applicable to the Project because the Project may affect water-induced disasters by disturbing steep slopes prone to landslides.

2.3.5 Plans

Fifteenth Plan 5-Year Plan Approach Paper, 2076/77–2080/81 BS (2019/20-2023/24 AD)

Nepal started formulating periodic development plans in the late 1950s. These plans outline the country's development policies and programs for a 5- or 3-year period. Nepal has already completed 14 periodic development plans. An Approach Paper for this Fifteenth Plan has been prepared. Environmental problems identified by this Approach Paper include an imbalance between infrastructure development and the environment; lack of coordination among the tiers of government, industry, research organizations, and other stakeholders; and an increase in air, noise, water, and land pollution due to weak implementation capability.

One of the main objectives of the Fifteenth Plan is to maintain balance between physical infrastructure development and the natural environment. The Plan's strategy to achieve such balance is to make IEEs and EIAs an inseparable part of infrastructure development. The Plan also aims to make the EIA approval process simple and transparent and proposes to set aside a specific percentage of the budget for the minimization of adverse environmental impacts in the EIA report itself. This Plan is applicable to the Project because the Project is a physical infrastructure development project.

National Biodiversity Strategy and Action Plan, 2071–2077 BS (2014 to 2020AD)

This Strategy and Action Plan promotes the conservation of forest biodiversity by promoting people's participation. However, it strictly prohibits development projects that have a negative impact on forest habitat. Most of the transmission lines in Nepal are routed through forest. In order to install transmission poles to supply high-voltage electricity, excavation is required in forest areas. The high-voltage wires may have impacts as well. Therefore, this Plan explicitly restrict projects that would hamper biodiversity and natural habitat. It also promotes community participation, as most of the forests in Nepal are community forests. This Strategy and Action Plan is applicable to the Project because the Project will affect community forests.

National Water Plan (NWP), 2062 BS (2005 AD)

The objective of the National Water Plan is to contribute to the overall national goal of economic development, poverty alleviation, and to enhance standards of living, while protecting the natural environment. It aims to provide guidance for the development and management of water resources and water services. It includes short, medium and long-term action plans for the water sector including investment and institutional aspects. It also provides for an environmental action plan on management of watersheds and aquatic ecosystems.

The Plan adopts the following major doctrines:

- Integration to achieve: a) efficiency and effectiveness of water management by empowering users, b) integration between water use across river basins, c) involvement of users to set out priorities and management decisions, and d) effective data collection for continuous development of the water sector
- Coordination among various stakeholders to ensure sustainable water management
- Decentralization and capacity building of local institutions
- Popular participation to ensure that all stakeholders are consulted to build consensus on overall development including users group
- Equity to include women and vulnerable communities

This Plan is applicable to the Project because the Project will affect watersheds and aquatic ecosystems.

Nepal Environmental Policy and Action Plan, 2050–2055 BS (1993–1998 AD)

This Policy and Action Plan includes the following five policy principles:

- Manage natural and physical resources efficiently and sustainably.
- Balance development efforts and environmental conservation for sustainable fulfilment of the basic needs of the people.
- Safeguard natural heritage.
- Mitigate adverse environmental impacts of development projects and human actions.

- Integrate environment and development through appropriate institutions, adequate legislation and economic incentives, and sufficient public resources.

This Policy and Action Plan is applicable to the Project because the Project is a development project with the potential to affect the environment adversely.

National Plan of Action Against Gender-based Violence, 2066 BS (2010 AD)

This Plan focuses on the response to and prevention of gender-based violence (GBV). Through legal and institutional reform and implementation, it aims to provide improved access to justice for survivors; establish/strengthen community-based and outreach services for the protection of survivors; and strengthen the health sector for effective and efficient response. The prevention aspect focuses on evidence-based awareness raising, zero tolerance, socioeconomic empowerment, coordination, communication, and monitoring the implementation of the plan.

2.3.6 Manuals, Guidelines, and Standards

Hydropower Environmental Impact Assessment Manual (Ministry of Forests and Environment), 2075 BS (2018 AD)

This manual includes generic information on the procedures for EIA scoping, terms of reference (ToR) preparation, baseline environmental studies, information disclosure, public consultation, prediction and evaluation of impacts, mitigation prescriptions, monitoring, and EIA report preparation in line with the EPA and the EPR. This Manual is applicable to the Project because the Project triggers the need for an EIA. The requirements of this Manual have been incorporated into the structure and content of this EIA.

Community Forest Timber Collection and Sale Guideline, 2073 BS (2016 AD)

- Section 2 provides guidelines for the inventorying of community forests and the demand for timber.
- Section 3 provides guidelines for the stamping, felling, and transportation of community forests trees.
- Section 4 provides procedures for timber sales for local consumption, based on priorities.
- Section 5 provides guidelines for selling the community forest timber outside the community forest user groups.

This Guideline is applicable to the Project because the Project will affect community forests.

Forest Sector Strategy, 2073–2082 BS (2016–2025 AD)

This Forest Sector Strategy was developed to achieve the vision of MoFE to ensure sustainable forest management, biodiversity conservation, and integrated watershed management for the development and prosperity of the country. The strategy identifies eight key strategic pillars to meet its objectives:

- Sustainably managed resources and ecosystem services
- Conducive policy process and operational environment
- Responsive and transparent organizations and partnerships
- Improved governance and effective service delivery
- Security of resources used by the community
- Private sector engagement and economic development
- Gender equality, social inclusion, and poverty reduction
- Climate change mitigation and resilience

This Strategy is applicable to the Project because the Project will affect forests.

Forest Products Collection and Sales Distribution Guidelines, 2073 BS (2017 AD)

These Guidelines specify various procedures and formats for obtaining approval for vegetation clearance, delineation of lands for vegetation clearance, and evaluation of wood volume. These Guidelines are applicable to the Project because the Project will involve forest products collection.

Community Forest Development Program Guideline, 2072 BS (2015 AD)

This Guideline will help to strengthen community forest user groups to manage the community forest in a more scientific way so that the local community will benefit directly or indirectly for their livelihood. This will help conserve and protect the natural resources and biodiversity. This Guideline is applicable to the Project because the Project will affect community forests.

Non-Timber Forest Products Resources Inventory Guidelines, 2070 BS (2013 AD)

These Guidelines focus on conducting the forest inventory and procedures for any development projects like hydropower or transmission lines. It focuses on making the plots and the methods for sampling the plots. These Guidelines are applicable to the Project because the Project is a development project and was required to conduct a forest inventory.

Forest Encroachment Control Strategy, 2068 BS (2012 AD)

Forty percent (40%) of the land area in Nepal is covered by forest. Nepal's national strategy is to stop this percentage from decreasing. Therefore, this Strategy emphasizes the need to stop the increase of forest encroachment and promote the maximum percentage of forest area. This Strategy is applicable to the Project because the Project will involve forest clearing.

Forest Fire and Management Strategy, 2067 BS (2011 AD)

The Forest Fire Management Strategy is aimed at "safeguarding lives and properties, protecting environment and providing livelihood supports to the local communities." The strategy has four pillars for forest fire management in Nepal: 1) Policy (legal and institutional development and improvement); 2) Education (awareness raising, capacity building, and technology development); 3) Participation (involving local community), fire management and research; and 4) Coordination and collaboration (international cooperation, networking, and infrastructure development). This Strategy is applicable to the Project because the Project has the potential to affect and be affected by forest fires.

Nepal Electricity Authority, Operational Manual of Environmental and Social Impact Assessment (ESIA) for Sub-projects Financed under the Additional Financing of the Power Development Project, Revised, 2066 BS (April 2009 AD)

This Operational Manual highlights the impact of development projects related to climate and the environment. It provides guidelines for the implications of an EIA and social impact assessment. The manual includes all the relevant laws, polices, and guidelines to design projects related to electricity. This Operational Manual is applicable to the Project because the Project transmission line will become part of the Nepal Electricity Authority–managed electricity transmission system of Nepal.

Guideline to Provide Land for Construction of Infrastructure Projects in Conservation Area 2080 BS (2024 AD)

Article 3(1) states that project sites shall be selected outside the boundary of a conservation area, to the extent possible. Article 3(2) elaborates that, if complete avoidance is not possible, the site shall be selected with minimum impacts on the land and trees in a conservation area. Article 4(1) requires the consent from the Department of National Park and Wildlife Conservation, through the concerned ministry, before a survey license is issued for a feasibility study and EIA. Article 6(1) defines the procedure for the application and the documents required to be submitted along with application while making a request to use land in a conservation area. Article 9(1) makes provision for land for land compensation for forest land in a conservation area leased by a development project. This article also states that such land shall be provided in similar topography and ecological area. Article 14(1) highlights that projects shall implement mitigation measures specified in the EIA report at their own cost. Article 14(3) states that wildlife friendly infrastructure shall be constructed within the conservation area. Article 18 highlights the plantation of trees at 10 samplings for the loss of one tree and that this plantation must be managed for 5 years.

Nepal Water Quality Guidelines for the Protection of Aquatic Ecosystems, 2064 BS (2008 AD)

These Guidelines set water quality standards for the protection of aquatic ecosystems. They are applicable to the Project because the Project has the potential to affect aquatic ecosystems.

Nepal Water Quality Guidelines for Irrigation Water, 2064 BS (2008 AD)

These Guidelines set water quality standards for irrigating fields. They are applicable to the Project because the Project may affect the quality of water used for irrigation.

Nepal Water Quality Guidelines for Aquaculture, 2064 BS (2008 AD)

These Guidelines set water quality standards for aquaculture. They are applicable to the Project because the Project may affect the quality of water used for aquaculture.

Nepal Water Quality Guidelines for Recreation, 2064 BS (2008 AD)

These Guidelines set water quality standards that can be used for recreational purpose. They are applicable to the Project because the Project may affect the quality of water used for recreation.

Procedural Guideline for the Use of Forest Land for National Priority Project with Standard 2076 (2019AD)

Article (3) of this guideline sets out that while doing a feasibility study for a development project by the concerned ministry, the “no national forest option” or “minimum forest loss option” shall be considered. It describes the need for an IEE/EIA, as per the EPR and EPA. The guideline emphasizes that, if a project is not covered by the EPR, there is still a need to prepare an EIA, along with an Environment Management Plan, if there is forest loss. The guideline mentions the compensatory plantation rate of 1:10 and the management of planted sites for 5 years, if trees are felled from national forest. The guideline also mentions land for land compensation for the permanently acquired national forest.

Community Forest Inventory Guidelines, 2062 BS (2005 AD)

These Guidelines detail the process and procedures for evaluating the forest stock and its harvesting potential in community forests. They are applicable to the Project because the Project was required to conduct a forest inventory and were employed in the field surveys and data analysis conducted during the EIA study.

National Health Care and Waste Management Guidelines, 2059 BS (2002 AD)

These Guidelines provide a minimum standard for safe and efficient waste management to protect public health and safety, provide a safer working environment, and minimize waste generation and the environmental impacts of waste treatment. They are applicable to the Project because the Project will generate waste.

Department of Electricity Development (DoED) Manuals 2058 BS (2001 AD)

Seven manuals have been prepared by the DoED to cover different components of the EIA, environmental management, and monitoring, such as the scoping document, public involvement in the EIA process, ToR, the environmental management plan, water quality monitoring plans and results, conducting public hearings, and addressing gender issues. These manuals are applicable to the Project because the Project is subject to DoED Regulation.

Community Forest Guidelines, 2058 BS (2001 AD)

These Guidelines establish processes and procedures to identify and build capacity within the community forest user groups, prepare community forest management plans, and implement community forest management plans. They are applicable to the Project because the Project will affect community forests.

Water Resources Strategy, 2058 BS (2002 AD)

This Strategy outlines social development and environmental sustainability principles related to sustainable management of watersheds and aquatic ecosystems. It is applicable to the Project because the Project may affect watersheds and aquatic ecosystems.

National Biodiversity Strategy and Action Plan, 2074–2080 BS (2014–2020 AD)

This Strategy refers to cross-sector coordination for biodiversity conservation for Protected Area conservation, the conducting of IEE/EIAs for development projects to avoid significant impacts on biodiversity, and the implementation of the provisions to minimize impacts. It is applicable to the Project because the Project will affect biodiversity.

Conservation Area Management Guideline, 2056 BS (2000 AD)

This Guideline provides a legal framework for the management of conservation areas. It is applicable to the Project because the Project will affect the Makalu Barun National Park.

Environmental Management Guidelines (Road), 2056 BS (1999 AD)

These Guidelines (prepared by the Department of Roads) ensure that environmental considerations are integrated into the project survey and design, tender documents, contract documents, project supervision, and monitoring. All new and road upgrade developments are mandated to comply with the guideline provisions to ensure that the road developments are environmentally sustainable. These Guidelines are applicable to the Project as the Construction Contractor will construct new access roads and upgrade some existing roads.

Forestry Sector EIA Guidelines, 2052 BS (1995 AD)

These Guidelines specify the EIA procedures to be followed while undertaking environmental studies that involve forest areas. They aim to facilitate the sustainable use of forest resources for socioeconomic 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 with the goal of conserving genetic resources and biodiversity. Although not a forestry sector project, these Guidelines are applicable to the Project because the Project will affect forest areas and require forest studies.

EIA Guidelines for Water Resource Sector, 2050 BS (1994 AD)

These Guidelines set out procedures for the following:

- Identification of positive and negative impacts of water resource over both short-term and long-term periods on natural and human environments

- Development of mitigation management and monitoring plans
- Public hearings and interaction with affected groups, non-governmental organizations (NGOs), donors, and relevant government agencies

These Guidelines are generally applicable to the Project because the Project will affect water resources.

National EIA Guidelines, 2050 BS (1993 AD)

These generic Guidelines include procedures for EIA scoping, ToR preparation, baseline environmental studies, information disclosure, public consultation, prediction and evaluation of impacts, mitigation prescriptions, monitoring, and EIA report preparation. These Guidelines are applicable because the Project triggers the requirement for the preparation of an EIA.

2.3.7 International Conventions and Agreements

United Nations Declaration on the Rights of Indigenous Peoples, 2063 BS (2007 AD)

This Declaration sets forth the individual and collective rights of indigenous people, as well as their right to culture, identity, language, employment, health, education, and other issues. It also emphasizes the rights of indigenous people to maintain and strengthen their own institutions, cultures, and traditions, and to pursue their development in keeping with their own needs and aspirations. It prohibits discrimination against indigenous people; promotes their full and effective participation in all matters that concern them; and upholds their right to remain distinct and pursue their own visions of economic and social development. This Declaration is applicable to the Project because the Project will affect indigenous peoples.

United Nations Framework Convention on Climate Change, 2049 BS (1992 AD)

This Convention sets an overall framework for intergovernmental efforts to tackle the challenges posed by climate change. It is applicable to the Project because the Project will generate greenhouse gas emissions.

Convention on Biodiversity, 2049 BS (1992 AD)

This Convention contains a series of far-reaching obligations related to the conservation of biological diversity and sustainable uses of its components. One of these obligations is the requirement for an environmental study. The purpose of an environmental study is to identify in advance the aspects of the project that are likely to have significant adverse effects on biological diversity at the genetic species and ecosystem level, and the steps to be taken to avoid or minimize significant adverse effects, ensuring that the proposed project complies with existing environmental legislation. This Convention is applicable to the Project because the Project will affect biodiversity.

Convention on Indigenous and Tribal Peoples (No.169) 2048 BS (1991 AD)

This Convention sets out the right of the indigenous and tribal people to decide their own priorities for development. For national development plans and programs, it mandates consultation with indigenous and tribal people in the formulation of the plans and programs. It also mandates the participation of indigenous and tribal people in the decision-making process and resettlement process, with full compensation of any resulting loss or injury. This Convention is applicable to the Project because the Project will affect indigenous people.

Convention on International Trade in Endangered Species of Wild Fauna and Flora, 2040 BS (1983 AD)

The objective of CITES is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. As part of the EIA, consideration is made of CITES species listed in

Appendices I, II, and III. Species listed within these appendices and identified within the project area must be evaluated to identify management measures, if required. This Convention is applicable to the Project because the Project will employ workers who could engage in activities prohibited by CITES.

2.3.8 Others Requirements

Nepal Vehicle Mass Emission Standard, 2069 BS (2012 AD)

This Standard addresses compliance with Type I to Type V tests for vehicles fueled with gasoline and diesel while importing vehicles for a project. It is applicable to the Project because the Project may import some construction vehicles.

National Ambient Air Quality Standards for Nepal, 2069 BS (2012 AD)

These Standards establish limits of ambient air quality parameters around construction sites. They are applicable to the Project because the Project will generate some construction and operation emissions.

National Ambient Sound Quality Standard, 2069 BS (2012 AD)

This Standard establishes noise levels for different land use categories and noise-generating equipment. It is applicable to the Project because the Project will use noise-generating equipment during both construction and operation phases.

Exhaust Emission Standards for Diesel Generating Sets, 2069 BS (2012 AD)

These Standards establish emission standards for exhaust emissions of diesel plants and generating sets. They are applicable to the Project because the Project will use diesel generating sets during construction and as emergency power during operations.

National Indoor Air Quality Standards, 2066 BS (2009 AD)

These Standards establish time-weighted (1~24 hour) standards for particulate matter (PM_{10}, $PM_{2.5}$), carbon monoxide (CO), and carbon dioxide (CO_2) for indoor environments. They are applicable to the Project because the Project will involve the construction and occupancy of some buildings.

National Drinking Water Quality Standards, 2063 BS (2006 AD)

These standards establish minimum requirements for the quality of drinking water in the project camps and construction sites and are, therefore, applicable to the Project.

Generic Standard Part I: Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters, 2058 BS (2001 AD)

This Standard establishes tolerance limits for effluent discharged into inland surface water. It is applicable to the Project because the Project will discharge effluents into inland surface water from wastewater treatment facilities at each of the work camps.

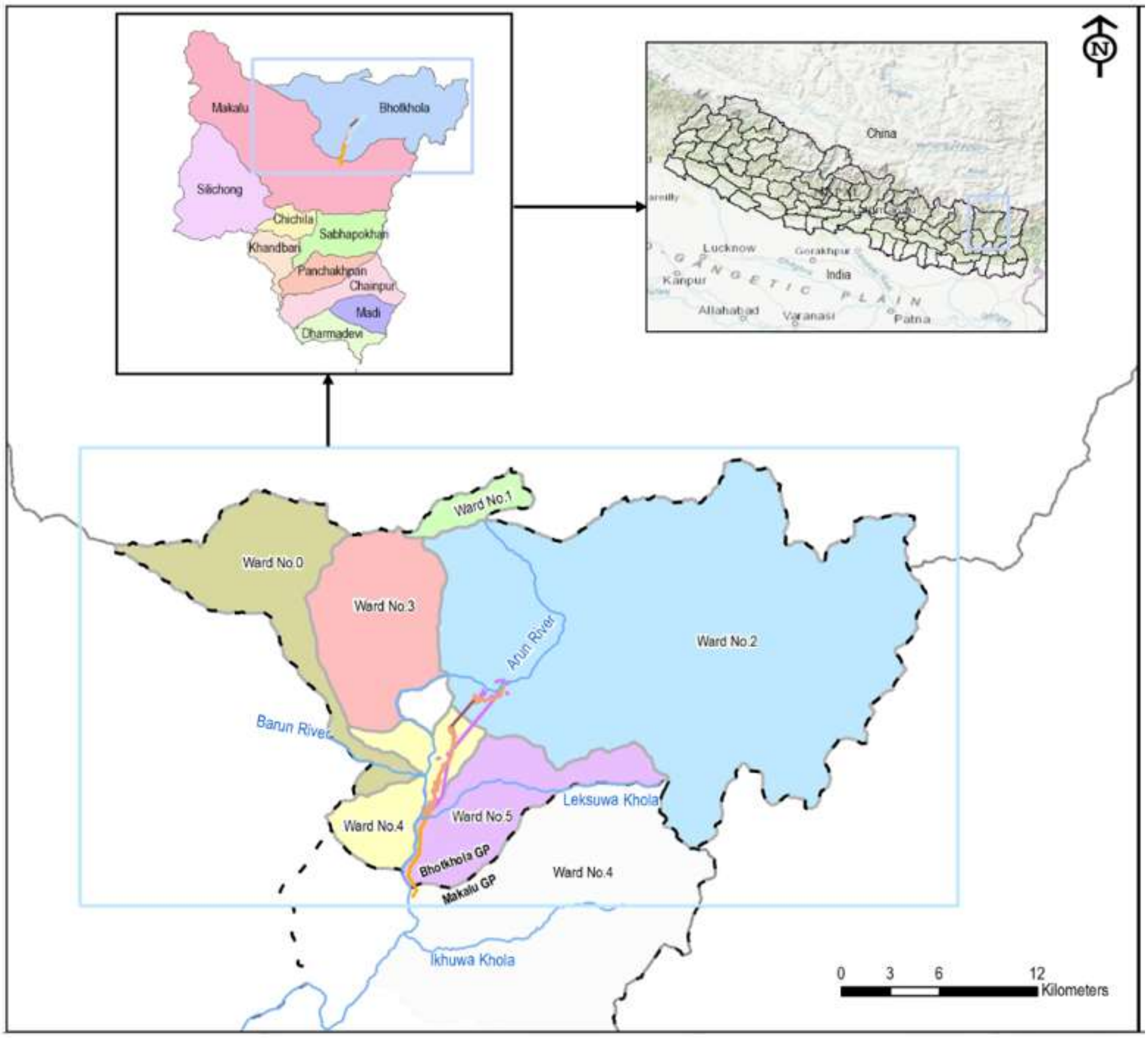
3. PROJECT DESCRIPTION AND DESIGN MEASURES

3.1 Project Location

The Project is located at longitude 87°20’00” to 87°30’00” East and latitude 27°38’24” to 27°48’09” North in Koshi Province, Sankhuwasabha District, in the Bhotkhola and Makalu rural municipalities of eastern Nepal. It lies in a straight line about 200 km east of Kathmandu, the capital of Nepal, and approximately 140 km north of the provincial capital, Biratnagar, about 40 km north of the district headquarters at Khandbari, and about 10 km south of the border with China (see ***Figure 1.1***). Most of the Arun River catchment upstream from the dam lies within China.

The proposed UAHEP dam site is located in a narrow gorge about 350 m upstream from the confluence of the Chepuwa Khola and the Arun River near the village of Rukma in Ward No. 2 of Bhotkhola Rural Municipality (***Figure 3.1***). The powerhouse lies near the village of Sibrun in Ward No. 4 of Bhotkhola Rural Municipality, about 750 m upstream from the confluence of Arun River with Leksuwa Khola. A short portion of the project access road and some temporary construction phase ancillary facilities lie within Ward No. 5. Ward No 3, while not hosting any of the Project infrastructure, is located between the dam and the tailrace outlet and is expected to experience reduced flow in the Arun River between the dam and the powerhouse once the Project is operational. The transmission line extends into Ward No. 4 of Makalu Rural Municipality. On the right bank of the Arun River, across the river from most of the UAHEP facilities, lies within the Makalu Barun National Park Buffer Zone.

Figure 3.1: Project Administrative Setting – Bhotkhola and Makalu Rural Municipality



3.2 Project Accessibility

This section describes the accessibility of the project site from within Nepal, as well as its accessibility from India for transporting equipment and materials.

3.2.1 Domestic Access

For construction workers, materials, and most equipment, the project site can be accessed from Kathmandu via the following options (***Figure 3.2***):

Vehicle Access

Vehicular access from Kathmandu to the project site is achieved by driving the following road segments:

- Kathmandu to Mithila – two-lane surfaced (asphalt) B.P. Highway (Nepal Highway [NH] 06) 201 km
- Mithila to Itahari – two-lane surfaced East-West Highway (NH 01) 164 km
- Itahari to Khandbari – two-laned surfaced Koshi Highway (NH 08) 152 km
- Khandbari to Num Bazar at the Arun River bridge – partially two-lane, partially surfaced Koshi Highway (NH 08) 49 km
- Num Bazaar to just north of Gola – currently under construction unsurfaced (compacted dirt) one-lane Koshi Highway (NH 08) 23 km. This is the current farthest extent of vehicle access to the project site and is difficult to use and often subject to landslides during the monsoon season.
- Koshi Highway to project site – current and future site access is described below:

  Current – from the Koshi Highway, hike across the Arun River using the existing footbridge and then approximately 0.5 km via trails to the proposed powerhouse site. Hike an additional approximately 15 km via trails to access the proposed headworks site.

  Future – the 21.6 km project access road (see Section 3.3) will be constructed, including a vehicular bridge across the Arun River, an approximately 2 km tunnel through a steep ridge, and another vehicular bridge over Chepuwa Khola) to provide vehicular access to the headworks sites.

This represents a total vehicular travel distance from Kathmandu to the project headworks of approximately 610 km, which includes about 517 km on improved surfaced highway, 49 km on partially surfaced road, 23 km on unsurfaced road, and then 21.6 km on the proposed project access road. The time to travel this distance by vehicle can vary significantly depending on road, traffic, and weather conditions, but will take two to three days.

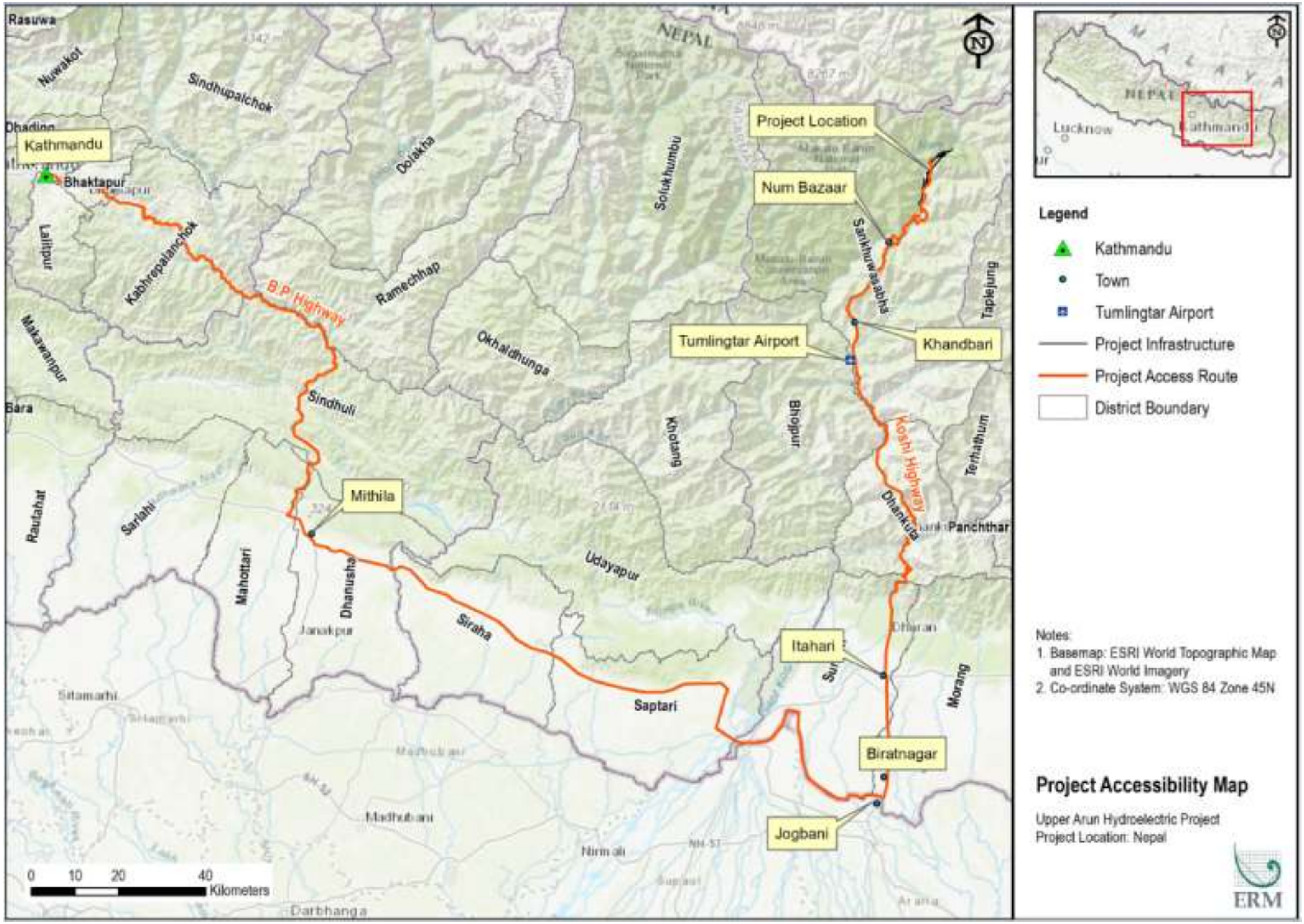
Airport Access

The nearest airport to the Project is Tumlingtar Airport (airport code TMI), which is located south of Khandbari. This small airport only accommodates domestic flights from a few airlines (e.g., Buddha Air, Yeti Airlines) with regular connections to Kathmandu and the provincial capital Biratnagar. From Tumlingtar Airport, it is approximately a 16 km drive along the Koshi Highway to Khandbari, and then an additional 72 km drive via the Koshi Highway to the project site, as described above (84 km total).

Helicopter Access

The project site is also accessible via helicopter from Tribhuvan International Airport (KTM) in Kathmandu. During construction and operations, helicopter landing pads will be designated within proposed workers’ camps near the powerhouse and headworks areas.

Figure 3.2: Project Accessibility Map



Railroad and Waterway Access

The Project is not near any railroads and the Arun River is not suitable for use as a commercial waterway, so neither of these methods can provide construction access to the project site.

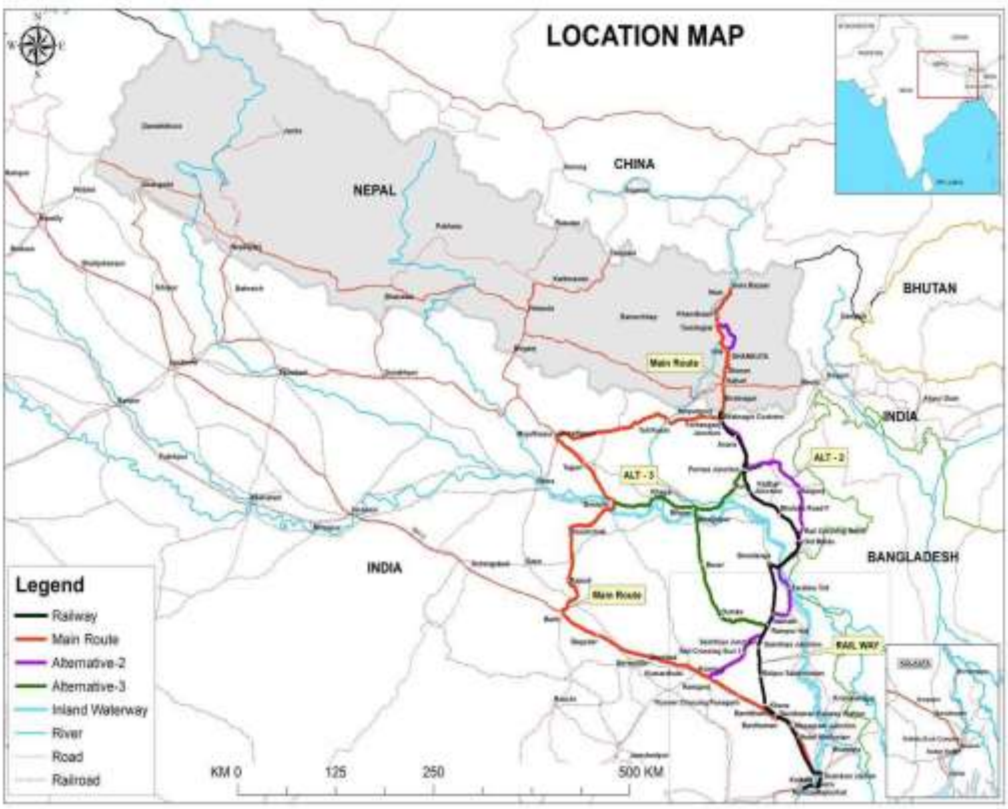
3.2.2 International Access

Nepal is a landlocked country, but has established an agreement with India for use of the Port of Kolkata for the import of construction equipment or materials that are not manufactured in Nepal or which cannot be flown into Nepal via commercial aircraft. CSPDR has determined that the Port of Kolkata has adequate facilities (e.g., cranes, tugboats, docks) to accommodate the needs of the Project (CSPDR, 2020). Since the Project is not accessible via railroad or waterway, cargo from the Port of Kolkata will need to be transported by truck, partially across difficult terrain, especially from Khandbari to the project site. As a result of road conditions, CSPDR concludes that only truck trailers less than 18 m in length can navigate these roads.

From the Port of Kolkata, trucks will follow one of three routes, ranging from 575 km to 1,020 km in length, to reach Jogbani near the Nepal border, depending on height restrictions and bridge load limits. From Jogbani, vehicular traffic will follow the Koshi Highway for 253 km from Biratnagar to the project site (***Figure 3.3***). The Koshi Highway rises from an approximate elevation of 68 m at Biratnagar to nearly 2,100 m at Deurali, and has steep gradients and sharp curves, especially north of Khandbari.

These cargo trucks will have to cross many bridges between the Port of Kolkata and the project site. CSPDR has reviewed these bridges and determined that all of the bridges along this route are designed to accommodate loads up to 80 tons capacity, but it is difficult to confirm their current condition and actual capacity. Some bridges may need to be strengthened to accommodate heavy loads, the need for which will be determined by the Construction Contractor.

Figure 3.3: International Access Routes



Source: CSPDR 2020, p. 422

At the current time, the road conditions do not allow transport of at least some of the project equipment coming from Kathmandu or India by truck after Num Bazaar/Arun-3 dam. The Nepal Department of Roads, however, is currently upgrading this section of the Koshi Highway and this work is expected to be completed by sometime in 2022, which is before UAHEP construction will begin. The Koshi Highway upgrade should ensure a minimum centerline curve radius of 15.5 m and a minimum road width of 6 m to support the UAHEP. CSPDR has allowed about NPR 89,250,000 (about US$750,000) in the project cost estimate for various potential bridge and road improvements.

3.3 Project Structures and Facilities

This section lists the salient features and briefly describes the major structures for the Project's three main components – the project access road, hydropower facility, and transmission line – their ancillary support facilities (e.g., workers' camps, infrastructure), and associated facilities. Although this project description reflects current project design, as with nearly all large capital projects, there will likely be changes that may be determined as the project design advances.

3.3.1 Project Access Road

The project access road will be 21.6 km long, within a 20 m wide RoW, providing access to both the project powerhouse and headworks, including a 2.03 km long tunnel between the villages of Namase and Rukma, and two bridges, one over the Arun River and one over Chepuwa Khola (***Figure 3.4***). The project access road will be a public road available for public use once construction is completed.

The project access road begins at the Koshi Highway about 2 km north of the village of Gola (see Section 3.2). The road crosses about 60 m of agricultural land to reach the proposed Arun River Bridge. Once over the Arun River and onto its east side (also referred to as the "left bank" of the river facing downstream), the road ascends up a steep forested slope through a series of switchbacks, passing the small settlement of Limbutar. It then gradually ascends passing through the village of Sibrun and north of the villages of Hema and Namase, where it again ascends steeply through a series of switchbacks to reach the southern tunnel portal. The road extends through a narrow (approximately 6 m wide) tunnel for 2.03 km emerging at the northern tunnel portal. The road then descends sharply through a series of switchbacks, remaining to the east of the village of Rukma, and continues to descend more gradually, eventually crossing the Chepuwa Khola Bridge and reaching the headworks site.

It should be noted that the WB still has concerns about the access road design, especially in terms of safety features and landslide risks. The assessment of access road-related impacts in this ESIA may need to be updated if the access road design is ultimately modified.

Features and Structures

Table 3.1 sets out the stations (i.e., distance in meters from the access road starting point) and elevations for key locations along the route.

Table 3.1: Project Access Road Locations, Chain Station, and Elevation

Location	Stations	Elevation (m asl)
Koshi Highway (start point)	0+000 m	1,097
Arun River Bridge	0+060 to 0+132 m	1,091
Sibrun Village	5+000 to 7+000 m	1,446–1,584
Namase Village	11+500 to 12+500 m	1,853–1,938
Tunnel	14+180 to 16+210 m	2,049–2,053
Chepuwa Khola Bridge	20+800 to 20+815 m	1,739
Headworks (end point)	21+650 m	1,687

Figure 3.4: Project Access Road Layout and Ancillary Facilities

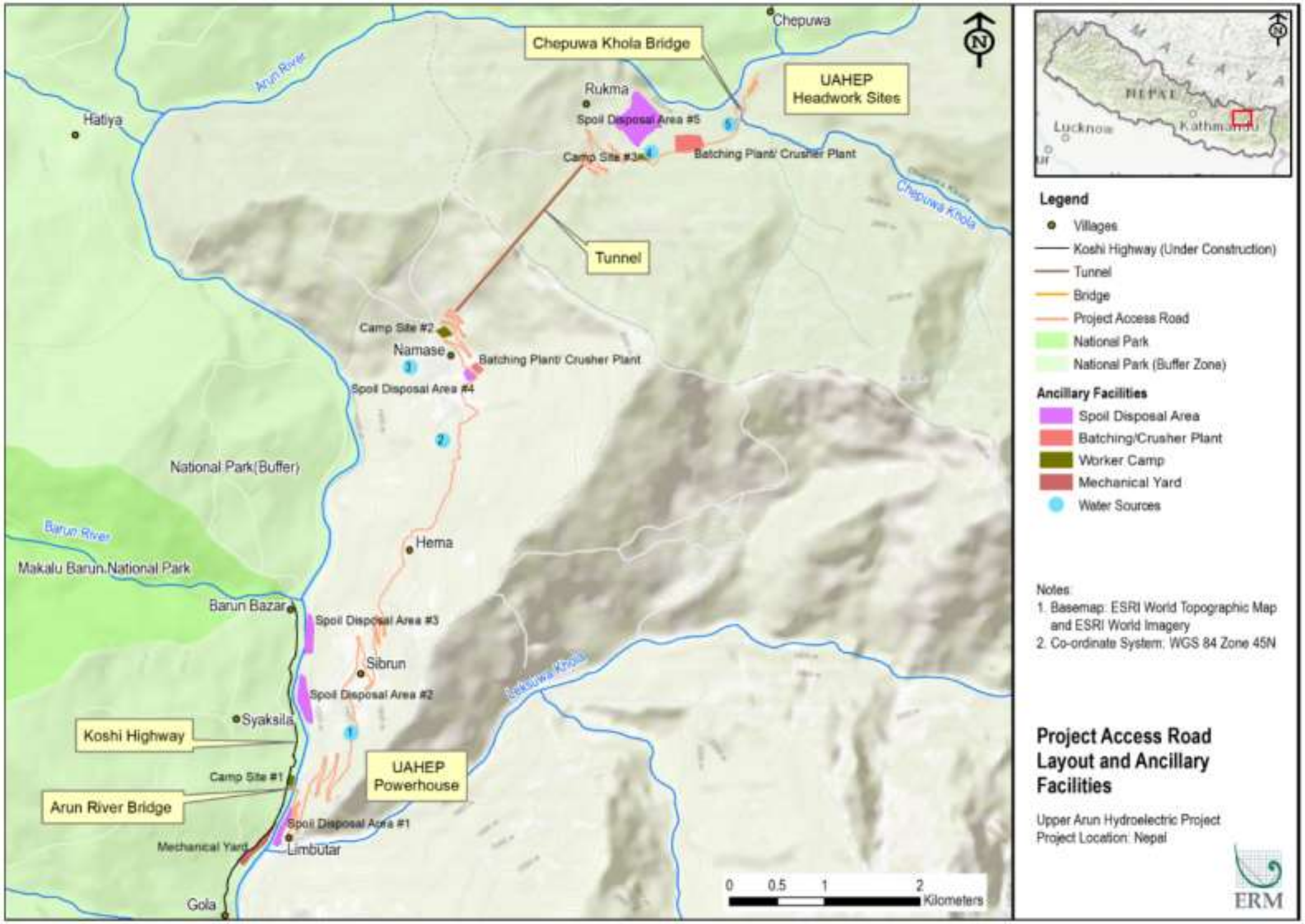


Table 3.2 presents the salient features of the project access road.

Table 3.2: Key Salient Features of the Project Access Road

Salient Features	Design Details
1. Road (Figure 3.5)	
Total length	21.65 km
Elevation range (start/high/finish)	Elevation 1,097 m to 2,053 m to 1,687 m
Design standard	Nepal Road Standards (2070) – Class IV
Design vehicle	2.5 m wide, 4.75 m high, 18.0 m long
Design speed	20 km/h
Number of lanes	1, with expanded shoulder for passing lanes
Lane (carriageway) width	4.5 m (expanded to 7 m in villages)
Shoulder width – minimum	0.75 on each side, paved
Total formation width	6.0 m
Road class	Class IV
Road type	Blacktop Road
Minimum horizontal radius	15 m
Maximum longitudinal gradient	4%
Maximum vertical gradient	10% (4% in switchbacks)
Minimum length of vertical curve	20 m
Maximum length at maximum vertical gradient	150 m
Lane widening at horizontal curves	Varies from 0.3 to 2.5 m depending on curve radius
Passing places	2 per km at 2.5 m wide x 30 m long
Stopping sight distance	30 m
Minimum junction radius at Koshi Highway	15 m
Design storm	Cross drains – 25 year storm/Side drains – 10 year storm
Right-of-way (RoW) width	30 m, except through the tunnel portion
Total RoW area	58.7 ha
2. Tunnel (Figure 3.6)	
Location and length	Station 14+180 to Station 16+210 for total of 2.03 km
Tunnel boring methods and distances - Cut and cover - New Austrian tunneling method - Total	 10.0 m 2,020 m 2,030 m
Tunnel lining	Steel fiber reinforced shotcrete and concrete lining in selected sections, anchored with rock bolts
Waterproof type	Wet system (partial waterproof)
Cross-section	Modified horseshoe section
Vertical grade	-1.0% ~ +1.0%
Vehicle vertical clearance	5.0 m
Number of lanes	1 lane in bi-direction
Lane (carriageway) width – standard	6.0 m (4.0 m carriageway with 1.0 m shoulders
Main tunnel section - Shoulder width - Max width - Max height	 1.0 m on each side of carriageway 9.06 m 7.43 m

Salient Features	Design Details
Widen tunnel section - Shoulder width - Max width - Max height	 2.0 m on each side of carriageway 11.08 m 7.94 m
Ventilation method	Mechanical jet-fan
3. Bridges	
Arun River Bridge (Figure 3.7)	
Location	27°40'30.28" N, 87°21'50.28" E
Type	Steel arch bridge – single span
Design load capacity	70 tonnes (1.5 factor of safety)
Total length of bridge	70.2 m
Total width of bridge	7.2 m
Width of carriageway	6.0 m
Width of footpath	0.5 m on each side of road
Type of bearings	Pot bearings
Type of abutment	RCC
Arun River design discharge	3,750 m^3/s
Bed level of Arun River at bridge	1,078.3 m
Flood level of Arun River at bridge	1,091.0 m
Design freeboard	3.0 m
Bottom (soffit) level of Bridge	1,094.0 m
Chepuwa Khola Bridge (Figure 3.8)	
Location	27°"4'21.5"" ', 87°"4'42.2"" E
Type	RCC bridge – single span
Design load capacity	70 tonnes (1.5 factor of safety)
Total length of bridge	15.0 m
Total width of bridge	7.2 m
Width of carriageway	6.0 m
Width of footpath	0.5 m on each side of road
Type of bearings	Neoprene pad bearings
Type of abutment	RCC
Chepuwa Khola design discharge	80 m^3/s
Bed Level of Chepuwa Khola at Bridge	1734.5 m
Flood Level of Chepuwa Khola at Bridge	1736.1 m
Design Freeboard above Flood Level	3.0 m
Bottom (Soffit) Level of Bridge	1739.1 m
Construction Duration	18–24 months from date of mobilization

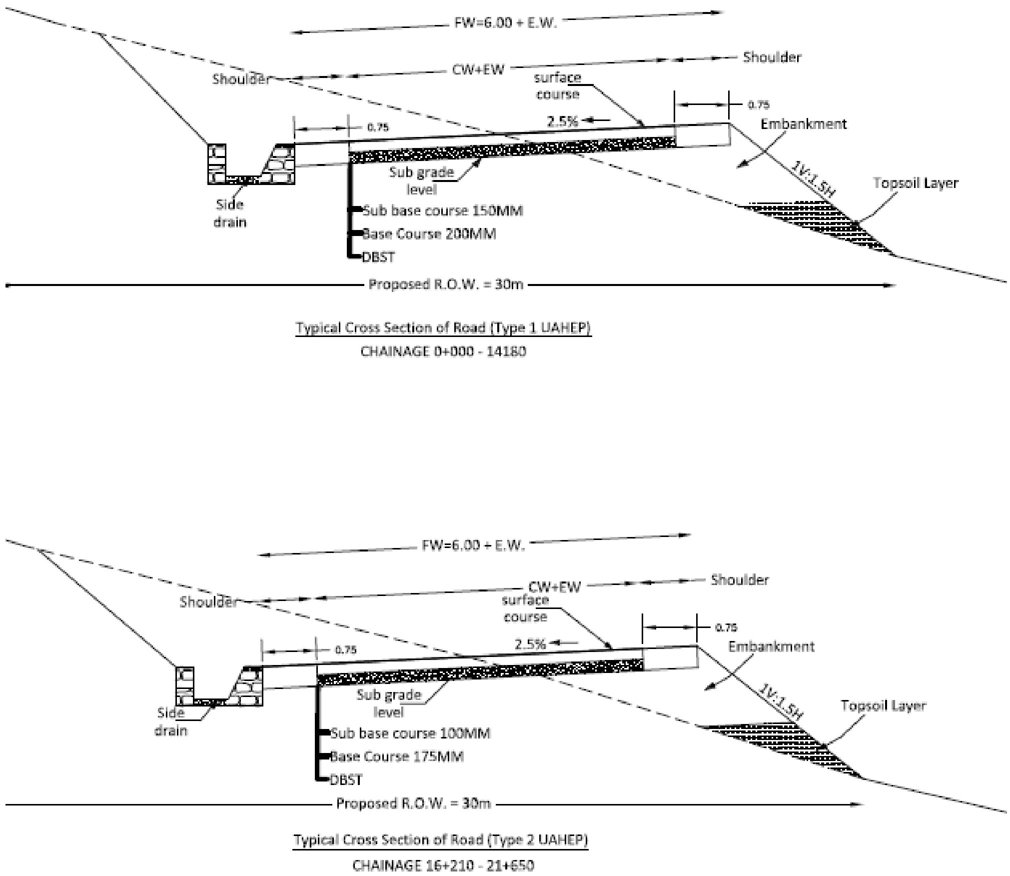
The road design includes cross-drainage in the form of culverts and causeways. Culverts are proposed at the location of natural swales/intermittent streams, and causeways are proposed for perennial streams and have been sized to pass monsoon season flows. Drains are proposed alongside the road to intercept surface drainage (***Figure 3.5***).

The access road will have several safety features, including:

- Covered side drains in villages
- Warning, traffic control, and informational signage
- Guard rails at critical points (e.g., sharp curves and drop-offs)

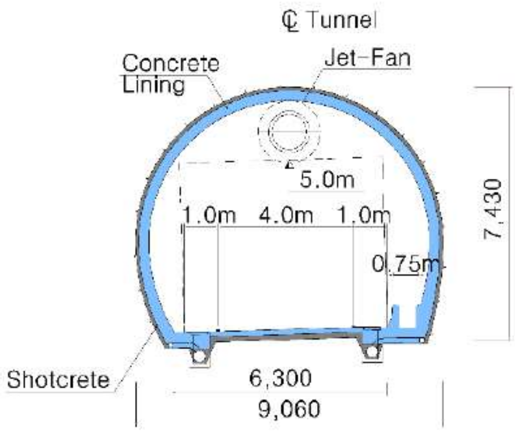
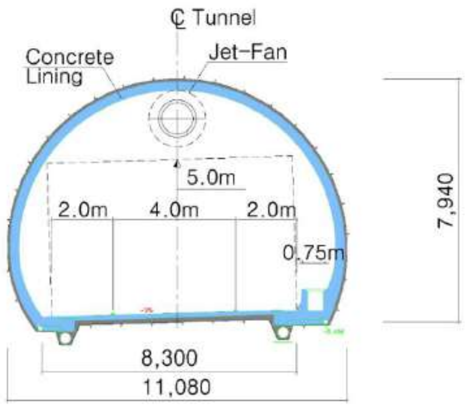
Figures 3.5, 3.6, 3.7, and ***3.8*** present typical road, tunnel, and bridge cross-sections or profiles.

Figure 3.5: Project Access Road Typical Cross-Section



Source: KEC 2019

Figure 3.6: Project Tunnel Typical Cross-Section

<table>
<tr><th>Main tunnel</th><th>Widennig tunnel</th></tr>
<tr><td>
</td><td>
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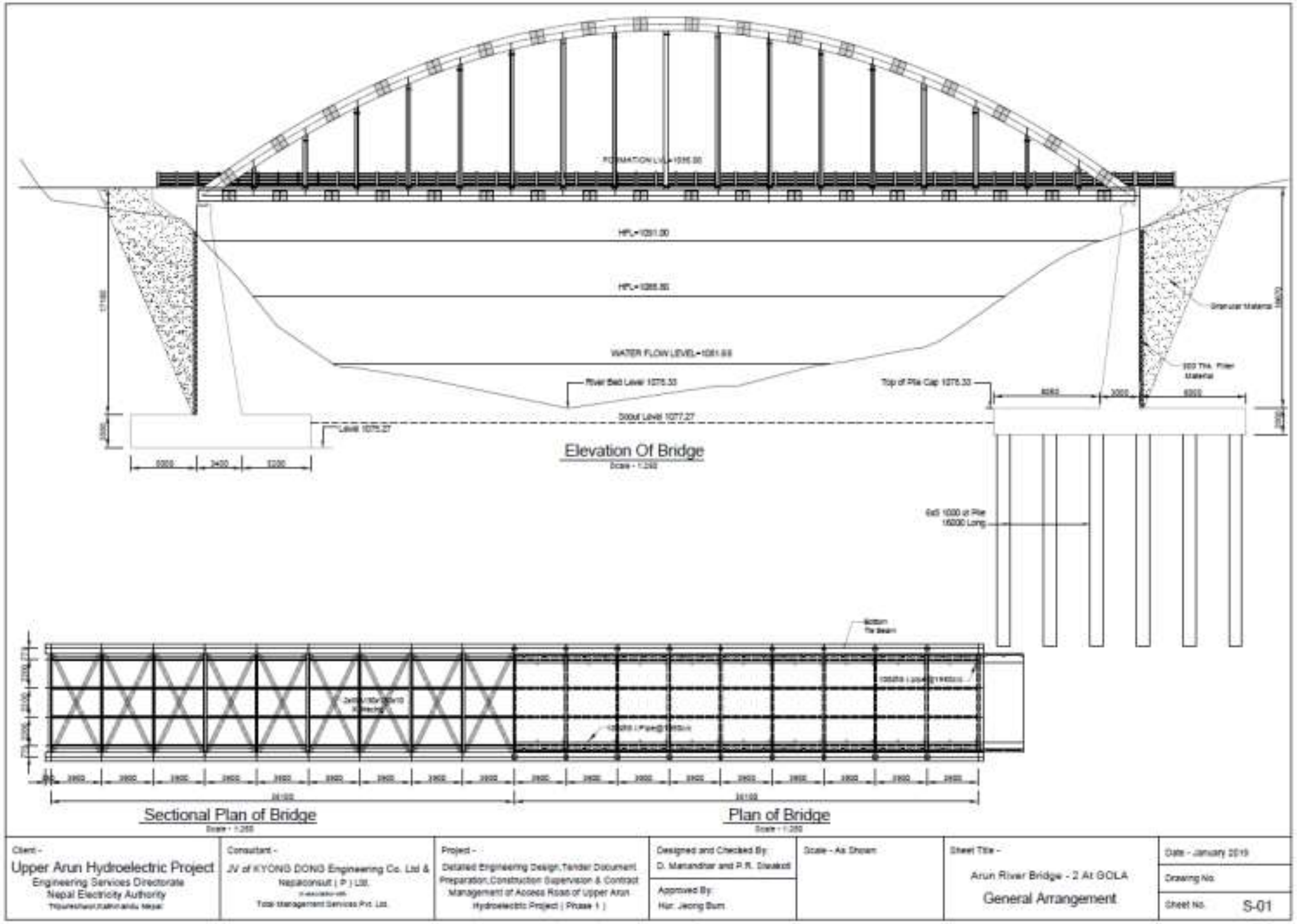
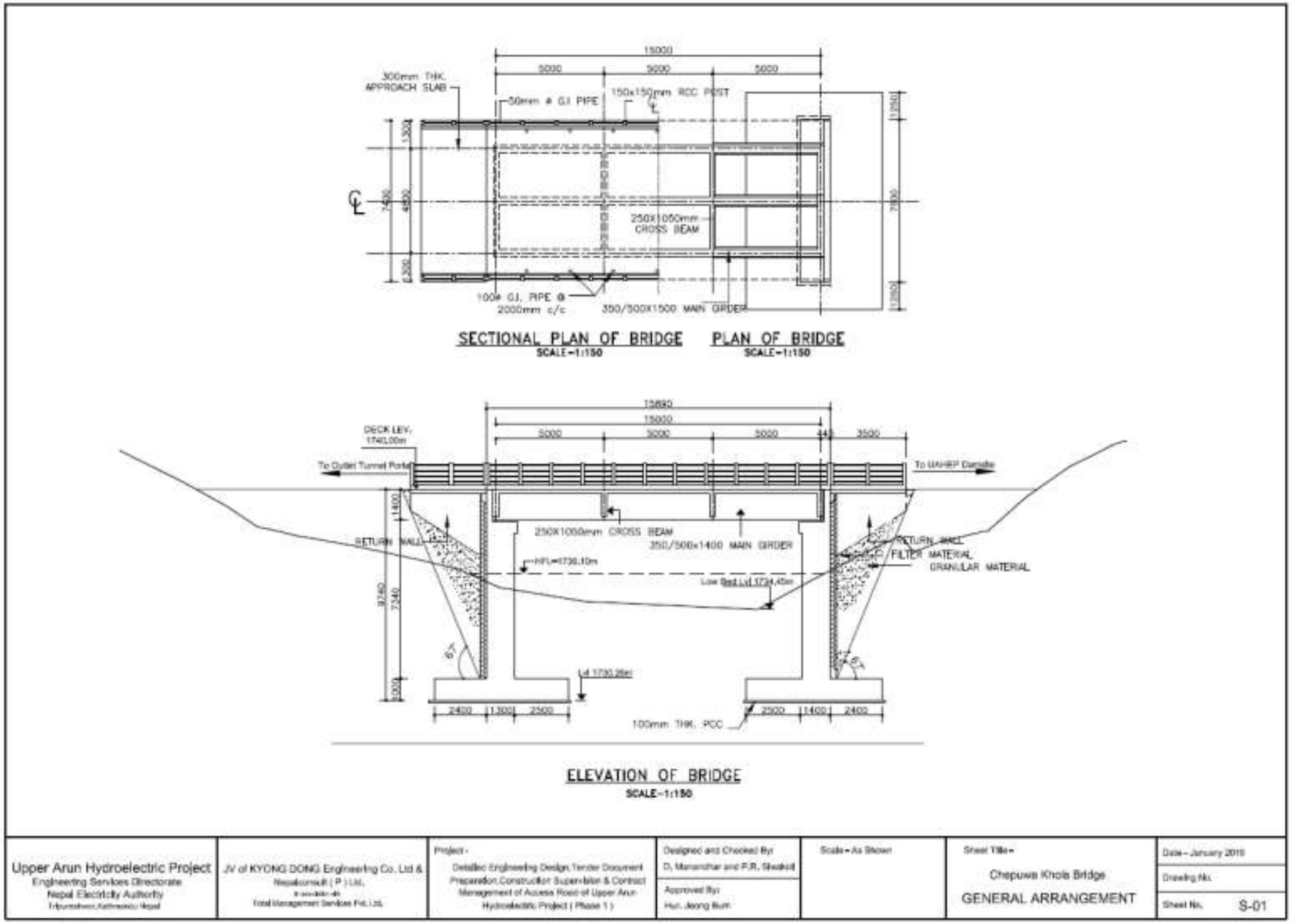
Source: KEC 2019

Figure 3.7: Arun River Bridge Drawing



Source: KEC 2019

Figure 3.8: Chepuwa Khola Bridge Drawing



Source: KEC 2019

Ancillary Facilities

Construction of the project access road will require various ancillary facilities, including supporting infrastructure, construction material sourcing, and spoil disposal (***Figure 3.4***).

Supporting Infrastructure

Table 3.3 identifies the supporting infrastructure (e.g., contractor's camps, processing equipment, helipad) required. As indicated in ***Table 3.3***, ancillary facilities for project access road construction are located in the same locations as facilities proposed for hydropower facility construction, to the extent possible, in order to minimize land acquisition and environmental (e.g., forest clearing) impacts.

Table 3.3: Project Access Road Infrastructure Facilities

Infrastructure Facilities	Location (Station)	Area (ha)	Capacity (# of workers)	Co-Located with Hydropower Facilities
Road Contractor's camps	Camp 1 – 0+000 Camp 2 – 12+000 Camp 3 – 17+000	3.4 1.3 0.7	85 75 70	Yes No Yes
Crusher/batching plant	Near Camp 2 Near Camp 3	0.90.9	NA	No Yes

Three contractor's camps are proposed to support the estimated 230 workers required to construct the project access road. Camps 1, 2, and 3 will exist for the duration of road construction with full camp facilities (***Table 3.4***). Two of these contractor's camps (Camps 1 and 3) are located at sites that are also planned for hydropower ancillary facilities. Camp 2 is not co-located with a proposed hydropower facility. This camp is located at the south tunnel portal and is intended to support tunnel construction. It is located adjacent to an area that will be disturbed by access road construction.

Two crusher/batching plants are proposed, one on each end of the tunnel to support tunnel construction. These crusher/batching plants will only be operated during regular working hours (7am–8pm) so as to minimize noise impacts for both the contractor's camps and the nearby villages of Namase and Rukma, respectively (see Section 7.1.9 on noise impacts for more details).

Table 3.4: Project Access Road Contractor Camp Facilities

Work Camp Facilities	Facility Requirements
Total area	Varies from 0.7 to 3.4 ha (see ***Table 3.3***)
Accommodation	Comply with the *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009)
Sanitation facilities	Comply with the *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009)
Canteen/cooking/laundry facilities	Comply with the *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009); food to be purchased locally to the extent possible
Medical facilities	Onsite first aid room to address non-emergency incidents to comply with the Workers' Accommodation: Processes and Standards (IFC and EBRD 2009)
Security	Unarmed security to comply with *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009) and WB Good Practice Note *Assessing and Managing the Risks and Impacts of the Use of Security Personnel* (World Bank 2018a); perimeter fencing to be installed around each work camp
Initial access	Camp 1 – Koshi Highway and helipad Camp 2 – helipad Camp 3 – helipad
Power	One 500 kW diesel generator at each camp
Fuel storage	One 3,000-liter diesel storage tank for vehicle refueling at each camp One 1,000-liter diesel storage tank for onsite diesel generator at each camp
Water	Source – onsite well or stream (downstream from any community use) Treatment – water treatment system Potable Water – 25 liters/person/day Other Water – 50 liters/person/day
Wastewater	Package wastewater treatment plant or community septic system at each camp
Stormwater	Provision shall be made at the sites for surface water drainage systems, sumps to collect sediment, and safe non-erosive discharge points into a natural swale or stream.
Solid waste	All solid waste will be collected at the camps, transported by covered truck, and disposed of at the Khandbari municipal landfill.

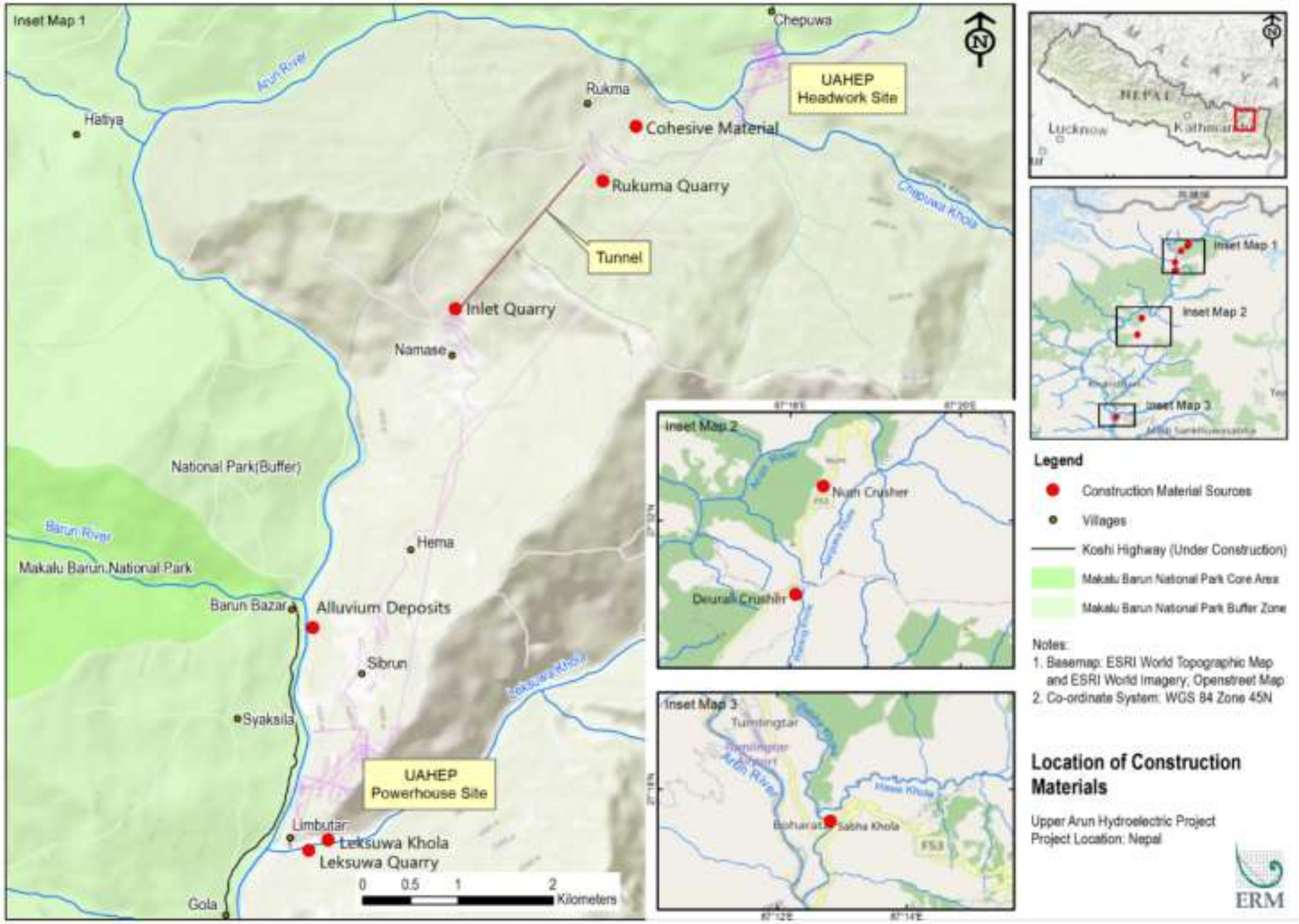
Construction Material Sourcing

Construction of the project access road will require sourcing of construction materials (e.g., various types/sizes of aggregate) in the local area as it would be cost-prohibitive to haul this material long distances. There are no existing quarries in the local area, so the Project will need to source construction materials from government-owned land or from private-owned land with the agreement of the property owner.

The Road Engineer has confirmed the availability of sufficient quantities of hard rock; material suitable for the road subbase, base, and surface dressing; aggregate and coarse sand for concrete; and cohesive material in the greater project area. The following are the acceptable sources from an environmental and social perspective, identified by the Road Engineer (see ***Figure 3.9***):

- Hard rock – Rukma, Inlet, and Leksuwa Quarries – all within project site
- Road subbase course – offsite from the existing commercial Num or Deurali Crushers, or a similar facility
- Road base course – offsite approximately 200 m upstream from the Sabha Khola bridge, which is located south of Khandbari
- Road surface dressing – offsite approximately 200 m upstream from the Sabha Khola bridge
- Aggregate for concrete – Leksuwa Khola, adjacent to project site (no in-stream removal allowed)
- Coarse sand for concrete – sand deposit in Arun River adjacent to the location of proposed Road Contractor’s Spoil Disposal Area #3
- Cohesive material – clay deposit at location of proposed Road Contractor’s Spoil Disposal Area #5

Figure 3.9: Locations of Sources of Construction Material



Source: KEC 2019

The Road Construction Contractor will be responsible for the sourcing of construction materials, with the approval of UAHEL in accordance with a Construction Material Sourcing Management Plan (see Appendix C, ESMP). This Management Plan will reference the requirements of WB ESF ESS 3 (Resource Efficiency and Pollution Prevention and Management) and use the following siting criteria for determining final sources construction material:

- Avoid community or religious forest land
- Avoid any forest clearing, or obtain any necessary forest clearing permits from the Department of Forests
- Avoid any physical displacement
- Obtain approval from the government or private land owner to remove the construction material
- Maintain a minimum 100 m buffer from any residences
- Maintain a minimum 100 m buffer from cultural heritage sites
- Avoid MBNP core and associated buffer land
- Avoid disturbance or creation of unstable slopes
- Avoid any in-water removal of construction material
- Avoid materials sourced using child or forced labor

Road construction will require water both to make concrete and for dust suppression. The quantities of water needed are estimated as follows:

- Bridge works – 330 m^3 (330,000 liters) for concrete production, or an average of less than approximately 0.1 liter/second over a one-year period. Water will be sourced from the Arun River and Chepuwa Khola, which have ample supply to meet this demand.
- Road works – 470 m^3 (470,000 liters) for concrete production for concrete production, or an average of less than approximately 0.1 liter/second over a one-year period. Water will only be obtained from the five water sources listed in ***Table 3.5***. The road works will also require substantial water for dust suppression. Assuming spraying the entire length/width of the road construction area 75 times during the dry season, the water demand would be an additional 425,000 m^3 per year, which equates to an average of approximately 27 liters/second, or 0.3 m^3/s during the approximately 6 month-long dry season. Water for dust suppression will only be sourced from the Arun River, Laju Khola, and Chepuwa Khola.
- Tunnel works – 330 m^3 (330,000 liters) for concrete production, which equates to an average of less than 0.1 liters/second over a one-year period. The water will be sourced from Kabo Khola for the south portal and Laju Khola for the north portal.

Water will only be sourced downstream from any community taps and micro-hydropower plant intakes via a pump to a water tanker. ***Table 3.5*** and ***Figure 3.4*** identify the approved streams with sufficient flow that the Road Construction Contractor will use.

Table 3.5: Project Access Road Water Sources

SN	Water Source	Location	Estimated Dry and Wet Season Flow
1	Arun River	At various locations	54,100–615,000 liters/second
2	Gurunsisa Khola	Road Station 10+700	1.92–2.72 liters/second
3	Kabo Khola	Road Station 11+600 (below micro-hydropower station)	6.8–9.0 liters/second

SN	Water Source	Location	Estimated Dry and Wet Season Flow
4	Laju Khola	Road Station 19+050	170–200 liters/second
5	Chepuwa Khola	Road Station 20+800	406–3,210 liters/second

Spoil Disposal Area

Construction of the project access road is estimated to generate approximately 1,625,000 m^3 of spoil (e.g., soil and rock). Sidecasting (i.e., the practice of dumping excavated material off the downslope side of the road RoW) will be prohibited. Therefore, all spoil needs to be reused for beneficial purposes or disposed of in technically, environmentally, and socially acceptable locations such as naturally stable or engineered spoil dumps. The Road Engineer identified several potential locations as technically suitable for spoil disposal (KEC 2019, ***Table 3.6*** and ***Figure 3.4***).

Table 3.6: Project Access Road Potential Spoil Disposal Sites

SN	Area (m^2)	Volume (m^3)	Land Ownership	Remarks
1	30,600	183,600	Public/private	Located within hydropower facility area of disturbance
2	45,000	270,000	Public/private	Co-located with proposed hydropower facility Spoil Disposal Area #3
3	23,000	92,000	Public/private	Co-located with proposed hydropower facility Spoil Disposal Area #4
4	19,300	77,300	Private	Located south of Namase
5	12,600	75,700	Private	Spoil to be used to construct platform upon which to construct Road Contractor’s Camp #2
6	35,900	35,900	Private	Spoil to be used to construct platform upon which to construct Road Contractor’s Camp #3 and mechanical yard and Hydropower Contractor’s Camp #1
7	70,200	339,100	Private	Co-located with proposed hydropower facility Spoil Disposal Area #1
Total	236,600	1,074,000		

3.3.2 Hydropower Facility

The UAHEP hydropower facility will involve the construction of a dam on the Arun River, which will form a 20.1 hectare reservoir, a headrace tunnel for transporting water from the reservoir, and a powerhouse with an installed capacity of 1,040 MW, which will use the transported water to generate an estimated 4,549.57 GWh of energy on an average annual basis. The Project will create a 16.45 km long diversion reach along the Arun River (i.e., the river segment between the dam and the powerhouse, where some river flow will be diverted, after which this diverted flow will be returned to the river from the powerhouse tailrace).

Hydropower Features and Structures

Figure 3.10 and ***Table 3.7*** presents the salient features of the UAHEP (CSPDR 2020).

Table 3.7: Salient Features of the Hydropower Facility

Salient Features	Design Details
Project Location	Longitude 87°20'00" to 87°30'00" East Latitude 27°38'24" to 27°48'09" North Koshi Province, Sankhuwasabha District, Bhotkhola Rural Municipality, Nepal
Power Generation	
Rated capacity	1,063.36 MW
Total installed capacity	1,040 MW plus 2.36 MW from the Eco-flow Power Station
Firm capacity	697 MW
Rated head	508.3 m
Annual average energy output	4,549.57 GWh
Plant factor	49.5%
Hydrology	
Catchment area (above the dam)	25,700 km^2
Length of flow series	39 years
Annual average runoff	6.85 billion m^3
Annual average flow	217 m^3/s
Annual average suspended sediment load	13.81 x 10^6 t
Annual average sediment bed load	2.43 x 10^6 t
Probable maximum flood (PMF)	4,990 m^3/s at dam site / 6,060 m^3/s at powerhouse
Glacial lake outburst flood (GLOF)	7,576 m^3/s at dam site / 8,478 m^3/s at powerhouse
Reservoir	
Maximum water level elevation	1,650.0 m
Full supply water level (FSL) elevation	1,640.0 m
Minimum operating level (MOL) during normal operations	1,625.0 m
MOL during sediment flushing operations	1,601.0 m
Reservoir surface area at FSL	0.201 km^2 or 20.1 ha
Reservoir length	2.1 km
Reservoir depth (max/average)	68 m/25 m
Total reservoir storage volume at FSL	5.07 million m^3
Peaking pondage (live storage)	2.41 million m^3
Storage under MOL	2.66 million m^3
Pondage factor (live storage/annual runoff volume)	0.035%
Water utilization rate	53%
Main Structures	
Dam	
Dam type	Concrete gravity dam
Foundation rock mass	Slightly weathered and fresh gneiss
Total height from foundation	100 m
Dam crest elevation	1,653 m
Minimum foundation level	1,553 m

Salient Features	Design Details
Dam length at dam crest	183 m
Dam width at dam crest level	10 m
Downstream face slope ratio	1.0/0.8 (V:H)
Diversion Tunnel	
Design flood	257 m^3/s
Section type	Inverted D-shape
Length of tunnel	490.41 m
Dimension(W×H)	7 m × 8 m
Upstream Cofferdam	
Type	Earth-rock overflow cofferdam
Crest elevation	1,586.0 m
Height	12 m
Downstream Cofferdam	
Type	Earth-rock overflow cofferdam
Crest elevation	1,568.0 m
Height	5 m
Flood and Sediment Discharge Facilities	
Low-level Outlet	
Number of low-level outlets	4
Sill elevation	1,590 m
Size of the orifice	6 x 6 m
Maximum discharge capacity at GLOF	3,633 m^3/s
Energy dissipation	Plunge pool
Service gate type	Radial gate
Mid-level Outlet	
Number of low-level outlets	2
Sill elevation	1,596 m
Size of the orifice	6 x 6 m
Maximum discharge capacity at FSL	1,691 m^3/s
Energy dissipation	Plunge pool
Service gate type	Radial gate
Surface Spillway	
Type	Free overflow
Crest elevation	1,640 m
Length	77 m
Maximum discharge capacity at GLOF	5,015 m^3/s
Energy dissipation	Plunge pool
Sediment Bypass Tunnel (SBT)	
Type	Pressurized tunnel
Length of SBT	1,321.5 m
Width x height of tunnel	9 m x 10.8 to ~ 14 m
Design discharge capacity	815 m^3/s

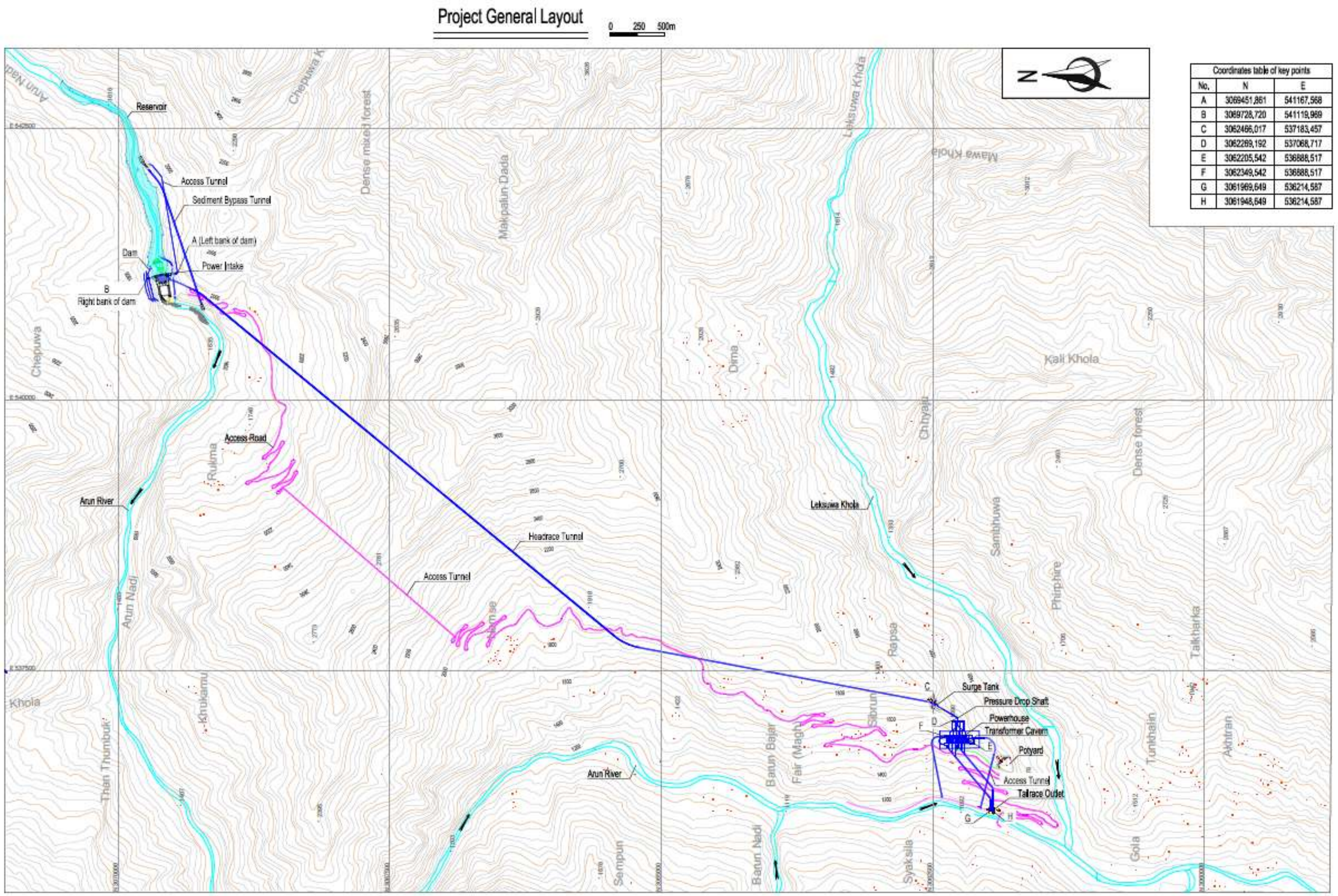
Salient Features	Design Details
Lining	Concrete
Project Waterways	
Rated discharge	235.44 m^3/s
Intake type	Dam Integrated Intake
Sill elevation of side channel	1,622.80 to 1,625.0 m
Low Pressure Steel-lined Conduit	
Diameter	8.4 m
Length	108 m
Center elevation	1,611 m
Flow velocity	4.29 m/s
Low Pressure Headrace Tunnel	
Type	Concrete lined
Length	8,362 m
Section net diameter	8.4 m
Flow velocity	4.29 m/s
Surge Tank	
Type	Open type with restricted orifice
Inner diameter	20 m
Diameter of restricted orifice	4.3 m
Maximum upsurge	1,671.56 m
Maximum down surge	1,587.84 m
Top elevation	1,674.5 m
Bottom elevation	1,584.0 m
Pressure Drop Shaft	
Type	Concrete lined
Length	558 m
Section diameter	7.3 m
Elevation	1,095.0 m ~ 1,577.8 m
Main High Pressure Headrace Tunnel	
Type	Steel lined
Length	39 m
Diameter	6.0 m
Centre elevation	1,095 m
Branch High Pressure Headrace Tunnel	
Number and type	10 Steel lined
Length	31~69 m
Diameter	4.2 m, 3.5 m, 2.5 m
Centre elevation	1,095 m
Branch Tailrace Tunnel	
Number and type	6 Concrete Lined
Length	127 m ~161 m

Salient Features	Design Details
Dimension (W x H)	3.80 m x 6.53 m
Sill elevation	1,084.85 m ~1,085.0 m
Powerhouse	
Type	Underground
Powerhouse cavern size	230.1 × 25.7 × 59.4 m (L × W × H).
Transformer and gas insulated switchgear (GIS) cavern size	238.2 × 16.7 × 37.2 m (L × W × H)
Units	6 Pelton turbines and 3-phase synchronous generators
Installed elevation	1,095 m
No. of main transformers	19
Main Tailrace Tunnel	
Number and type	2 Concrete lined
Section type	Inverted D-shape
Length	602/605 m
Dimension (W x H)	9.0 m x 7.20 m
Sill elevation	1,084.2 m ~ 1,084.8 m
Tailrace Outlet	
Number and section type	2 Inverted D-shape
Size of the orifice	9.0 m x 7.20 m
Plane dimension	15.0 m x 6.5 m
Sill elevation	1,084.2 m
Top elevation	1,098.1 m
GLOF tail water elevation	1,097.0 m
E&M Equipment	
Turbine	
No.	6 set
Unit Capacity	173.33 MW
Rated speed	250 r/min
Rated head	508.26 m
Rated flow	39.24 m^3/s
Generator	
No.	6 set
Generator capacity	213 MVA
Power factor	0.85
Rated Voltage	15.75 kV
Construction Period	
Total construction period from mobilization	60 months
Project Cost	
Total static project cost (CAPEX)	1,377.31 million US$
Economic Indicators	
Static cost per kW	1,324 US$/kW
Economic internal rate of return	16.5%
Net present value	576 million US$

Salient Features	Design Details
Benefit/cost ratio	1.8

Source: CSPDR 2020

Figure 3.10: General Layout Plan of the UAHEP



NOTES:

1. Modified Universal Transverse Mercator(MUTM) is used as the coordinate system.
2. Mean Sea Level is used as the elevation datum.
3. Structure dimensions are in centimeters and elevations are in meters.

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The following sections describes the key project features, including the headworks area, the waterway (e.g., headrace tunnel), and powerhouse area.

UAHEP Headworks Area

The headworks area is located approximately 350 m upstream from the confluence of Chepuwa Khola with the Arun River, near the villages of Rukma (on the left bank) and Chepuwa (on the right bank) and about 14 river kilometers (10 km direct line distance) downstream from the China border. The Arun River in this location flows through a narrow gorge (***Figure 3.11***). The headworks area includes the dam, reservoir, diversion tunnel, and the sediment bypass tunnel (SBT), as shown in ***Figure 3.12***. Each of these structures are described briefly below, as well as proposed downstream riverbank protection measures.

UAHEP Dam

The dam will be a 91m high roller-compacted concrete (RCC) gravity dam, with a crest elevation of 1,644 m and a length at the crest of 184 m. This dam is considered a “large dam” by the definition of the International Commission on Large Dams (ICOLD), which includes all dams over 15 m in height. The project reservoir’s full supply level (FSL) is at elevation 1,640 m, with a maximum flood level of 1,641.4 m, which reflects a glacial lake outburst flood (GLOF) of 7,576 m^3/s. The dam is designed to pass this GLOF flow of 7,576 m^3/s, which is greater than the probable maximum flood (4,990 m^3/s).

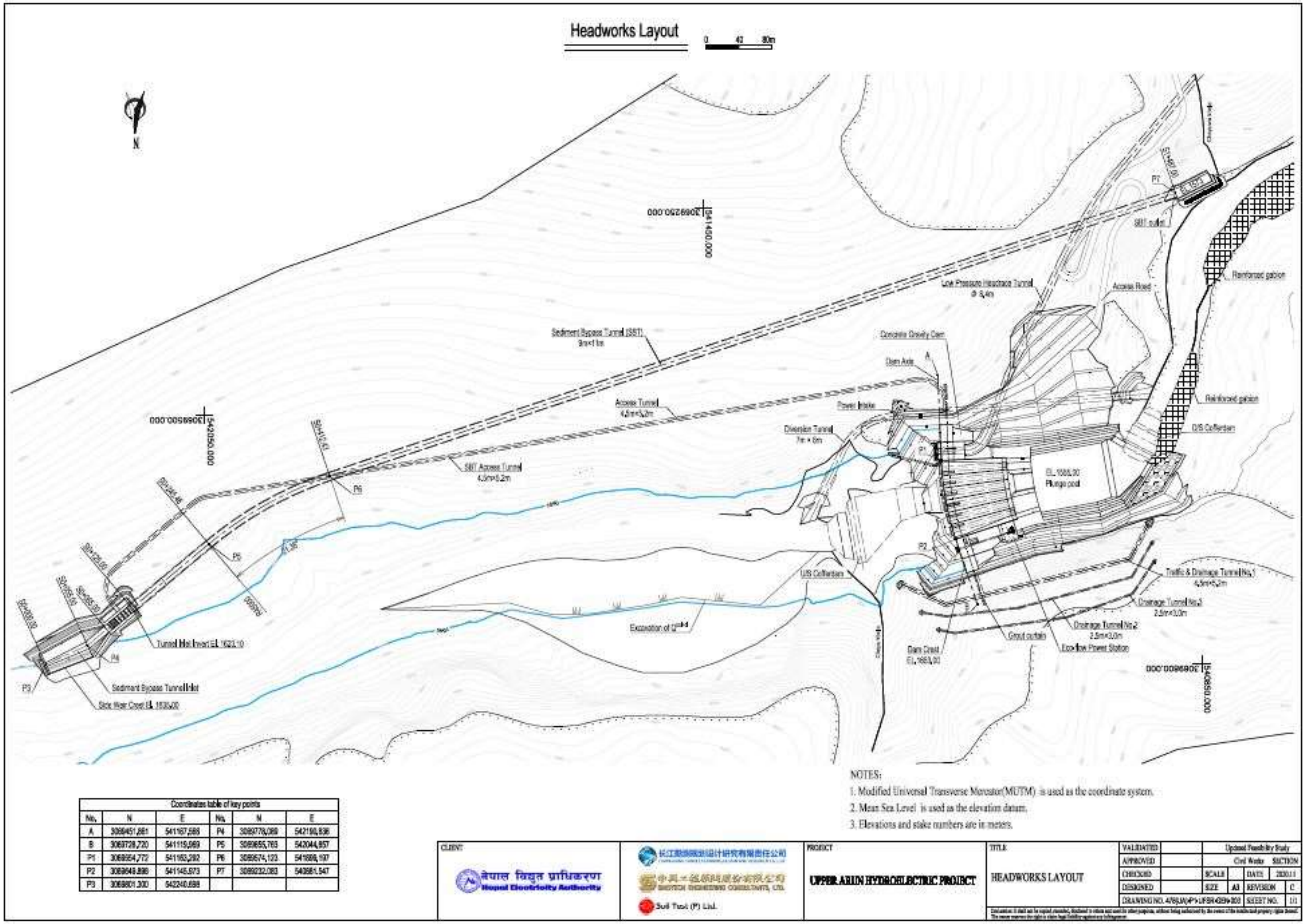
The dam is divided into 10 sections, from left to right (***Figure 3.13***):

- A left bank non-overflow section (Section No. 1)
- A power intake section (Section No. 2)
- Six spillway sections (Sections No. 3–8)
- An ecological flow power station section (Section No. 9)
- A right bank non-overflow section (Section No. 10)

Figure 3.11: Photograph of Dam Setting*

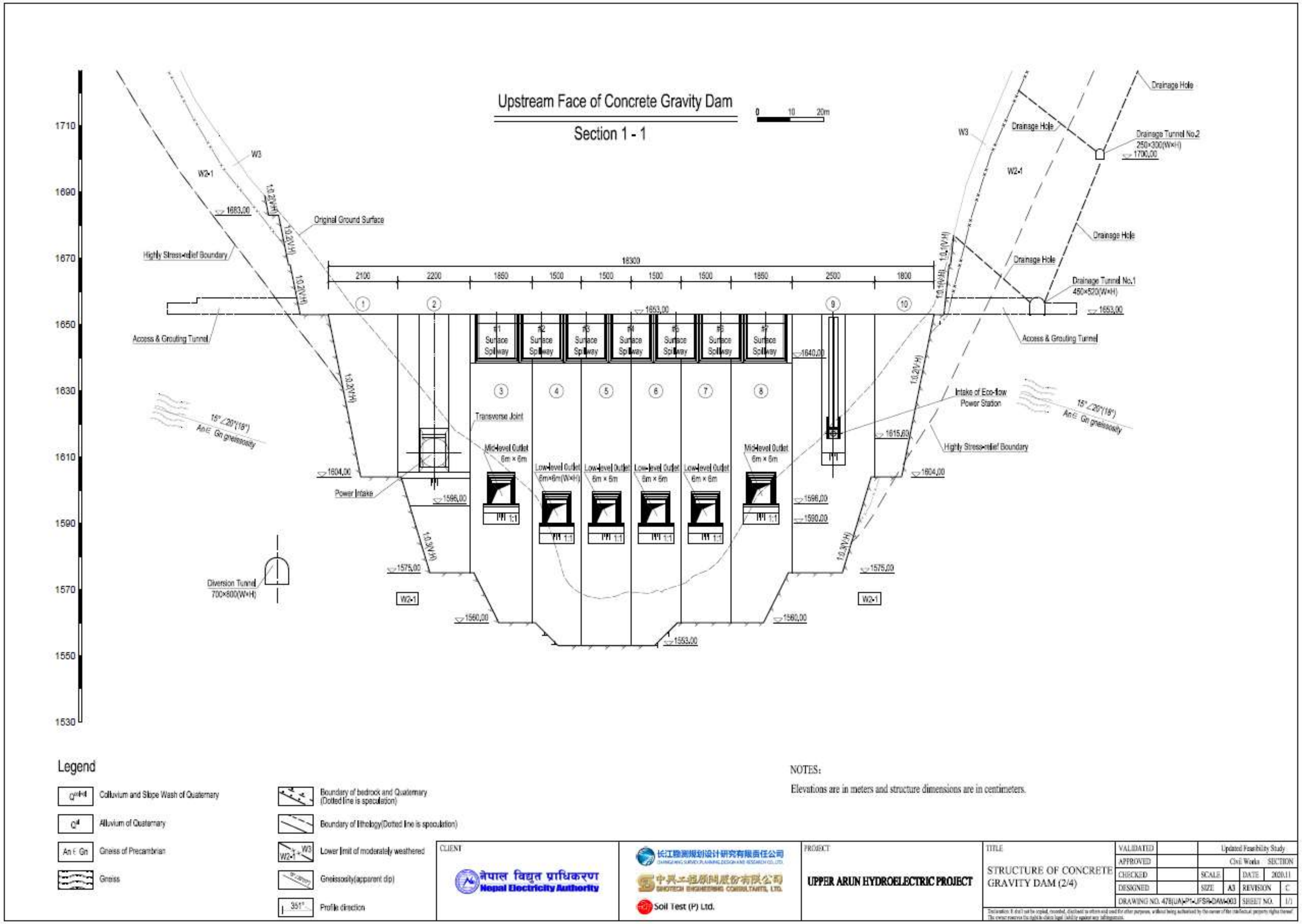
*View looking upstream with Chepuwa Khola on the left (i.e., river’s right bank when looking downstream)

Figure 3.12: Layout of the Headworks



Coordinates table of key points					
No.	N	E	No.	N	E
A	3069451,861	541167,588	P4	3069778,089	542190,836
B	3069729,720	541119,069	P5	3069655,763	542044,857
P1	3069554,772	541163,292	P6	3069674,123	541699,197
P2	3069648.896	541145.973	P7	3069232.083	540881.547
P3	3069801.300	542240.698			

Figure 3.13: Dam Cross-Section



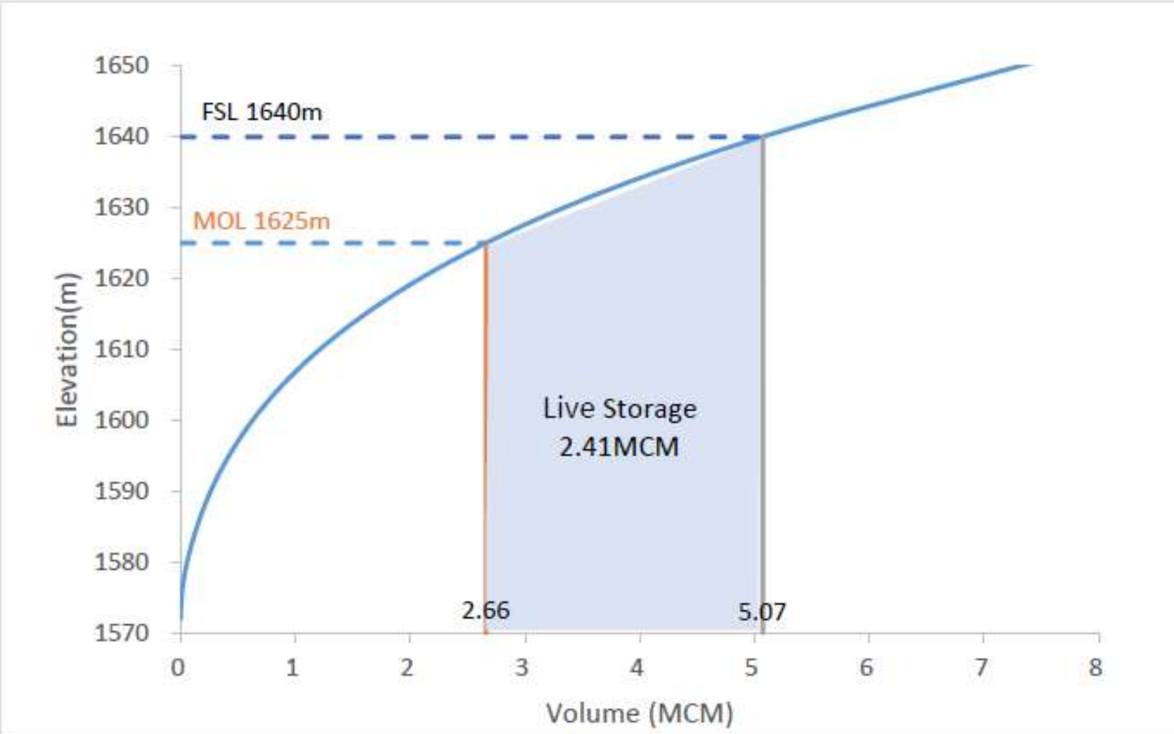
Eco-Flow Power Station

To take advantage of the energy potential of the Project's required environmental flow, an eco-flow power station is proposed at the toe of dam sections No.2 and No.3. The power station will contain horizontal Francis turbine units with a design flow equaling the required environmental flow of 5.41 m³/s. The eco-flow power station will have an installed capacity of 2.36 MW, and is estimated to generate 18.57 GWh of annual average energy.

Reservoir

The dam will form an approximately 2.1 km long reservoir with a surface area of 20.1 ha, gross storage of 5.07 million m³ at FSL and live storage of 2.41 million m³, which will provide storage to support the peaking operation (***Figure 3.14***).

Figure 3.14: Reservoir Elevation – Storage Capacity Curve



Because of the relatively high river flows and relatively small storage volume of the reservoir combined with typical winter air temperatures and peaking operations, there is minimal possibility of large scale freezing of the reservoir. The reservoir is located in a river valley underlain with relatively impermeable rock, so water losses due to leakage from the reservoir are expected to be negligible. Given the relatively small surface area of the reservoir and short average residence time (6.5 hours based on average flow), water losses due to increased evaporation are also expected to be negligible.

Diversion Tunnel and Cofferdams

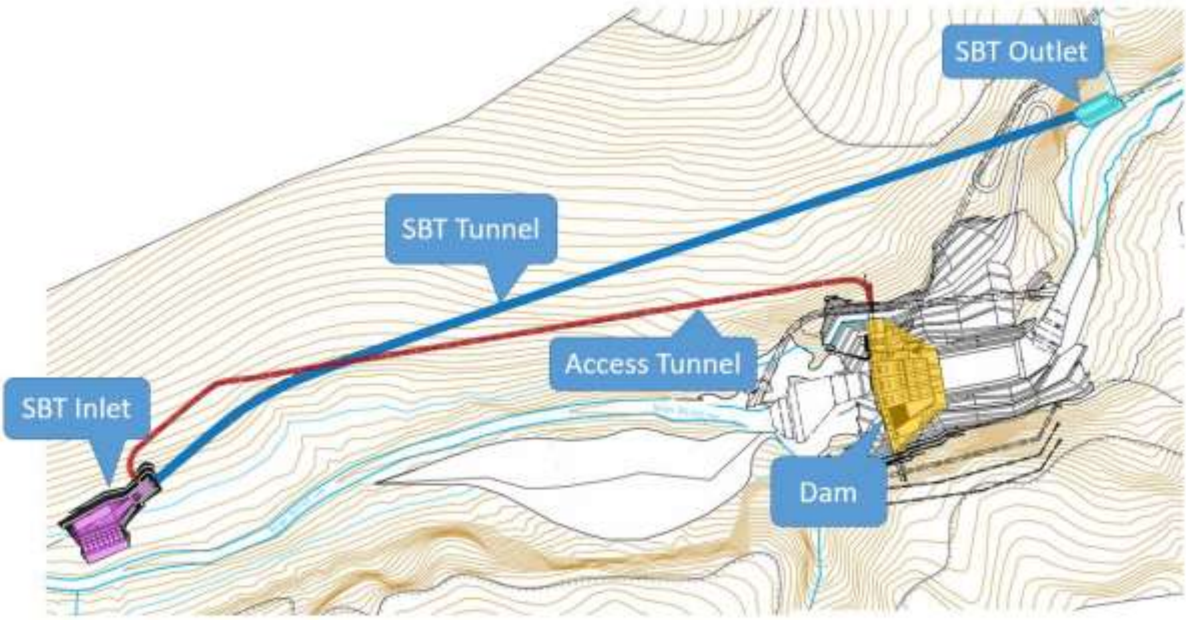
During construction, river flow must be diverted around the dam. UAHEL proposes a 490.4 m long diversion tunnel with a longitudinal slope of 2.85%. Energy dissipation using reinforced concrete slabs anchored by rock bolts will be used to prevent scouring and protect the outlet channel.

An upstream cofferdam, which will be filled with rock spoil and covered in RCC, will be used to divert river flow into the diversion tunnel. Similarly, there will be a downstream cofferdam designed to direct the diversion tunnel discharge back into the natural rock channel. This downstream cofferdam will consist of rock spoil materials protected by cast-in-situ concrete on the upstream side and reinforced gabions and large rocks on the downstream side.

Sediment Bypass Tunnel

The sediment bypass tunnel (SBT) is intended to divert a portion (up to 815 m^3/s) of large monsoon flows in the Arun River, which typically carry large sediment loads, around the dam to reduce sediment deposition within the reservoir and minimize sediment from entering the headrace tunnel, where it could cause abrasion of the turbine blades in the powerhouse. The SBT will be located on the left bank of the Arun River, with its inlet approximately 1.1 km upstream from the dam, and its outlet approximately 500 m downstream from the dam, with a total length of approximately 1.3 km (***Figure 3.15***). The SBT inlet includes a flow guide structure to preferentially divert higher sediment content water from the deeper portions of the reservoir. More detail on SBT operations is provided in Section 3.6.2.

Figure 3.15: Sediment Bypass Tunnel Layout

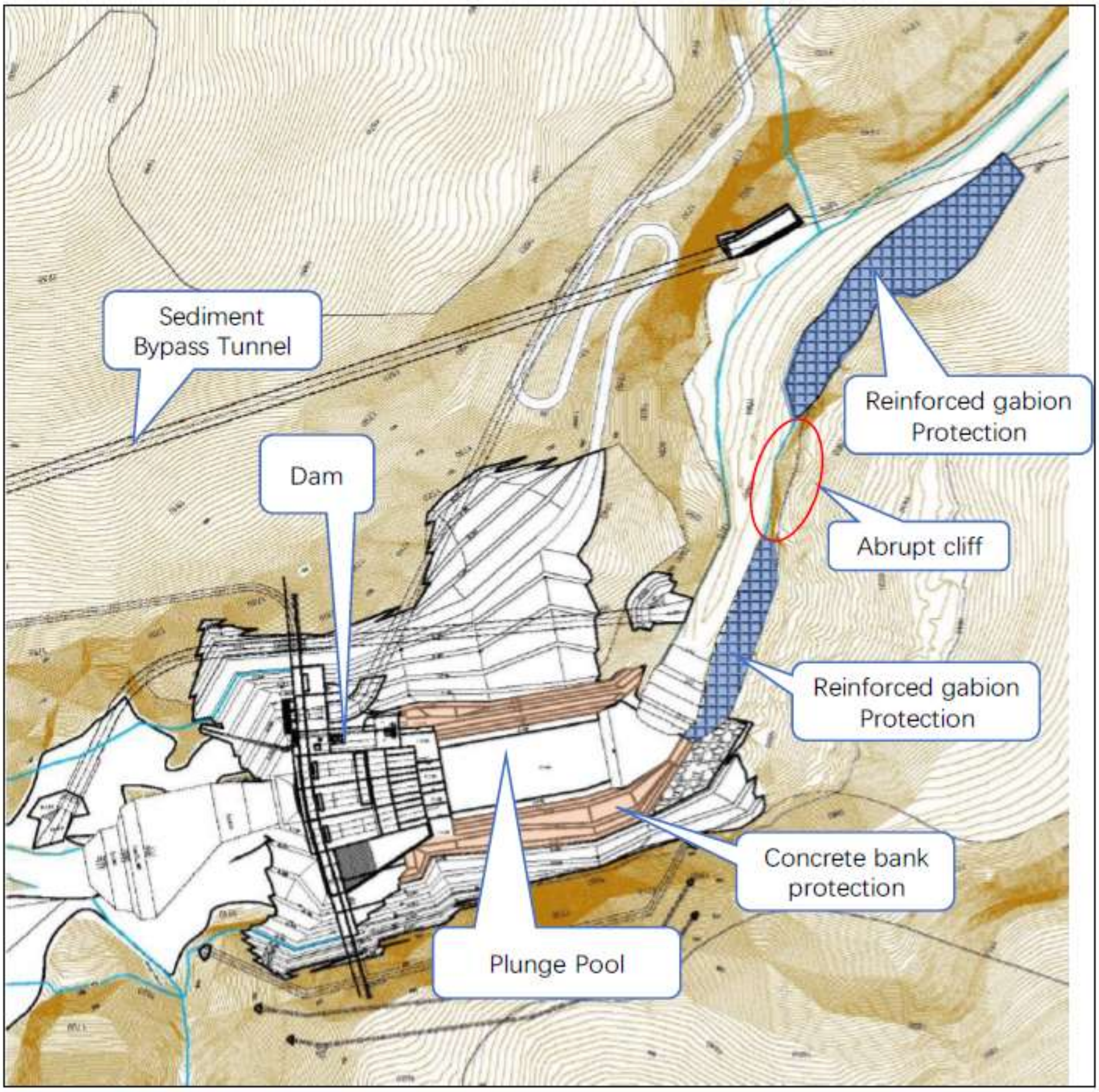


Source: CSPDR 2020

Downstream Riverbank Protection

Under high flow conditions, water released from the low level outlet (LLO) gates and flowing out of the plunge pool at the base of the dam will need to flow to the left to follow the river channel and discharge from the SBT. This flow has the potential to affect the opposite riverbank. This situation creates the potential for erosion along the right bank of the river. CSPDR proposes to install reinforced gabion baskets along 180 m of the right bank downstream from the plunge pool and about 220 m of the right bank near the SBT outlet to protect the riverbank from erosion in these areas (***Figure 3.16***).

Figure 3.16: Downstream Riverbank Protection Measures



UAHEP Waterway

The waterway includes the structures involved in diverting river flow from the reservoir to the powerhouse. In this case, the waterway consists of the following structures (see ***Figures 3.10*** and ***3.17***), with the various tunnels being at a depth of 30 to 1,315 m below the ground surface:

- An intake structure, with a sill elevation of 1,606.8 m and a top elevation of 1,644.0 m, equipped with a trash rack to prevent debris from entering the waterway and potentially damaging the turbines
- A 108 m long low pressure steel lined conduit
- A 8,226 m long low pressure headrace tunnel, which will include a gravel trap
- A 90.5 m high surge tank with a net diameter of 20.0 m
- A 136 m long low pressure headrace tunnel
- A 558 m long pressure draft shaft with a net diameter of 7.3 m

- A high pressure headrace tunnel

UAHEP Powerhouse Area

The powerhouse area includes the powerhouse, transformers, switchyard (also referred to as the “potyard”), and tailrace tunnel/outlet (***Figure 3.17*** and ***3.18***). Each of these are described briefly below.

Powerhouse

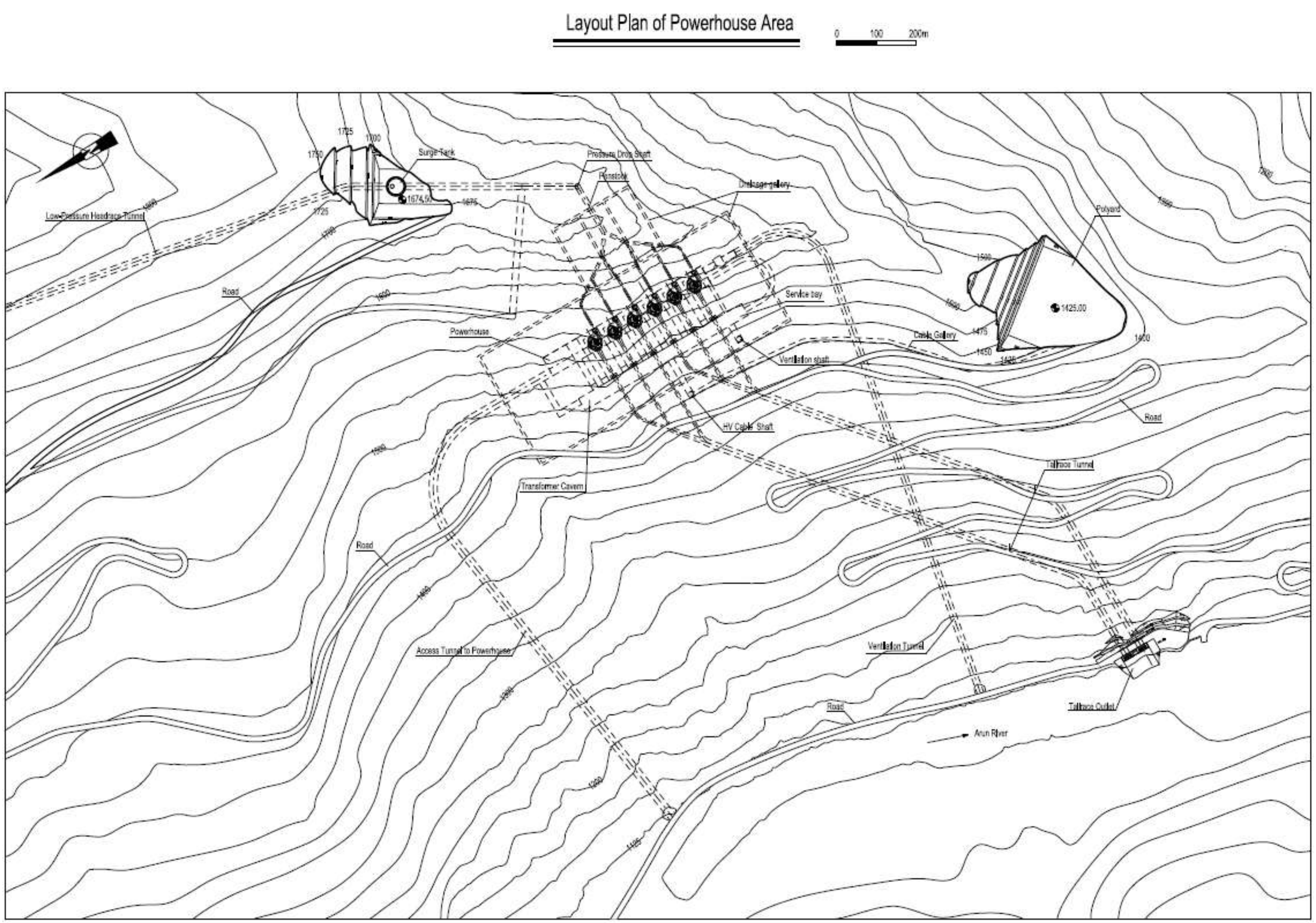
The powerhouse will be in an underground cavern with an excavation dimension of 230 m × 25.7 m × 59.4 m (L×W×H). The powerhouse will include four floors, including a generator floor, a busbar floor, a turbine floor, and a valve floor. It will contain six vertical shaft Pelton turbine-generator units, each with an installed capacity of 173.33 MW.

An access tunnel originating about 600 m upstream from the tailrace outlet, with a total length of 741 m, and net dimensions of 9 m in height x 9 m in width will provide access to the cavern.

Transformer Cavern

The transformer cavern will be adjacent to the powerhouse canyon, but with 41 m of separation. The cavern will have dimensions of 238 m × 16.7 m × 37.2 m (L×W×H). The transformer cavern is divided into a service bay section and a transformer section from left to right. The transformer section will be divided into two floors, including the transformer floor and the gas insulated switchgear (GIS) floor. Eighteen single-phase transformers and one backup single-phase transformer will be arranged on the downstream side of the transformer floor, and the transportation access of the transformer will be arranged on the upstream side. A fireproof wall is proposed around the service transformer, and the backup transformer will be arranged on the right side of the transformer floor. The oil spill containment structure, intended to capture accidental spills of transformer oil, will be arranged below the backup transformer, and the oil storage pit below each service transformer will connect to the oil spill containment basin by a drain pipe.

Figure 3.17: Layout Plan of Powerhouse Area



NOTES:

1. Modified Universal Transverse Mercator(MUTM) is used as the coordinate system in this drawing.
2. Mean Sea Level (India) is used as the elevation datum in this drawing.
3. Strucure dimensions are in centimeters and elevations are in meters.

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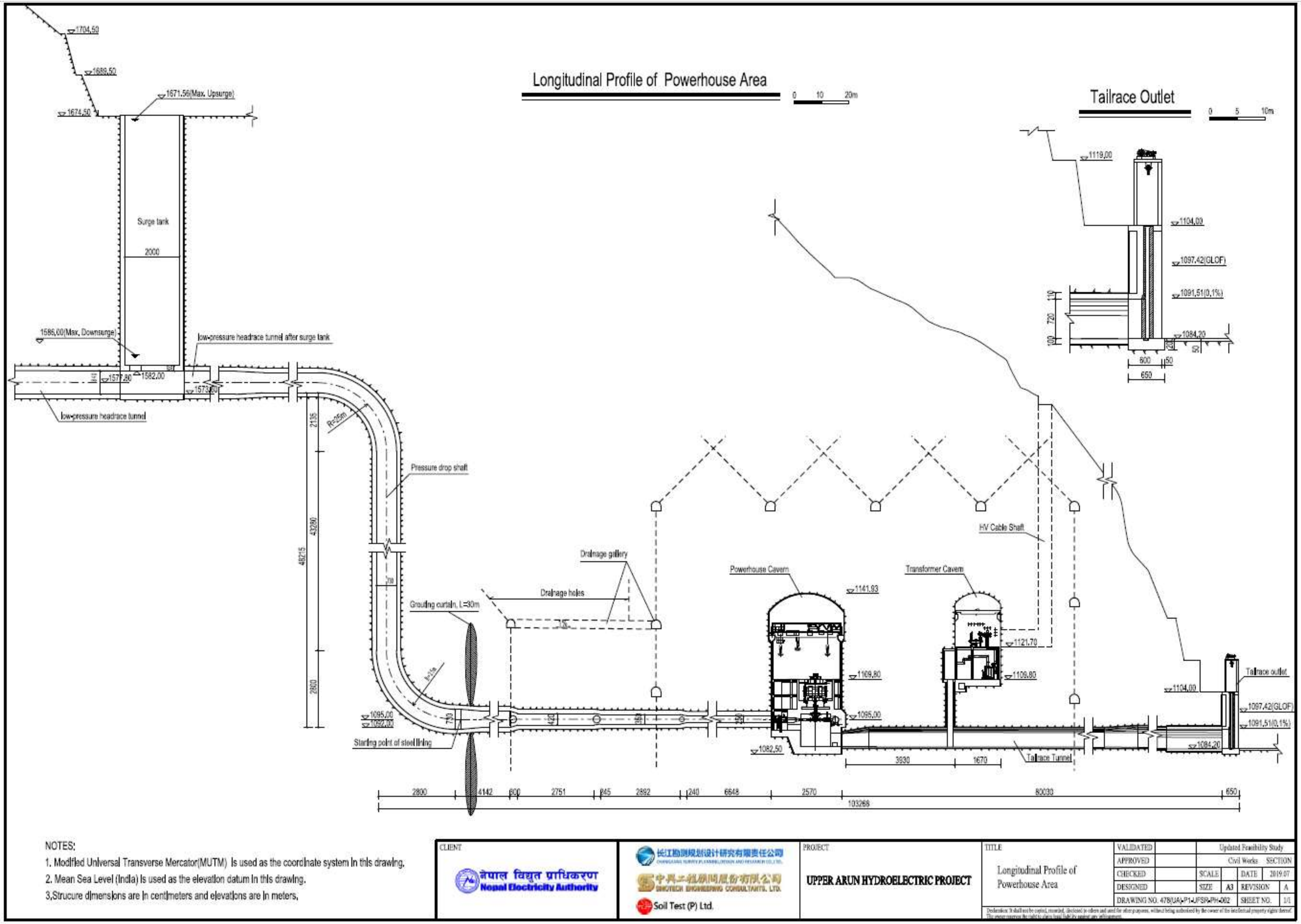
Figure 3.18: Longitudinal Profile of the Powerhouse Area



Switchyard

The switchyard will be sited on the ridge that is about 400 m south of the powerhouse, with a dimension of 120 m × 42 m and the ground elevation of 1,425 m. The outgoing line gantry, a management building and a diesel generator room will be located in the switchyard. The switchyard connects to the HV cable shaft through a cable gallery and the cable gallery.

Tailrace Tunnel and Outlet

The tailrace tunnel includes six branch tunnels (one for each turbine), which merge into two main tailrace tunnels with an overall length of about 600 m, that discharge back into the Arun River about 700 m upstream from the confluence of the Arun River with Leksuwa Khola at elevation 1,084.2 m.

Secondary Access Roads and Bridges

The secondary access roads are intended to provide construction access and support long-term project operation and maintenance. These roads were designed in accordance with the following standards:

- Design speed – 20 km/hour
- Maximum longitudinal gradient – 10.5%
- Minimum curve radius – 12 m

Table 3.8 lists the Project's secondary access roads.

Table 3.8: Project Service Roads and Length

Road Name	From	To	Width (m)	Length (m)	Pavement Type	Duration
#1 Road	Project access road	Adit #2	8.5	2,417	Crushed stone	Temporary
#2 Road	No.2 bridge right bank	Dam abutment	8.5	1,050	Crushed stone	Temporary
#3 Road	#2 Road	Dam abutment	5.5	610	Crushed stone	Temporary
#4 Road	#3 Road	Construction Adit # 7	5.5	1,680	Crushed stone	Temporary
#5 Road	Outlet of SBT	Inlet of SBT	8.5/5.5	750/870	Crushed stone	Temporary
#6 Road	Powerhouse-dam road	Left bank platform of cable crane	5.5	430	Crushed stone	Permanent
#7 Road	Project access road	Chepuwa quarry	8.5	940	Crushed stone	Permanent
#8 Road	Project access road	Spoil Disposal Area #2	8.5/5.5	1,420/ 1,600	Crushed stone	Permanent
#9 Road	Project access road	Surge tank	8.5	1,000	Asphalt	Permanent
#10 Road	#9 Road	Construction Adit #4	8.5	680	Asphalt	Temporary
#11 Road	Project access road	Switchyard	5.5	310	Asphalt	Permanent
#12 Road	Project access road	Explosive magazine	5.5	250	Crushed Stone	Temporary
#13 Road	Project access road	Powerhouse access tunnel portal	8.5	720	Asphalt	Permanent
#14 Road	Powerhouse access tunnel portal	Spoil Disposal Area #4	5.5	770	Crushed stone	Permanent
	Total			16,647		

Construction Bridges

Two Bailey-type bridges are proposed at the headworks to provide temporary construction access across the Arun River:

- Bridge No.1 is proposed about 370 m downstream from the dam site, at an elevation of 1,580 m, a length of 40 m, and a width of 9 m.
- Bridge No.2 is proposed about 1,180 m downstream from the dam site, at an elevation of 1,580 m, a length of 100 m, and a width of 9 m.

Hydropower Ancillary Facilities

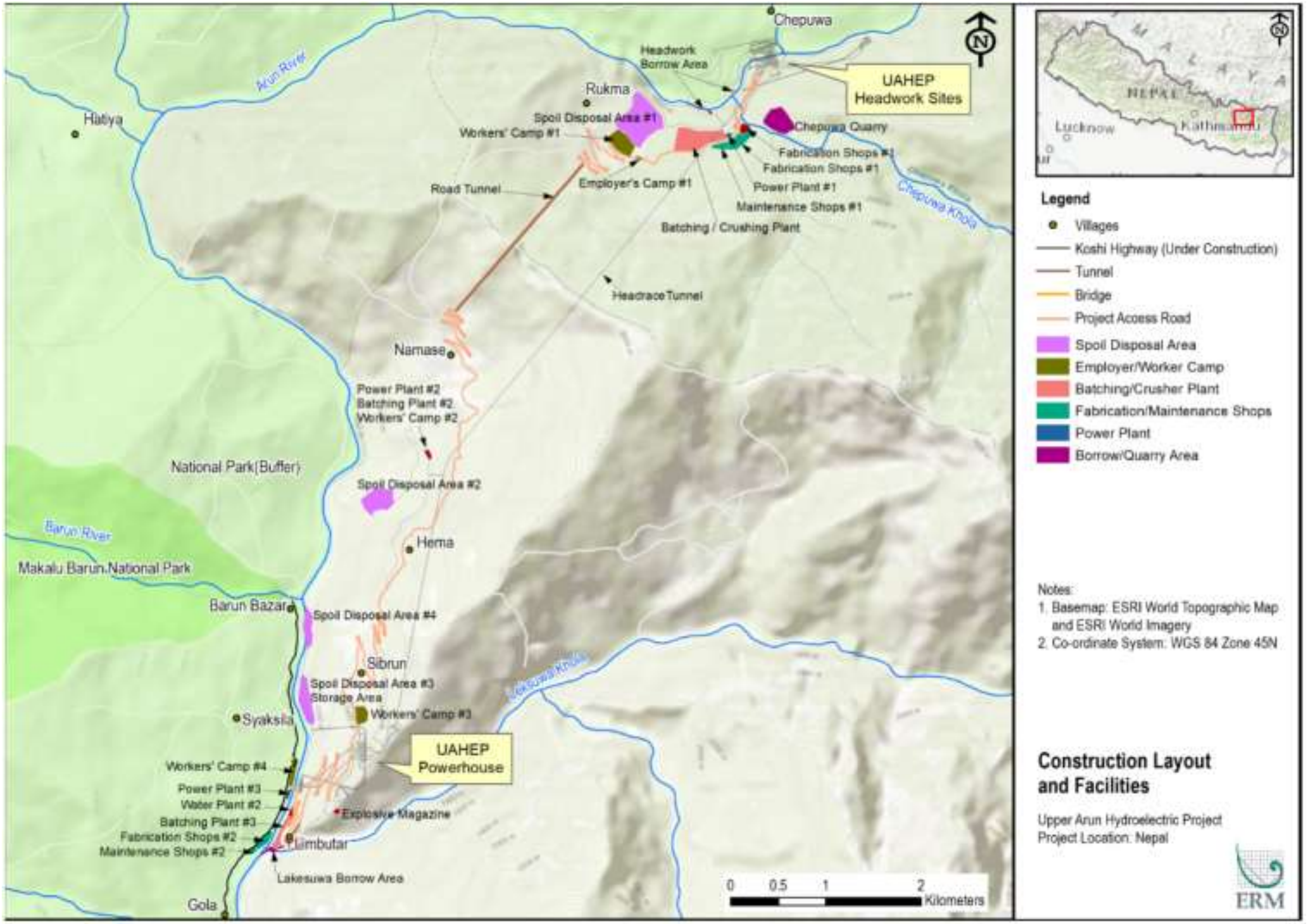
Construction of the UAHEP hydropower facility will require several ancillary support facilities. ***Figure 3.19*** shows the location of these facilities and ***Table 3.9*** lists these facilities by hydropower area where they are found, their approximate area, and indicates if these are temporary or permanent facilities. All temporary facilities would be required for the duration of facility construction (~6 years) with the exception of the borrow areas, which would only be required for the first 6 months until the Chepuwa Quarry is fully operational.

Table 3.9: Hydropower Project Ancillary Facilities

Ancillary Facilities	Location	Approximate Area	Status
Headworks Area near Rukm'			
Owner's Camp #1	1,500 m^2 building with capacity for 50 workers	5,000 m^2	Permanent
Contractor's Camp #1	25,000 m^2 building area with capacity for 2,500 workers	51,000 m^2	Temporary
Power Plant #1	12 MW diesel power plant	3,000 m^2	Temporary
Water Plant #1	Chepuwa Khola will be water source	7,800 m^2	Temporary
Chepuwa Quarry	Quarry to provide suitable quality aggregate	169,000 m^2	Temporary
Borrow Area	Along left bank of Arun River	5,000 m^2	Temporary
Crushing Plant	320 tons coarse aggregate/140 tons fine aggregate/hr	5,400 m^2	Temporary
Batching Plant #1	55,000 m^3/month capacity for headworks area	5,400 m^2	Temporary
Fabrication Shop #1	For precast concrete, embedded parts, steel formwork	25,000 m^2	Temporary
Maintenance Shop #1	For general automotive repair and maintenance	10,000 m^2	Temporary
Spoil Disposal Area #1	For spoil from dam and various tunnel excavation	155,200 m^2	Permanent
Waterway Area/Headrace Tunnel Adit near Namase and Hema			
Contractor's Camp #2	1,200 m^2 building area with capacity for 120 workers	1,700 m^2	Temporary
Power Plant #2	2.1 MW diesel power plant	1,000 m^2	Temporary
Batching Plant #2	5,600 m^3/month capacity for headrace tunnel	2,000 m^2	Temporary
Spoil Disposal Area #2	For spoil from headrace tunnel	66,400 m^2	Permanent
Powerhouse Area – Left Bank near Limbutar and Sibrun			
Owner's Camp #2	7,500 m^2 building area with capacity for 100 workers	7,000 m^2	Permanent
Contractor's Camp #3	10,000 m^2 building area with capacity for 1,000 workers	20,000 m^2	Temporary
Water Plant #2	Arun River or Leksuwa Khola will be water source	4,000 m^2	Permanent
Borrow Area	Along Leksuwa Khola	2,000 m^2	Temporary
Batching Plant #2	14,000 m^3/month capacity for powerhouse area	15,000 m^2	Temporary
Fuel Depot	For storage and dispensing of fuels and lubricants	2,000 m^2	Temporary
Explosives Magazine	Located away from Project & villages for safety reason	1,400 m^2	Temporary
Spoil Disposal Area #3	For good rock storage and spoil from powerhouse	56,000 m^2	Permanent

Ancillary Facilities	Location	Approximate Area	Status
Spoil Disposal Area #4	For spoil from powerhouse/tailrace tunnel	31,600 m^2	Permanent
Powerhouse Area – Right Bank near Syaksila and Gola			
Contractor's Camp #4	7,000 m^2 building area with capacity for 700 workers	15,000 m^2	Temporary
Power Plant #3	6 MW diesel power plant	3,600 m^2	Temporary
Fabrication Shop #2	For steel formwork and penstock components	19,000 m^2	Temporary
Maintenance Shop #2	For general automotive repair and maintenance	10,000 m^2	Temporary
General Across Project			
Distribution Line	25 km of 11 kV line strung along the access roads	NA	Permanent
Total Area			
Total Area		699,500 m^2 or 70 ha	

Figure 3.19: Location of Construction Layout and Facilities



Workers' Camps

Six workers' camps (two owner's camps and four contractor's camps) are proposed to house the approximately 4,500 workers needed to build the hydropower facility. ***Figure 3.19*** shows the location of these workers' camps and ***Table 3.9*** indicates the area and capacity of these camps. These construction camps will be located where they can provide efficient access to works areas, while also avoiding physical displacement and minimizing impacts on nearby villages. The camps will be completely self-contained and provide all necessary services and utilities to support the construction workforce without drawing upon local community services or supplies (***Table 3.10***).

Table 3.10: Workers' Camp Facilities

Workers' Camp Facilities	Facility Requirements
Total area	Varies from 0.5 to > 5 hectares (see ***Table 3.9***)
Accommodation	Comply with the *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009)
Sanitation facilities	Comply with the *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009)
Canteen/cooking/laundry facilities	Comply with the *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009); food to be purchased locally to the extent possible
Medical facilities	Onsite health post with medical professionals to address non-emergency incidents to comply with the *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009). Community health facilities will not be used by construction workers.
Security	Unarmed security to comply with *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009), WB Good Practice Note *Assessing and Managing the Risks and Impacts of the Use of Security Personnel* (World Bank 2018a), and the Security Personnel Management Plan (see Appendix C, ESMP); perimeter fencing to be installed
Access	Direct access to project access road
Parking	For approximately 10–20 cars
Power	Diesel generator – see discussion on power supply below
Fuel storage	One 5,000-liter diesel storage tank for onsite diesel generator
Water	Source: Chepuwa Khola or Arun River – see discussion on water plants treatment/water treatment system
Wastewater	Treatment – package wastewater treatment plant
Stormwater	Provision shall be made at the sites for surface water drainage systems, sumps to collect sediment, and safe non-erosive discharge points into a natural swale or stream.
Solid waste	All solid waste will be collected in accordance with the Waste Management Plan (Appendix C, ESMP), transported by covered truck, and disposed of at the Khandbari municipal landfill.
Helipad	Only at Contractor Camp #1 at headworks area and Contractor Camp #4 near powerhouse area; each pad approximately 20 m x 20 m area

Solid Waste Disposal

Project construction and, to a lesser extent, project operations will generate significant quantities of solid waste. The topography and geology of the project area are not well suited for the development of a waste disposal facility. Non-hazardous and non-special waste and construction debris that cannot be reused or recycled will be disposed of at the municipal landfill near Khandbari (***Figure 3.20***). UAHEL will assess the Khandbari landfill to determine the landfill improvements or other measures required to properly manage project waste. Section 7.1.6 (Impacts on Water Quality) identifies other required mitigation measures to ensure the proper management of project solid waste.

Power Supply

Project construction will require about 12,200 kW of power, plus the electrical requirements of the workers' camps, for a total capacity of 20,100 kW. Due to the lack of nearby power supply from the Nepal power grid, three diesel power stations are proposed – one in the headworks area, one at the Headrace Tunnel adit portal to operate the ventilators and water pumps, and one at the powerhouse area (see ***Table 3.9*** and ***Figure 3.19*** for more details.

Water Supply

It is proposed to construct two water plants for the Project. Water Plant #1 will source water from Chepuwa Khola and will service the water requirements of camps and other infrastructure facilities at the headworks area. Water Plant #2 will source water from Leksuwa Khola and service the water requirements camps and support infrastructure facilities in the powerhouse area. All underground works will be provided with a water tank located at the portal.

Construction Materials

The Project will require a significant quantity of aggregate for concrete production to construct the dam, and other facilities. There are no commercial sources of aggregate in the local area, and the cost of transporting it to the site would be prohibitive. Therefore, UAHEL proposes to source the required aggregate locally. At the initial stage of construction, natural aggregates will be secured from along the left bank of the Arun River to supply the headworks construction area, and along Leksuwa Khola to supply the powerhouse construction area. These borrow areas will only be used temporarily until the various tunnel excavations proceed and Chepuwa Quarry is operational. Good quality rock from tunnel excavation will be used as the primary aggregate source, with any deficient quantities sourced from the Chepuwa Quarry. The Project will have a single crushing plant at the dam site to supply the aggregate needs for all construction work fronts, with aggregate hauled by truck from the headworks site to the powerhouse site. Batching plants will be located at each of the headworks, headrace tunnel adit, and powerhouse work fronts for concrete production.

Spoil Disposal Facilities

Project construction will generate a large quantity of spoils, estimated at approximately 5,930,000 m^3. Some of this spoil material will be used for project purposes, including 838,100 m^3 for aggregate production and 42,300 m^3 for cofferdam construction, but the remaining spoils will need to be disposed of. Four spoil disposal facilities are proposed, which collectively represent nearly half of the ancillary facilities land requirements (***Table 3.11***). Spoil Disposal Area #3 will also include some temporary storage of "good rock" suitable for reuse as aggregate. Topsoil will be stockpiled and used for land restoration purposes. These spoil disposal areas are large facilities and there are limited suitable sites given topographic and geotechnical constraints (see Chapter 4 – Project Alternatives and Environmental and Social Considerations). These will be engineered facilities including safety fencing, slope protection, appropriate drainage, and stormwater management. UAHEL will work with the nearby communities to find beneficial uses for these sites, although they will remain government property and will not be suitable for agricultural use.

Figure 3.20: Existing Khandbari Municipal Landfill Location

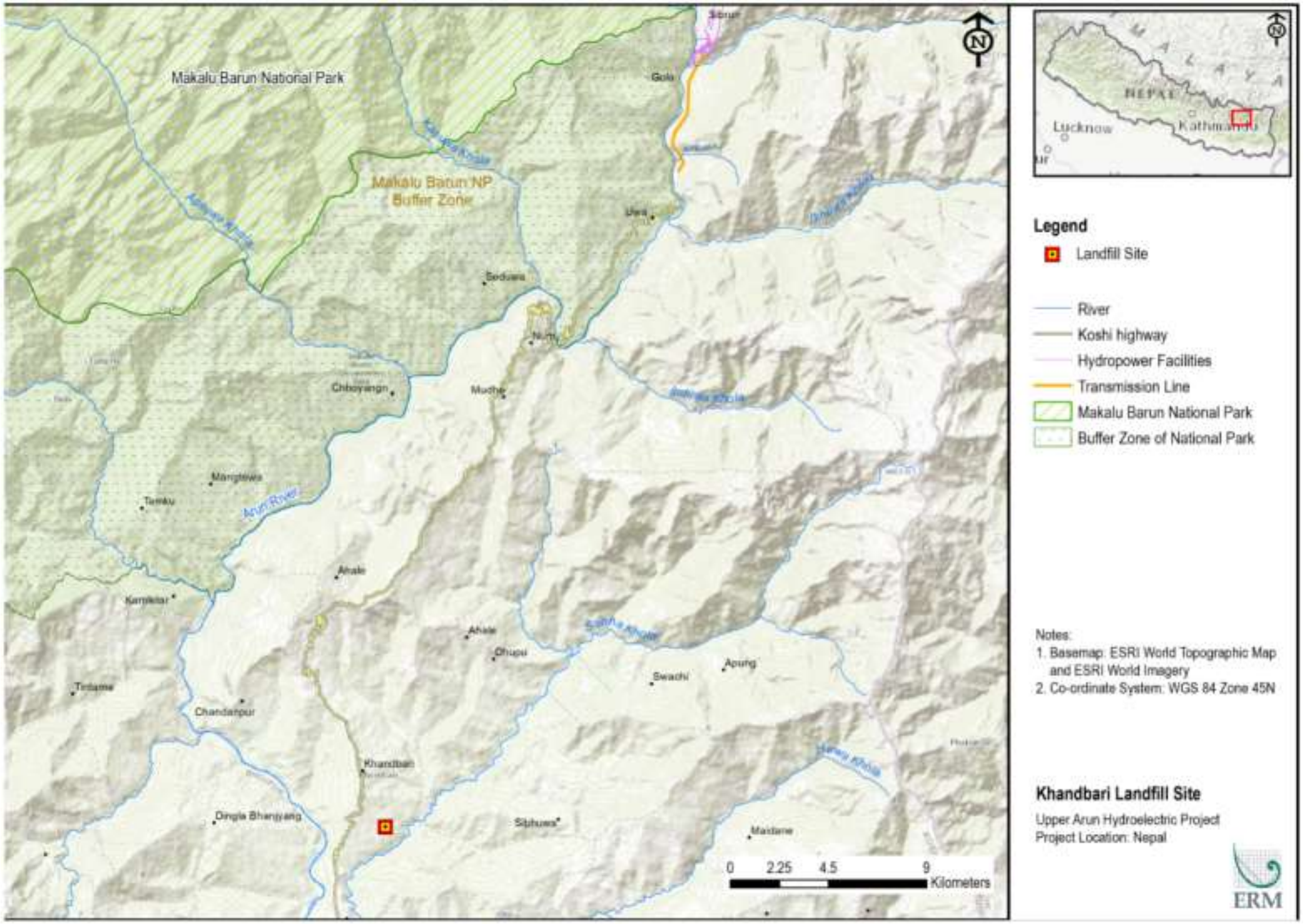


Table 3.11: Hydropower Spoil Disposal Facility Characteristics

SN	Name	Location	Footprint (ha)	Volume (m^3)	Slag Quantity (m^3)	Storage Quantity (10^4 m^3)
1	Spoil Disposal Area # 1	500 m east of Rukma	15.5	3,520,000	3,460,000	Negligible
2	Spoil Disposal Area # 2	Between Namase and Sibrun	6.6	840,000	740,000	Negligible
3	Spoil Disposal Area # 3	Along Arun River	5.6	980,000	470,000	510,000
4	Spoil Disposal Area # 4	Along Arun River	3.2	430,000	400,000	Negligible
Total			**30.9**	**5,770,000**	**5,070,000**	**510,000**

3.3.3 Transmission Line

The UAHEP will require construction of a transmission line to evacuate the electricity generated at the powerhouse and connect it to Nepal's electricity grid. The NEA proposes to construct a 5.8 km long, 400 kV double circuit transmission line within a 46 m wide RoW, extending from the UAHEP switchyard to the proposed Arun Hub substation at Hitar (***Figure 3.21***). The Arun Hub substation is currently undergoing a detailed feasibility study carried out by the NEA. The current UAHEP transmission line shows a connection to the proposed Arun Hub substation location, but it is understood that at least the terminal tower shown in the current transmission line design may need to be adjusted to properly align with the substation electrical bay orientation.

The RoW is the area of land that will be used to locate, construct, operate, and maintain the transmission line. Most structures and certain activities are restricted within the RoW to ensure there will be no future incompatible development that will affect transmission line operations and to protect local residents from any potential adverse health effects from electric and magnetic fields. The standard RoW width for a 400 kV transmission line in Nepal is 46 meters – 23 meters horizontally on each side from the centerline. The transmission line towers will be located along the centerline of the RoW. In Nepal, typically just the land required for the tower pad is acquired, while private owners of other land within the RoW receive compensation for the restrictions placed on their land (e.g., restrictions on construction of new structures within the RoW).

Figure 3.21: Transmission Line Alignment Map

Transmission Line Features and Structures

Table 3.12 presents the salient features of the project transmission line.

Table 3.12: Transmission Line Salient Features

Salient Features	Design Details
General	
Location	Koshi Province, Sankhuwasabha District, Bhotkhola Rural Municipality Ward 5 and Makalu Rural Municipality Ward 4
Total right-of-way (RoW) length	5.8 km
RoW width	46 m
Total RoW area (L x W, or 5,790 m x 46 m)	26.6 ha
Highest elevation along the route (masl)	1,405 m
Lowest elevation along the route (masl)	987 m
Construction duration	1.0 year starting from mobilization
Operational life expectancy	50+ years
Project cost	
System Data	
System nominal voltage	400 kV
System maximum voltage	420 kV
Number of phases	3
System nominal frequency	50 Hz
Estimated transmission line power loss	0.06%
Conductor Data	
Circuit	Double circuit
Conductor type	Aluminum conductor steel reinforced (ACSR) “Moose”
Total conductor cross-sectional area	597 mm^2
Overall conductor diameter	31.77 mm
Wire diameter (mm)	Aluminum 3.53mm +/- 2mm Steel 3.53 mm +/- 7 mm
Approximate mass	Overall conductor – 2004 kg/km Aluminum wire (per wire) – 26.45 kg/km Steel wire (per wire) – 76.34 kg/km
Ultimate tensile strength (kg)	161.20 kg
Coefficient of linear expansion	19.35 x 10^{-6} per °C
Maximum D.C. resistance at 20°C	Conductor – 0.05552 ohm/km Aluminum wire – 2.921 ohm/km
Galvanized steel earth wire	Stranding wire nominal diameter – 3.66 mm Number of strands – 7 Inner core – 1 Outer core – 6

Salient Features	Design Details
Number of overhead ground wires (OHGW)	2 per tower
Climatic Conditions	
Maximum ambient temperature	45°C
Minimum ambient temperature	-5°C
Maximum temperature of conductor	80°C for ACSR 53°C for galvanized steel wire (GSW) and optical ground wire (OPGW)
Annual average temperature	32
Maximum ice thickness	10 mm
Maximum average speed of wind	47m/s for 3 seconds
Pollution contamination severity	31 mm/kV
Transmission Line Crossings	
Number of highway/major road crossings	0
Number of large stream, river, and reservoir crossings	2 (Leksuwa Khola and Ansuwa Khola)
Number of transmission line crossings	0
Tower Features	
Total number of towers	19
Average tower span (m)	321
Maximum tower span (m)	768
Suspension (S1)	7
Suspension (S2)	2
Tension (T1)	6
Tension (T2)	2
Terminal towers	2
Tower foundation type	Representative list, including pad and chimney, concrete foundation, RC, micropiles; monopoles, steel grillages,
Minimum Conductor Clearance (at +80°C conductor temperature) – NEA Standards	
To ground	8.84 m
Residential area	9.5 m
Crossing road	9.5 m
Crossing highways	9.5 m
Crossing communication lines	8.0 m
Crossing rivers (non-navigable)	7.6 m
Buildings (m)	5.3 m
Power line crossings (m)	6.5 m

Salient Features	Design Details
Tree clearance	5.5 m

Transmission Towers

The transmission towers will be self-supporting lattice steel tower types, with four tower legs each embedded in concrete foundations. The Project will require five tower types as described in ***Table 3.13***.

Table 3.13: Tower Types and Characteristics

Tower Type	Tower	Number of Towers	Angle (Degrees)	Design Span		Nominal Height (m)
				Wind Span (m)	Weight Span (m)	
Suspension	S1	7	2	450	900	30 (-3~+12)
Suspension	S2	2	2	850	1,300	30 (-3~+6) 54 (-3~+6)
Tension	T1	6	30	450	900	25 (-3~+6)
Tension	T2	2	60	450	900	25 (-3~+6)
Tension/terminal	T3	2	90 as tension 45 as terminal	450	900	25 (-3~+6)

Several types of standard tower foundations are proposed, including excavated, pad and chimney, and rock anchor foundations. The type of foundation is determined by the underlying geotechnical conditions. Excavated foundations will be the most common type, with rock anchor foundations used in areas with large intact rock. The tower foundations will be made of concrete and extend to cover the tower leg to a height of 0.3 m above ground surface, or the highest expected water level, whichever is greater, to ensure no tower bracing will be below ground or surface water levels. In addition to standard foundations, special foundations may be required if the underlying ground has very low bearing capacity.

The towers will be designed In accordance with the *Suggested Practices for Avian Protection on Power Lines* (APLIC 2006), which includes designing the transmission lines to include bird thorns to prevent birds from nesting on the transmission tower and ensuring the distance between the conductors is greater than the maximum wingspan of the largest bird in the project area (i.e., Himalayan Griffon, with a wingspan of up to 3.1 m), which effectively eliminates the risk of bird electrocution. These measures are discussed in more detail in Section 7.2.3 (Effects on Terrestrial Resources).

Each tower will be protected by two overhead cables (i.e., shield wires) that serve to shield the energized circuits from lightning strikes. In addition, each tower will be grounded, which establishes an electrical path from the steel tower to the earth to allow stray currents, which occur on all transmission lines due to lightning, switching, and surge events, to be conducted to the earth. Towers will have a level of physical security to prevent the public or climbing animals from ascending them. This may take the form of a security fence or anti-climbing device added to the supporting legs. Anti-climbing devices and safety warning notices will be installed on towers close to roads and areas with easy public access.

Conductors and Overhead Shield Wires

The 400 kV transmission line conductors are made of aluminum wires wrapped around a stranded steel wire. The conductors will be suspended from an insulator string attached to the arms on the tower at a safe height above the ground. Two overhead shield wires will be installed at the top of the towers – one is a fiber optic ground wire and the other is a galvanized steel wire.

The transmission line will be designed in accordance with *Reducing Avian Collisions with Power Lines* (APLIC 2012), which includes making the cables more visible by fitting them with marker spheres and bird diverters. These measures are discussed in more detail in Section 7.2.2 (Impacts on Terrestrial Resources).

The electric and magnetic fields (EMFs) that naturally occur with energized circuits will be minimized at the edge of the transmission line RoW by establishing proper distances between the ground and the energized conductors.

Transmission Line Ancillary Facilities

The construction of the transmission line will require some supporting ancillary facilities. These facilities include tower workers' camps, laydown areas, and other facilities, as described below.

Access Roads

UAHEL does not propose to construct any new temporary or permanent access roads for the UAHEP transmission line. Construction workers will access the tower sites using existing trails or by creating new trails and will use porters, pack animals, small motorized vehicles (e.g., motorcycles, all-terrain vehicles [ATV]), and possibly helicopters to transport construction equipment and materials.

Tower Laydown Areas

The tower laydown areas will provide storage areas for construction equipment (e.g., cranes, cement mixers) and materials (e.g., cement, fine and coarse aggregate, steel and other tower parts, rebar, conductors). Two tower laydown areas are proposed – one at the UAHEP switchyard, which is vehicle accessible, and one at the Arun Hub substation. The exact location within the substation site cannot be identified at this time as the substation is still undergoing detailed feasibility study and design, but it is assumed that the substation will be vehicle accessible by the time the UAHEP transmission line is being constructed. Each of these laydown areas will also be able to support helicopter deliveries, if required.

Tower Work Camps

Temporary tower work camps will be established at 13 of the 19 tower sites (i.e., Towers 4–16). Workers at Towers 1–3, which are immediately adjacent to the UAHEP powerhouse, will be housed at the nearby Workers' Camps #3 and will walk/be transported to the tower sites each work day. Workers at Towers 17–19 will be housed at accommodation at the proposed Arun Hub substation at Hitar and will walk to these tower sites each work day. Towers 4–16 are located farther from available accommodation, are only accessible by hiking, and require crossing either Leksuwa Khola or Ansuwa Khola. Further, given the nature of transmission line construction, with separate crews working in "waves" for short periods (e.g., weeks) at each tower site and then moving on to the next tower (see Section 3.4.3 below for more details), it would be time consuming and expensive for a construction crew to return to a centralized workers' camp each evening. Rather, the common practice in Nepal is for the construction crews to camp at the tower sites, at least the non-local workers. UAHEL will not allow workers to do homestays, because of the risk of social conflict, the spread of communicable diseases, and trafficking in persons (TIP), among other things.

For the purposes of tower construction, a small (approximately 2,000 m^2) work camp and temporary storage area will be established near each tower site at the beginning of construction. These tower work camps will be used multiple times on a short-term basis (i.e., up to one month) as each of the various waves of construction crews pass through the tower site (e.g., geotechnical site investigation, clearing/excavation, foundation installation, tower erection, insulator assembly, and stringing). The tower work camps will be supplied from the tower laydown areas described above with construction equipment and materials appropriate for the next stage of tower construction. These equipment and supplies will be transported by porters, pack animals, and possibly small motorized vehicles to the tower sites, where they will be temporarily stored.

The tower work camps, including the storage areas, will generally be located within the transmission line RoW and will meet the following tower work camp siting criteria:

- Not require the clearing of any forest
- Not require any physical displacement
- Maintain at least a 100 m buffer from any cultural heritage sites
- Maintain at least a 100 m buffer from floodplains, streams, and springs
- Maintain at least a 100 m buffer from the nearest residence

There may be some tower sites, however, where, because of slope or other constraints, the work camps or storage areas may need to be located near, but outside of, the RoW. In these cases, the Construction Contractor will execute a Temporary Access Agreement with the property owner if located on private land.

Table 3.14 describes the facilities that will be provided at each tower work camp. The tower work camps will be required to comply with the World Bank's General Environmental, Health and Safety Guidelines.

Table 3.14: Transmission Tower Work Camp Facilities

Facilities	Facility Requirements
Total area	Up to approximately 2,000 m^2
Accommodation	Tents for up to 20 workers.
Sanitation facilities	Pit toilets with separate latrines for men and women
Canteen/cooking facilities	Cooking tent
Medical facilities	Each work crew will have a first aid kit to address non-emergency situations
Security	No security personnel or fencing
Access	Access via trails from either UAHEP powerhouse area or Arun Hub substation Construction equipment/materials will be transported by porters, pack animals, ATVs, and/or helicopters
Parking	No parking
Power	One portable 10 kW diesel generator
Fuel storage	Diesel for refueling generators stored in portable containers
Water	Sourced locally and/or carried to site
Wastewater	Separate male and female latrines with pit toilets
Stormwater	Provision shall be made at the sites for surface water drainage systems, sumps to collect sediment, and safe discharge points into the environment.
Solid waste	All solid waste will be carried out and disposed of with hydropower facility waste.
Office	No office
Storage area	Approximately 1,000 m^2 designated area (roughly 20 m x 50 m) within the workers' camp to store construction materials (e.g., aggregate, rebar, cement, steel)

The tower work camps will be cleaned up, but not removed, after each wave of construction crews. After completion of tower construction, these tower work camps will be dismantled and removed and the site restored to its pre-construction condition, before UAHEL releases the final payment to the Construction Contractor.

Other Transmission Line Ancillary Facilities

UAHEP transmission line construction will not require a dedicated quarry or crusher plant, rather it will use facilities available at UAHEP or Arun Hub construction sites. Batch plants will not be required at the tower work camps as concrete will be mixed at a small scale at each tower site. Depending on the tower type, the amount of concrete required for tower foundations will average approximately 125 m^3 (range of 100–150 m^3), which is within the capacity of a portable concrete mixer that can produce about 4 m^3/hour of concrete.

Tower foundation excavation will not generate a large amount of excavated materials, as most excavated material will be used to backfill the tower foundation or spread onsite, so dedicated spoil disposal sites are not required. The estimated amount of excavated material from a tower foundation is approximately 25 m^3, of which half will be used for backfilling. The remaining half will be spread at the site and stabilized using native plants or on agricultural land in consultation with the property owner.

3.3.4 Associated Facilities

Associated facilities are defined in the World Bank ESF as meaning “facilities or activities that are not funded as part of the project and, in the judgement of the Bank, are: (a) directly and significantly related to the project; and (b) carried out, or planned to be carried out, contemporaneously with the project; and (c) necessary for the project to be viable and would not have been constructed, expanded or conducted if the project did not exist.” To be considered an associated facility, the facility or activity must meet all three of these criteria.

The only facilities required by the UAHEP that are not included as part of the Project are as follows:

- Access road connecting the Koshi Highway to the powerhouse and headworks area, including two bridges and a tunnel
- Arun Hub substation and transmission line connection from the Arun Hub substation to the Nepal electrical transmission grid
- Koshi Highway improvements from Num Bazaar (Arun-3) to the UAHEP project access road

The access road will not be funded by the WB and does meet the three criteria above, so meets the definition of an associated facility, but is evaluated in this ESIA as part of the overall project.

The Arun Hub substation and associated transmission line from the substation to the Nepal electrical grid do meet associated facility criteria (a) and (b), but do not meet criteria (c). The Arun Hub substation and transmission line are the subject of a separate feasibility study being conducted by the NEA. This proposed substation and transmission line are intended to be regional facilities supporting other hydropower projects in the Arun River Basin, including the Barun HEP, Kimathanka HEP, Arun-4 HEP, and Ikhuwa Khola Hydro Power Project (HPP), and possibly other projects. The Arun Hub substation and transmission line connection would be constructed even if the UAHEP did not exist; therefore, these facilities do not meet the definition of associated facilities and are not included in this ESIA.

The Koshi Highway, or Nepal Highway 08 (NH-08), is a 390 km long planned highway extending from Biratnagar at the border with India, across Nepal, to Kimathanka near the border with China. Portions of this road exist, others are under construction, and others are planned. The section from approximately the Arun-3 HEP to the Barun River is under construction. The proposed UAHEP access road will start from the Koshi Highway in this section. This section of the Koshi Highway is currently not suitable for transporting the equipment and materials needed to support construction of the UAHEP. It is anticipated that construction of this section will be sufficiently advanced by the time UAHEP construction is scheduled to begin (circa 2022) to support construction traffic. The section of the Koshi Highway does meet criteria (a) and (b) above, but does not meet criteria (c). Koshi Highway has been planned for a long time and is currently under construction up to and beyond the intersection with the UAHEP access road. This road is intended to meet other transportation and economic development objectives independent of the UAHEP. Therefore, the Koshi Highway in this section does not meet the definition of associated facilities. Although the impacts associated with the construction of the Koshi Highway are not included in this ESIA, it should be noted that the Koshi Highway from Khandbari to the Project access road is included in the Project's Direct Impact Area (DIA) and the impact associated with the Project's use of this segment of the highway is included in this ESIA.

3.4 Construction Activities

This section describes how the UAHEP will be constructed, including pre-construction activities, and then construction of the access road, the hydropower facility, and the transmission line, recognizing that some of these construction activities will overlap.

3.4.1 Pre-Construction Activities

Once the Project receives environmental authorization from the GoN (i.e., approval of the EIA by the MoFE) and obtains a construction permit from the MoFE, the following project activities will commence:

- Issue tender bid documents for the Project.
- Award the contract(s) to the Construction Contractor(s). In this ESIA the term "Construction Contractor" is used to represent one or more prime or general contractors. All "Construction Contractor" requirements in this ESIA and ESMP apply to all Construction Contractors and flow down to include their subcontractors (see Appendix C, ESMP).
- Acquire required project lands and enter into temporary use agreements with affected property owners in compliance with Nepal's Land Acquisition Act and the approved EIA and Resettlement Action Plan (RAP); obtain a Forest Clearance Permit from the Department of Forests and Soil Conservation.
- Coordinate with Sankhuwasabha District regarding the use of municipal landfill near Khandbari for disposal of domestic solid waste from project construction and operation.

The selected Construction Contractor will be required to develop a Construction Environmental and Social Management and Monitoring Plan (CESMMP), in accordance with the minimum requirements established in the overall Project Framework ESMP (see Appendix C, ESMP), for review and approval by UAHEL. As part of this CESMP, the Construction Contractor will develop a Workers' Code of Conduct, for review and approval by MCA-Nepal, prior to the initiation of construction. The Workers' Code of Conduct will emphasize the importance of appropriate worker behavior towards local residents, respect for local communities and their customs, protection of the environment, and compliance with all Nepalese laws and regulations, as well as prohibit sexual harassment, exploitation and abuse. The Code of Conduct will also include disciplinary sanctions (e.g., penalties up to dismissal, and referral for potential legal sanction) for workers violating this Code of Conduct. The Code of Conduct will also be made available to local communities and be available at the UAHEL Project Office.

Prior to mobilizing construction crews in the field, UAHEL will require the Construction Contractor to conduct induction training for all field crews and subsequently for all new hires. This induction training will include:

- Appropriate health and safety training for all field crews, including provision of appropriate personal protective equipment (PPE) to all personnel
- Introduction to work conditions and the Worker Grievance Redressal Mechanism (GRM) and procedures

- Environmental and cultural sensitivity training
- Project's Workers' Code of Conduct training, including penalties, with a requirement that all personnel sign a copy of the code

3.4.2 Project Access Road Construction

The project site does not currently have vehicular access, so construction of the project access road will need to be one of the first construction activities to enable access for other equipment and materials required for construction of the hydropower facility. To expedite completion, access road construction will be conducted concurrently at six work fronts starting from four locations:

- Arun River Bridge (Stations 0+000 to 0+132) – This area is immediately accessible from Koshi Highway.
- Access road from Koshi Highway to Sibrun (Stations 0+132 to 7+180) – The Arun River Bridge will take approximately 2 years to construct, so until it is completed, a ferry will be used to get vehicles, equipment, and laborers across the river to this work area. The ferry will not be operational during the monsoon season.
- Southern Tunnel Portal near village of Namase – Since the access road will not yet exist, a helicopter will be used to transport all construction equipment (e.g., backhoe, drill, loader, grader, air compressors, generators) to this site. Construction from this site will proceed in two directions as indicated below:
  - Access road construction from the southern tunnel portal to Sibrun (Stations 14+180 to 7+000)
  - Tunnel excavation from the southern portal near Namaste (Stations 14+180 to 15+180)
- Northern Tunnel Portal near village of Rukma – A helicopter will be used to transport all construction equipment to this site. Construction from this site will proceed in two directions as indicated below:
  - Tunnel excavation from the northern portal near Rukma (Stations 16+210 to 15+180)
  - Access road construction from the Northern Tunnel Portal to the dam site (Stations 16+200 to 21+600), including the Chepuwa Khola Bridge. It is not possible to complete the proposed Chepuwa Khola Bridge during the first year of construction because of accessibility issues. A temporary causeway will be installed to allow construction equipment to cross the stream and access the approximately 1 km of the access road between Chepuwa Khola and the dam site (Stations 20+815 to 21+600).

The Road Construction Contractor will establish three main contractor's camps adjacent to the Arun River Bridge, and near the southern and northern tunnel portals (Camps 1, 2, and 3, see ***Table 3.3***), which will be in place for the duration of road construction. Road construction will use the typical construction methods of progressively grading the road alignment in accordance with the access roads plans and profiles (KEC 2019). The Road Contractor will source construction material from various sites within the Arun River valley, in accordance with the UAHEL-approved Construction Material Sourcing Plan referenced in Section 3.3.1, and any necessary government permits, and the agreement of the property owner.

There will be significant cutting and filling required because of the relatively steep slopes present along the road alignment. Side casting of spoils is specifically prohibited. The Road Contractor will use some of the spoil for construction of gabion walls and other road construction purposes, some to create level areas for the future installation of ancillary facilities for the hydropower facility (e.g., powerhouse water and batching plants), and some for beneficial re-use opportunities identified in consultation with the local communities. The Road Contractor will dispose of the remaining spoils in the approved spoil disposal areas, identified in Section 3.3.1. For each spoil disposal area, the Road Engineer will develop a specific design plan for approval by UAHEL.

Soil bioengineering techniques are proposed to stabilize disturbed areas (KEC 2019). Soil bioengineering is an engineering approach that uses live and dead plant material as building material for erosion control and land rehabilitation. It focuses on minimizing damage to the environment and reducing future maintenance costs. Some of the bioengineering techniques proposed for the access road include:

- Brush layering – where hardwood cuttings are laid nearly flat in a shallow trench across the slope and covered in soil
- Fascines – where hardwood cuttings are laid in bundles along shallow trenches across the slope and buried, but slow runoff, catch debris, and reinforce the slope by establishing roots
- Live check dams – where a series of large hardwood cuttings are set vertically on a line of holes across a gully; between them, long flexible hardwood cuttings are interwoven horizontally with their ends buried in short trenches cut into the gully sides

Soil bioengineering is labor intensive and it is envisioned that the Road Contractor will hire local workers to implement these measures.

See Section 3.4.5 for post-construction cleanup and restoration.

3.4.3 Hydropower Facility Construction

Construction of the UAHEP will be one of the largest civil works projects ever undertaken in Nepal, especially considering the amount of underground excavation required. Two key construction challenges relate to diverting the Arun River and construction of the various hydropower structures, which are described below.

Arun River Diversion

Management of the Arun River represents a key construction challenge for the Project. River diversion is proposed to occur in the following sequence:

- In November of Year 1, which is the onset of the dry season, construction of the diversion tunnel will start. The diversion tunneling and lining activities will be protected from flooding by the inlet and outlet cofferdams. The river will continue to flow along its natural course.
- In November of Year 2, the river will be diverted from its natural course into the diversion tunnel.
- At the end of April of Year 3, the cofferdam protection is scheduled to be complete. By this stage, the concrete of the dam will be completed up to elevation 1,557.5 m. During the flood season of Year 3, the dam foundation will be flooded, with the flood being discharged through the diversion tunnel and by overflowing of the cofferdams.
- In November of Year 3, after clearing of the dam surface, dam concreting is scheduled to resume. At the end of April of Year 4, the dam sections containing the LLOs are expected to reach elevation 1,590 m, while the abutment sections reach elevation 1,600 m. During the flood season, the diversion tunnel and the surface of the dam at elevation 1,590 m will discharge the flows together, while the abutment sections continue to rise.
- In November of Year 4, after clearing of the dam surface, dam concreting is scheduled to resume. At the end of April of Year 5, the dam concrete will be up to elevation 1,620 m. During the flood season of Year 5, dam construction is scheduled to continue. At the end of October, the dam concrete is expected to be up to elevation 1,644 m, which is the dam crest.
- From November of Year 5 to February of Year 6, installation of the hydraulic steel structures in the LLOs will be carried out. At the end of February of Year 6, the gate at the diversion tunnel inlet will be lowered and reservoir impoundment will start. During the period of diversion tunnel plugging, the river will discharge through the ungated spillway.

- After March of Year 6, the permanent water-releasing structure will discharge flows as designed.

Hydropower Structure Construction

The key construction activities at the different work fronts include the river diversion tunnel and cofferdam; SBT; dam and intake; low pressure headrace tunnel; surge tank; high pressure headrace tunnel; powerhouse cavern; tailrace tunnel; and switchyard.

Diversion Tunnel and Coffer Dam

At the headworks (dam site), construction will start with the diversion tunnel. Work sequence at the diversion tunnel is expected to take 18 months and is proposed to be executed as follows:

- Open excavation of the diversion tunnel inlet and outlet
- Excavation of the remainder of the diversion tunnel using the drill and blast method
- Concrete pouring at the diversion tunnel inlet and outlet
- Concrete lining of the diversion tunnel
- Installation of diversion tunnel gates and hoists
- Construction of the upper and lower cofferdams

Sediment Bypass Tunnel

The construction sequence of the SBT is expected to take 36 months and is proposed to be executed as follows:

- Open excavation of inlet and outlet
- Tunnel excavation
- Concrete pouring at the inlet and outlet
- Concrete linin
- Installation of gates and hoists

Dam and Intake

Once the river diversion is complete, dam construction work will commence. The proposed sequence of work is as follows and will take about 24 months to complete:

- Dam abutment excavation, which should occur before the closure of the Arun River
- Dam foundation excavation, which should occur after the cofferdam is completed
- Concrete pouring
- Installation of trash racks, gates, and gantry crane

Low Pressure Headrace Tunnel (LPHT)

The overall construction sequence of the low pressure headrace tunnel is expected to take 48 months and is proposed to be executed as follows:

- Three headrace adit tunnels construction
- Tunnel excavation using a combination of drill and blast and tunnel boring machine methods
- Concrete lining
- Adit plugging

Surge Tank

The proposed construction sequence for the surge tank is expected to take 11 months and is proposed to be executed as follows:

- Top platform open excavation using the top down method
- Tunnel excavation using the drill and blast method
- Concrete lining from bottom to top using sliding formwork

Pressure Drop Shaft

The proposed construction sequence for the pressure drop shaft is expected to take 15 months and will be executed as follows:

- Tunnel excavation using the shaft boring method
- Concrete lining

High Pressure Headrace Tunnel (HPHT)

The proposed construction sequence for the HPHT is expected to take 13 months and is proposed as follows:

- Adit construction
- Tunnel excavation using drill and blast method
- Steel and concrete lining
- Adit plugging

Powerhouse Cavern

The main powerhouse cavern is proposed to be excavated and supported in seven layers from top to bottom using drill and blast methods and rubber tired equipment. Rock bolts and shotcrete will be applied immediately behind the excavated face to ensure stability. When the roof arch excavation and support of the first layer of the powerhouse cavern are completed, the main transformer cavern excavation will be started. The main transformer cavern is proposed to be excavated and supported in five layers from top to bottom.

Turbine and generator components stored at Fabrication Shop #3 will be transported to the powerhouse for installation. Installation of turbine/generator units will be staggered, starting with Unit #1 and ending with Unit #6, with about a three-month lag from the start of one unit until the start of the succeeding unit. Installation of electrical control equipment will be delayed until the final year prior to operation to minimize contamination from dust. Installation of high voltage cables in the cable shaft will be preceded by erection of the steel access ladder and platforms which will then be used for installation of cable supports throughout the height of the shaft.

Construction of the powerhouse cavern is a critical path schedule item for the Project and is expected to take 60 months.

Tailrace Tunnel

The tailrace tunnel is also proposed to be constructed in two stage intervals. The first stage will be the tailrace tunnel for units No.1, No.3 and No.5. The second stage will be for units No.2, No.4 and No.6. The safe distance, between each excavation face, is 50–100 m. The tailrace tunnel is proposed to be used as construction access for layers A6 and A7 of the main powerhouse cavern and layer B5 of main transformer cavern. The tailrace tunnel is proposed to be constructed directly from the tailrace outlet.

Switchyard

The main construction activity for switchyard will be open excavation carried out by the top-down sequence. The earth works will be carried out through excavators, and followed by drilling and blasting methods in the hard rock section. The switchyard is scheduled to be completed before the first unit is tested and commissioned, and the construction period thereof is scheduled to be 15 months

3.4.4 Transmission Line Construction

Construction of the transmission line will commence approximately one year before commissioning of the hydropower facility. Transmission line construction typically occurs in a series of steps, as described below.

Initial Site Preparation

Once the transmission tower sites have been acquired, and compensation paid for restrictions on land use within the RoW, the construction crews will do a check survey and stake the tower corners, based on the tower type, and clear the vegetation from a limited area. The tower work camps and storage areas will be identified and underbrush removed, but no clearing of trees will be allowed.

As indicated above, no new access roads will be constructed. If vehicular access is not available to the tower site, then existing or new trails will be used/established to allow construction equipment and materials to be transported to the tower sites via porters, pack animals, ATVs, or, in some cases, helicopters. Access may require limited clearing of underbrush for construction of trails, but no trees will be cleared. The Transmission Line Contractor will execute temporary access agreements with any private property owners whose land is affected outside of the RoW.

Tower Foundation Excavation and Installation

Once the tower sites are surveyed and vegetation cleared, the tower foundation will be excavated. The Construction Contractor will be required to avoid or minimize tower foundation excavation during the monsoon season for environmental and health and safety reasons.

The size of the excavated area depends on the type of soil, presence of bedrock, and the type of tower. Tower sites with extremely steep slopes may require “benching” (significant excavation to level the pad site). The tower design allows for leg extensions between 1.5 to 12 meters to account for sloped terrain and to minimize benching. Topsoil will be salvaged and set aside for re-use in site restoration. In most cases, including all towers without vehicular access, the foundations will be excavated by hand. In areas with vehicular access, backhoes may be used. The excavated material will be stockpiled adjacent to the foundation area.

In areas with shallow bedrock or large boulders, and especially where benching may be required, the Construction Contractor may create small holes in the rock by drilling or jack hammering methods or by installing special rock anchor or micro-pile type foundations. Controlled blasting with the use of explosives may be required in some cases, however, this activity, if needed, will be carried out in coordination with the Nepal Army. The Nepal Army will be responsible for security of any explosives.

Concurrently with foundation excavation, foundation construction materials (i.e., aggregate, cement, rebar, and in some cases water) and equipment (e.g., portable generator, cement mixer) will be transported to the tower sites by porters, pack animals, ATVs, and, in a few cases, helicopters.

The construction crew will use pumps, if necessary, to remove groundwater and dry the site. Once the foundation area is excavated and dry, reinforced-steel anchor rebar cages will be installed. These cages are designed to increase the structural integrity of the foundations. They can be assembled at each site location. The cement, aggregates, and water will be mixed on site to produce concrete, typically using a small portable concrete mixer unless vehicular access is available and then a larger cement mixer can be used. The concrete will be used to create the foundation over the rebar cage.

Self-supporting lattice tower foundations typically produce about 25 m^3 of spoils per tower. About half of this material can be used to backfill around the tower foundation. The remaining spoils material will be spread, in consultation with the affected or adjoining property owners, in the general disturbance area to maintain grades and runoff and to facilitate restoration. No transport or disposal of spoil is planned beyond adjoining property owners.

Tower Assembly and Erection

Generally, the Construction Contractor will assemble the towers on site and construct them from the ground up. The selected towers will use pre-fabricated sections, which allow for simple transport and construction in remote locations. In some cases, semi-assembled tower structures may be fabricated at the tower laydown areas and transported to, and positioned on, the tower pad by helicopter.

Once the foundation is cured (in about two to four weeks), the construction materials required for the tower will be brought to the tower site by porters, pack animals, ATVs, or in some cases helicopters. The tower steel bundles will be opened and laid out for assembly by sections and assembled into subsections of convenient size and weight. The assembled subsections will then be hoisted into place using a gin and fastened together to form a complete tower. The crew will then tighten all the bolts in the required joints.

Prior to electrification, for safety purposes, the tower structures will be earthed. Depending on the soil resistance properties at the tower site, the tower will be earthed via a ground rod and/or counterpoise techniques.

Stringing of Conductors, Shield Wires, and Fiber Optic Ground Wire

Once the transmission towers are in place, construction crews will clear or trim vegetation, as previously marked by the Divisional Forest Office, to meet regulatory clearance requirements to ensure the reliable operation of the line. The type of clearing depends on the height of the trees, type of vegetation growing on the site, and presence of sensitive areas. Trees that could become tall enough to grow or fall into the transmission line must be removed or topped.

With the towers in place and the necessary RoW clearing completed, the next step is to string the transmission line wire, shield wire, and fiber optic ground wire. As with the foundation and tower construction equipment and materials, the conductors, insulators, hardware, and stringing sheaves needed for stringing will be delivered as close to each tower site as possible by vehicle and then transported by porters, pack animals, ATVs or helicopters to the tower site. The towers will be rigged with insulator strings and stringing sheaves at each shield (ground) wire and conductor position. The wires will be unreeled and strung section by section from tower to tower. A cable drum with a reel and tensioner will be positioned at one end, and a puller and take-up reel at the other. In this step, workers will make sure that the tension levels in the wires are within acceptable limits and that there is adequate clearance between the ground and the cables. Practices are adapted to account for sensitive and special environments.

Pilot lines can be pulled (strung) from tower to tower manually, by land-operated equipment (e.g., a winch, tensioner or puller machine), drones, or helicopter, and then threaded through the stringing sheaves at each tower. Following pilot lines, a stronger, larger-diameter line will be attached to conductors to pull them onto towers. This process will be repeated until the shield wire, fiber optic ground wire, and conductor are pulled through all sheaves. Once each type of wire has been pulled in, the tension and sag will be adjusted, stringing sheaves will be removed, and the conductors will be permanently attached to the insulators.

At tangents, the conductors will be attached to the insulators using clamps while at the small and larger angle dead-end structures, the conductors will be cut and attached to the insulator assemblies by “dead-ending” the conductors. The conductors need to be attached to the insulators, which will be required on all angle/tension and dead end tower types, and separate reels of conductors will need to be spliced together along the length of a span.

Ground rods and counterpoise wires will be installed to ground each tower and protect the line from lightning. A counterpoise wire is a special conductor that ensures the electrical connection between some or all of the line's towers and the ground.

3.4.5 Post-Construction Cleanup and Restoration

After the completion of construction for each of the project components (i.e., access road, hydropower facility, and transmission line), each Construction Contractor will cleanup and restore their affected areas in accordance with the approved Project Commissioning and Construction Close-Out Management Plan (see Appendix C, ESMP), as follows:

- Dismantle and remove all remaining contractor equipment, surplus materials, rubbish, debris, waste, and all temporary facilities from the site for reuse, recycling, or disposal at a GoN approved disposal facility
- Repair any infrastructure damaged during the work (e.g., roads, fences)
- Complete all re-grading, slope stabilization, and revegetation of disturbed areas, including the spoil disposal area, workers' camps, and land within the transmission line RoW
- Restore all disturbed areas to their previous condition either for agricultural use or replanting forest using native species
- Contact property owners, repair any damage, and address any claims for settlement
- Return land used under temporary access agreements to its owner

3.5 Construction Planning

Construction planning includes determining project land, workforce, construction materials, and construction equipment and materials requirements, as well as the overall project implementation schedule.

3.5.1 Project Land Requirements

The UAHEP will require land for the access road, hydropower facility, and transmission line. ***Table 3.15*** details the project land requirements and distinguishes land requiring permanent acquisition (i.e., required for project operations), land subject to permanent land use restriction that will remain in current ownership (i.e., land within the transmission line RoW), and land subject to temporary land use restrictions that will be returned to the original property owner (i.e., required only for construction purposes) land requirements. Land required permanently will be acquired in accordance with the RAP, while land required temporarily will be secured in accordance with a temporary access agreement.

For the access road, 57.2 ha of land will be acquired for the 30-m-wide RoW (not accounting for any RoW for the road tunnel) and Spoil Area #4; and 2.3 ha will be subject to temporary use (1.0 ha for the Namase crusher/batch plant and 1.3 ha for Camp #2), and no land will be subject to permanent land use restrictions. Other land needed for workers' camps or spoil disposal areas are co-located with hydropower facility facilities and are accounted for below.

For the hydropower facility, 138.6 ha of land will be acquired and 73.5 ha of land will be subject to temporary use.

For the transmission line, an area of 25 m x 25 m (625 m^2/tower) will be acquired for each of the 18 towers (terminal tower is within substation), for a total area of 11,250 m^2 (about 1.1 ha). The area subject to land use restrictions will be about 25.5 ha for the 5.79 km long x 46 m wide transmission line, subtracting the area to be acquired for the towers. An additional 1.1 ha will be subject to temporary use for workers' camps and access trails. The total length of the RoW may vary slightly depending on the final boundary of the proposed Arun Hub substation.

A total of 196.9 ha of land will be acquired for the Project, of which, 119.5 ha is privately-owned, while 76.3 ha is government land, and about 1.1 ha is currently unknown pending the final location of the transmission line towers. Of the approximately 299.3 ha of land required, including land acquisition, permanent land use restrictions, and temporary access agreements, 175.1 ha is currently forested/shrub and about 103.6 ha is in agricultural use, with the remaining land including water, rock/scree, and developed (e.g., paths, villages) land. ***Figure 3.22*** and ***Figure 3.23*** details the land area required for the different locations of the Project.

Table 3.15: Land Requirements for the Project

Particulars	Private Land			Govt. Land			Total Land (ha)
	Agriculture (ha)	Forest (ha)	Other (ha)	Agriculture (ha)	Forest (ha)	Other (ha)	
Project Access Road							
Land acquisition	29.0	4.2	10.4	1.0	12.6	0	57.2
Land restrictions	0	0	0	0	0	0	0
Temporary access	0.6	1.7	0	0	0	0	2.3
Subtotal	29.6	5.9	10.4	1.0	12.6	0	59.5
Hydropower Facility							
Land acquisition	48.3	4.1	10.3	0	75.9	0.0	138.6
Land restrictions	0	0	0	0	0	0	0
Temporary access	16.2	31.5	0	0	25.8	0	73.5
Subtotal	64.5	35.6	10.3	0	101.7	0	212.1
Transmission Line (values estimated as final tower locations not yet finalized)							
Land acquisition	0.2	0.4	0	0	0.5	0	1.1
Land restrictions	7.9	6.1	0	0	11.5	0	25.5
Temporary access	0.4	0	0	0	0.7	0	1.1
Subtotal	8.5	6.5	0.0	0	12.7	0	27.7
Total							
Land acquisition	77.5	8.7	20.7	1.0	89.0	0	196.9
Land restrictions	7.9	6.1	0	0	11.5	0	25.5
Temporary access	17.2	33.2	0	0	26.5	0	76.9
Grand total	102.6	48.0	20.7	1.0	127.0	0	299.3

Figure 3.22: Headworks Area Land Requirement

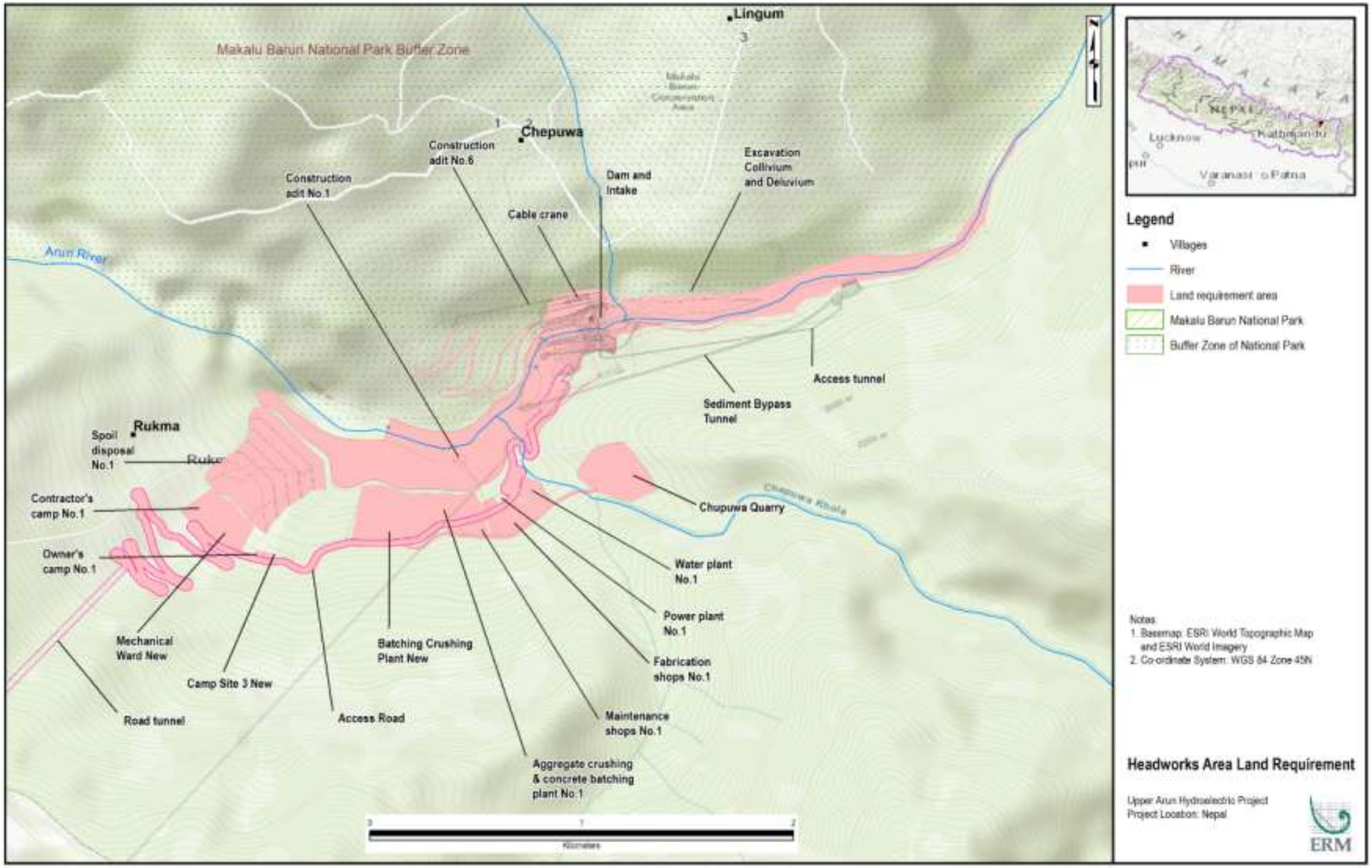


Figure 3.23: Namase/Hema Area Land Requirement

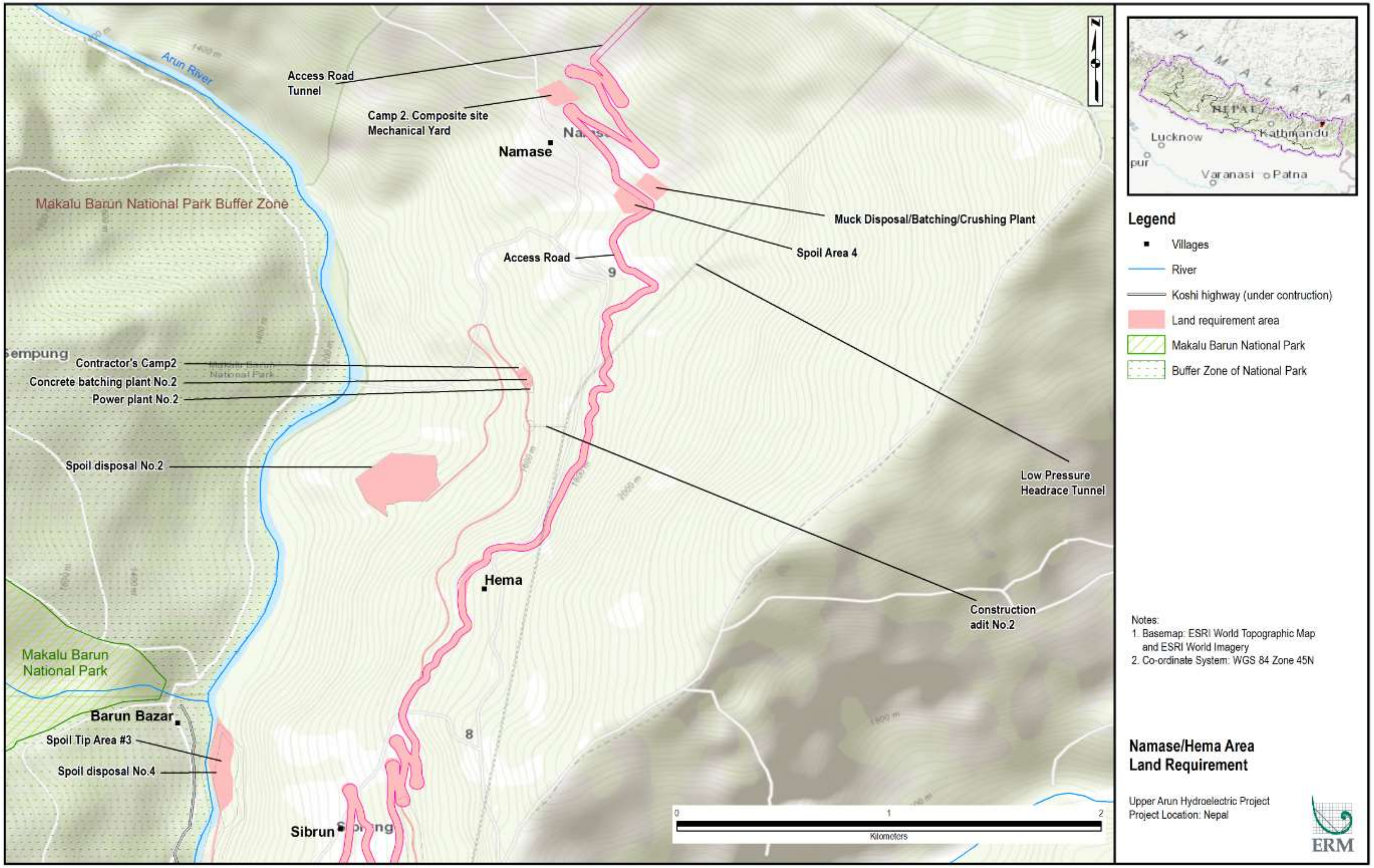
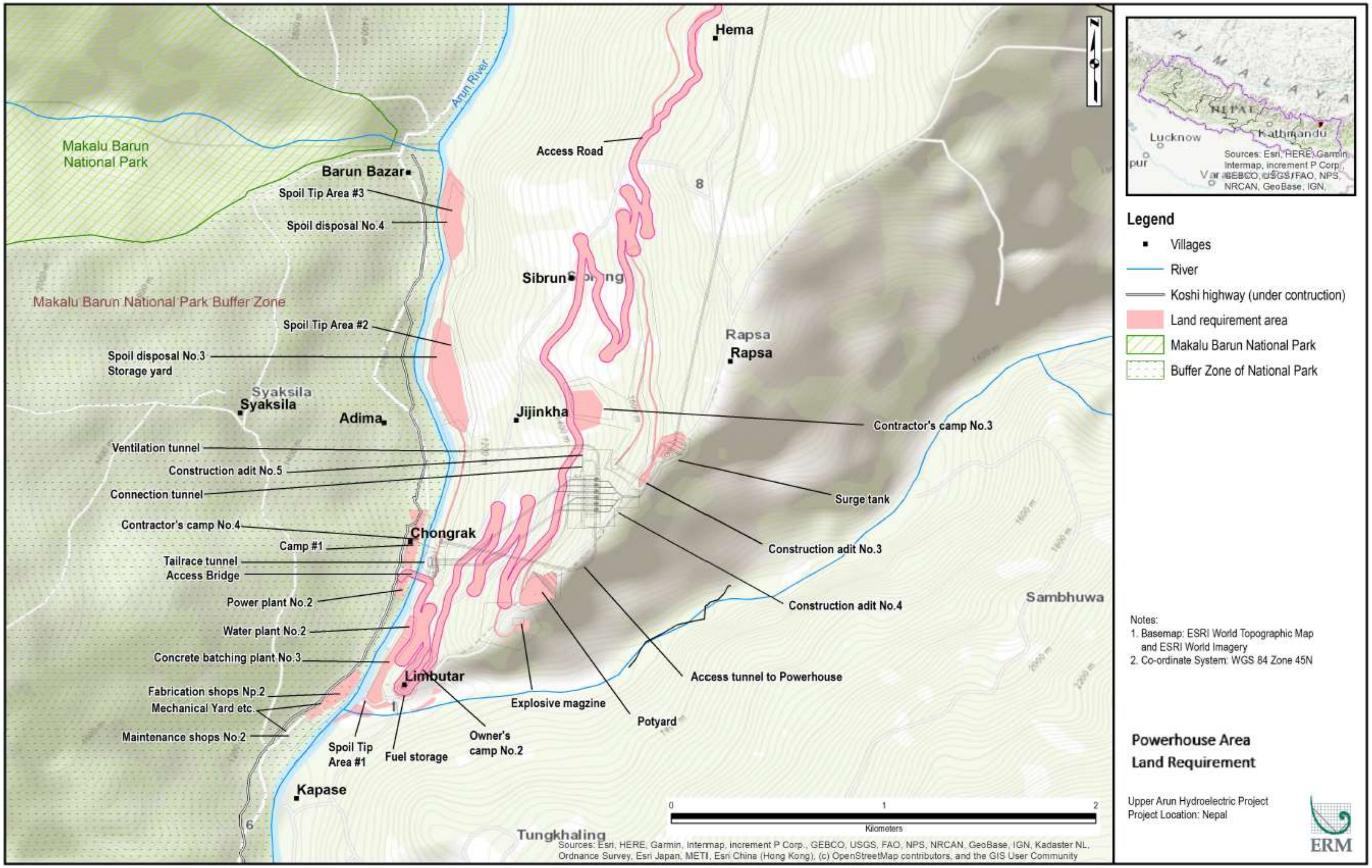


Figure 3.24: Powerhouse Area Land Requirement



3.5.2 Project Workforce

Each component of the overall Project will likely have a separate workforce because of differences in timing and skill requirements. ***Table 3.16*** provides a breakdown of workforce by component by construction year, with a peak of approximately 4,450 workers during Construction Year 5. The number of workers will also vary seasonally, with the peak workforce occurring during the dry season (October to May) and fewer workers during the monsoon season (June to September).

Table 3.16: Construction Workforce Estimate

Construction Year	Access Road	Hydropower Facility	Transmission Line	Total Workforce
Year 1	230	0	0	230
Year 2	230	1,600	0	1,830
Year 3	0	3,000	0	3,000
Year 4	0	4,300	0	4,300
Year 5	0	4,500	0	4,500
Year 6	0	3,700	0	3,700
Year 7	0	2,300	100	2,400

Table 3.17 provides an estimate of the number of workers by skill level based on information provided by the Project Engineers. It is estimated that Nepali workers could fill about 40% of these construction jobs, with many of the unskilled positions likely being filled by workers from Nepal. The Construction Contractors will be encouraged (see Section 7.3.14) to give preference to qualified persons from the local area (i.e., Sankhuwasabha District). Although construction work tends to be male dominated, Construction Contractors will be encouraged to hire women and other marginalized/traditionally excluded groups (see Section 7.3.14).

Table 3.17: Construction Workforce by Skill Level

Construction Year	Skilled Workers	Semi-skilled Workers	Unskilled Workers	Total Workforce
Year 1	90	30	110	230
Year 2	410	830	590	1,830
Year 3	600	1,500	900	3,000
Year 4	860	2,150	1,290	4,300
Year 5	900	2,200	1,350	4,450
Year 6	740	1,850	1,110	3,700
Year 7	480	1,200	720	2,400

3.5.3 Construction Materials

A range of construction materials will be required for the Project, which vary by project component. ***Table 3.18*** presents the construction material required and likely supply source for these materials per component. Much of the construction materials required for the access road construction will be sourced within the project area (e.g., aggregate). It is envisaged that much of the remaining construction materials required for the Project can be sourced from within Nepal, unless sufficient materials are not available in the required time to meet the construction schedule. Specialized equipment (e.g., electro-mechanical equipment) and pre-fabricated steel will need to be imported. UAHEL and the Construction

Contractor will be responsible for ensuring that the Project's primary suppliers (i.e., those who, on an ongoing basis, provide directly to the project goods or materials essential for the core functions of the Project) comply with the applicable requirements of the WB's ESS 2 (Labor and Working Conditions) and ESS 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources).

Table 3.18: Key Construction Materials Required for the Project

Construction Material	Quantity	Sourcing
Project Access Road		
Subbase course material	46,100 m^3	Locally sourced (Leksuwa Khola)
Base course material	25,000 m^3	Locally sourced (Sabha Khola)
Chipping aggregate	5,800 m^3	Locally sourced (Sabha Khola)
Aggregate for concrete	21,800 m^3	Locally sourced (Arun River)
Sand for concrete	23,100 m^3	Locally sourced (Arun River)
Cement	540 metric tonnes	Nepal
Steel (bars and plates)	805 metric tonnes	Nepal (e.g., Biratnagar)
Bitumen	460,500 liters	Nepal
Explosives	105 metric tones	Nepal
Hydropower Facility		
Coarse aggregate	1,969,500 tonnes	Chepuwa Quarry/reuse project spoils
Fine aggregates	844,100 tonnes	Chepuwa Quarry/reuse project spoils
Cement and admixture	341,000 tonnes	Nepal
Rebar	49,877 tonnes	Nepal and/or foreign import
Steel mesh reinforcement	1,743 tonnes	Nepal and/or foreign import
Steel	2,080 tonnes	Nepal and/or foreign import
Steel bolts	1,255,537 m	Nepal and/or foreign import
Anchor cable	103,987 m	Foreign import
Penstock	3,187 tonnes	Nepal and/or foreign import
Explosives	2,558 tonnes	Nepal
Diesel	59,766 tonnes	Nepal
Transmission Line		
Coarse aggregate (60 m^3/tower)	1,140 m^3	Locally sourced
Fine aggregate (20 m^3/tower)	380 m^3	Locally sourced
Water (15 m^3/tower)	285 m^3	Locally sourced
Cement (1,500 bags/tower)	28,500 bags	Nepal
Rebar (9 tonnes/tower)	170 tonnes	Nepal
Steel (25,000 kg/tower)	475,000 kg	Foreign import
Transmission wire	150 km	Foreign import
Optical ground wire	6 km	Foreign import
Overhead ground wire	6 km	Foreign import

Source: KEC 2019; CSPDR 2020

3.5.4 Construction Equipment and Machinery

As with the Construction Materials (Section 3.5.3), the construction equipment required will vary by project component (broken down by component in ***Table 3.19***). The transmission line will be in a remote area with limited road access, so most tower construction and conductor stringing will be done by hand. Therefore, little construction equipment or machinery will be required except for the first and last three towers that can be accessed from the UAHEP switchyard and the Arun Hub substation, respectively.

Table 3.19: UAHEP Construction Equipment and Machinery

Construction Equipment	Quantity	Capacity/Comments
Project Access Road		
Excavator	6	111 to 150 horsepower (HP)
Truck tipper	6	Up to 150 HP
Loader	2	~2.2 to 2.5 m^3
Jumbo driller	2	
Generator	6	500 kW
Air compressor	2	150 to 275 cfm
Backhoe loader	2	
Shotcrete machine	2	
Concrete mixer	2	
Grouting machine	2	
Roller	1	
Grader	1	
Hydropower Facility		
Down-the-hole drill	10	100 type
Raise boring machine	2	
Multi-arm drilling platform	6	
Excavator	11	1～3 m^3
Bulldozer	10	
Loader	13	
Dump truck	82	15～20 t
Vibrating roller	2	
Anchor hole drill	6	
Concrete sprayer	20	
Impact reverse circulation drill	10	
Hydraulic casing extractor	2	
Geological drilling rig	4	
Grout pump	4	
Axial flow fan	13	
Belt crane	1	Concrete spreading radius >30 m
High speed belt conveyor	1	B=760 mm
Cable crane	1	Span 355 m, lifting capacity 20 t
Temporary bridge crane	1	Lifting capacity 10 t
Vacuum chute	1	
Concrete pump	10	Production rate 60 m^3/h
Crawler crane	2	Lifting capacity 10 t
Crawler crane	1	Lifting capacity 40 t

Construction Equipment	Quantity	Capacity/Comments
Vibrating roller joint cutter	9	BW202AD or DA-50
Concrete mixer truck	32	6 m^3
Crane on placement surface	2	Lifting capacity 16～20 t
Telescoping steel form	6	8 to 12 m long
Flat truck	2	Load capacity 40 t and 80 t
Truck crane	3	50 t (2) and 100 t (1)
Penstock transport truck	2	40 t
Transmission Line		
Backhoe	1	
Crane	1	
Portable cement mixers	2	
Winches	2	

Source: KEC 2019; CSPDR 2020

3.5.5 Construction Traffic

Depending on the sourcing of various construction materials and equipment, project-related construction traffic may be originating from various locations in India, Nepal, and possibly China. This volume of traffic will be low and dispersed, but will be concentrated on a single road, the Koshi Highway, from Khandbari to the project site. Construction truck traffic from Khandbari to the project site will average about 23 trucks and 5 buses each way per day during construction. Heavy trucks traffic will adhere to the following requirements:

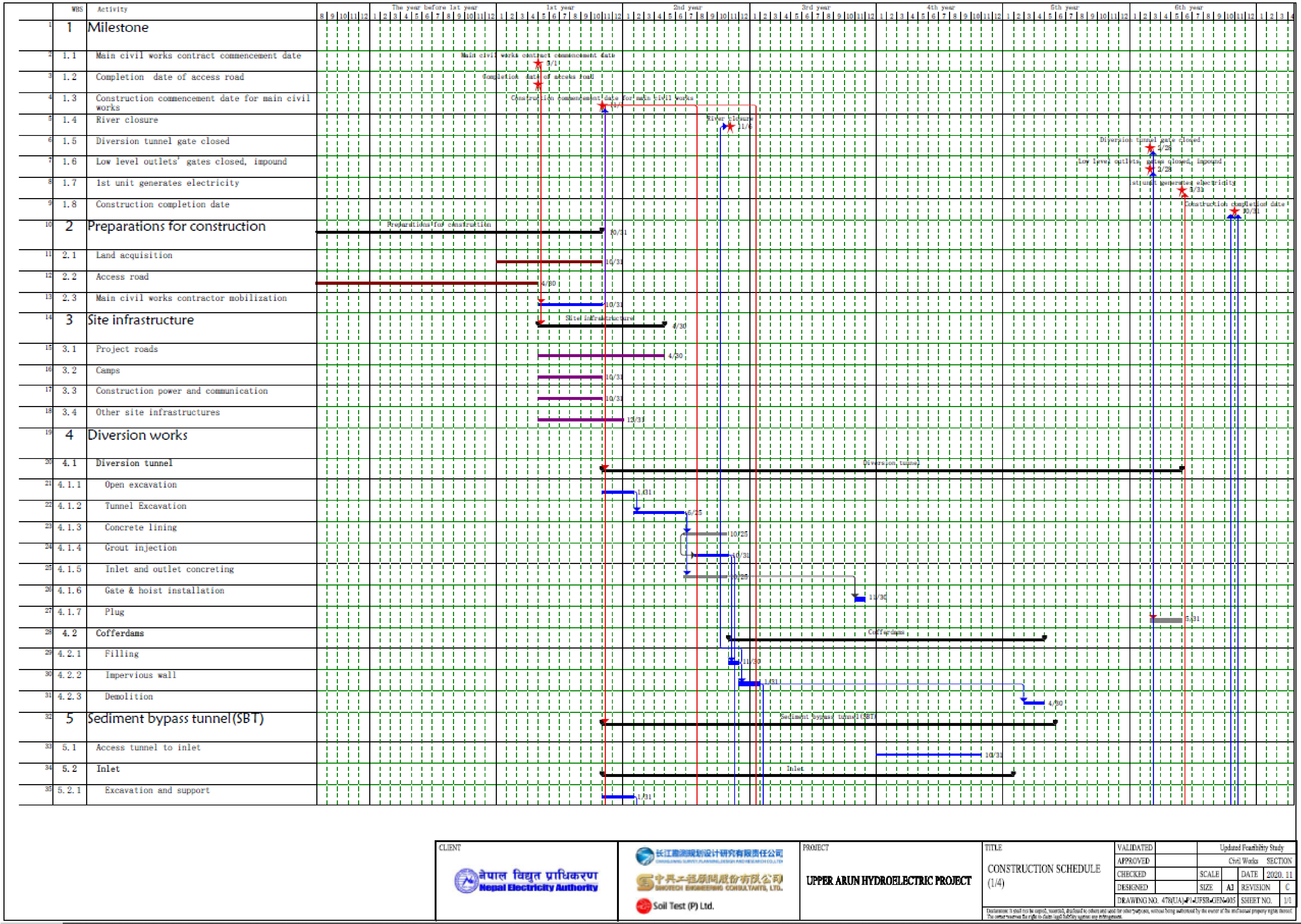
- A pilot/escort vehicle with flashing lights, siren, and megaphone will lead the truck to warn traffic, especially at bridges, and be staffed with an Engineer, overseer, and surveyor.
- Approach and cross all bridges at a maximum speed of 5 km/hour
- Traverse bridges through mid-width (center)
- Stop other traffic approaching the bridge in both directions
- Clear the bridge of all pedestrians, cyclists, and animals
- Avoid travel during the monsoon season to the extent possible

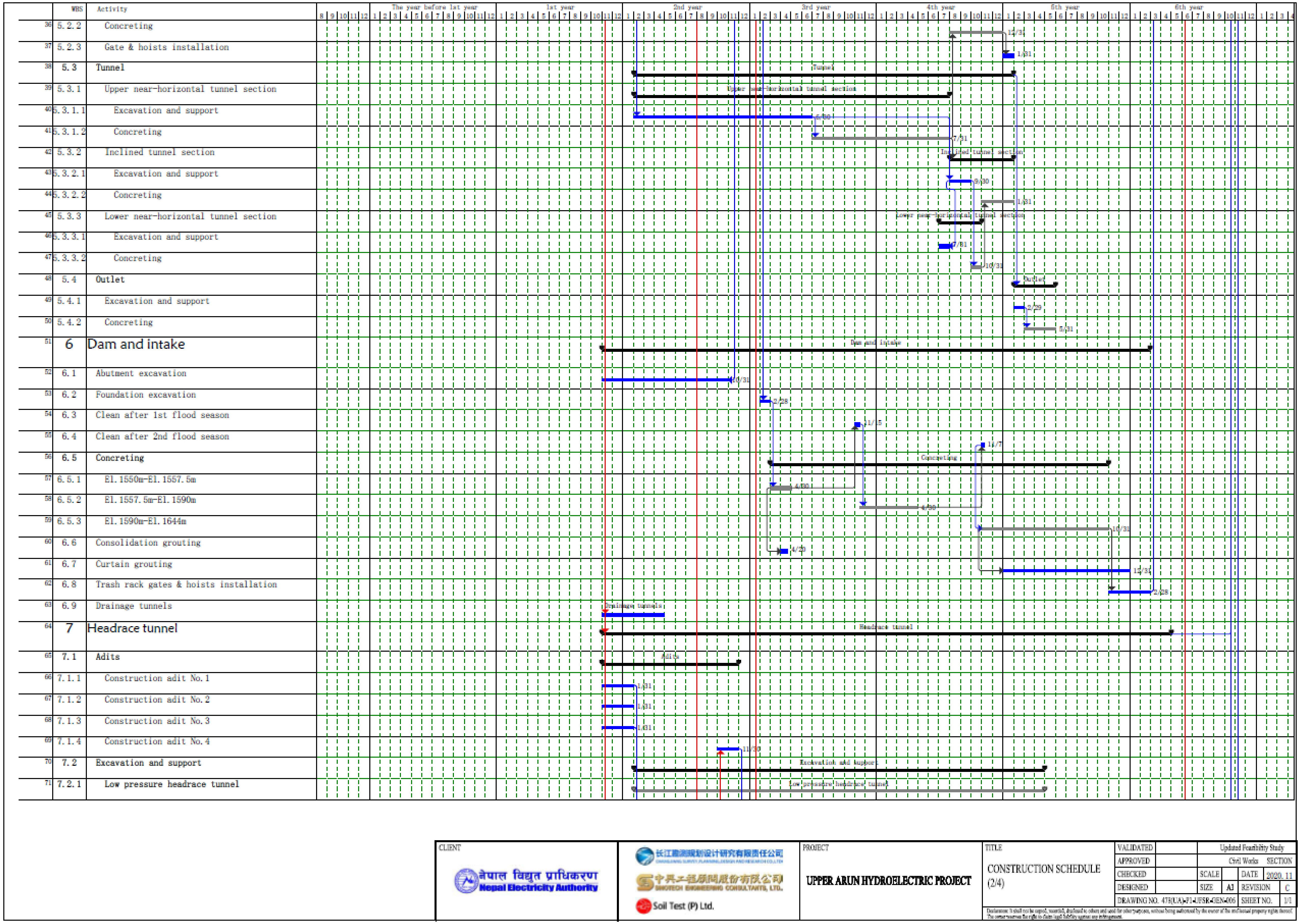
Average daily construction traffic along the project access road (within the project footprint) is estimated at 102 vehicles per day (72 trucks; 30 buses), which are proposed to transporting workers from workers' camps to the construction work areas (KEC 2019, updated to reflect expanded project capacity). This does not include additional traffic associated with project-related influx.

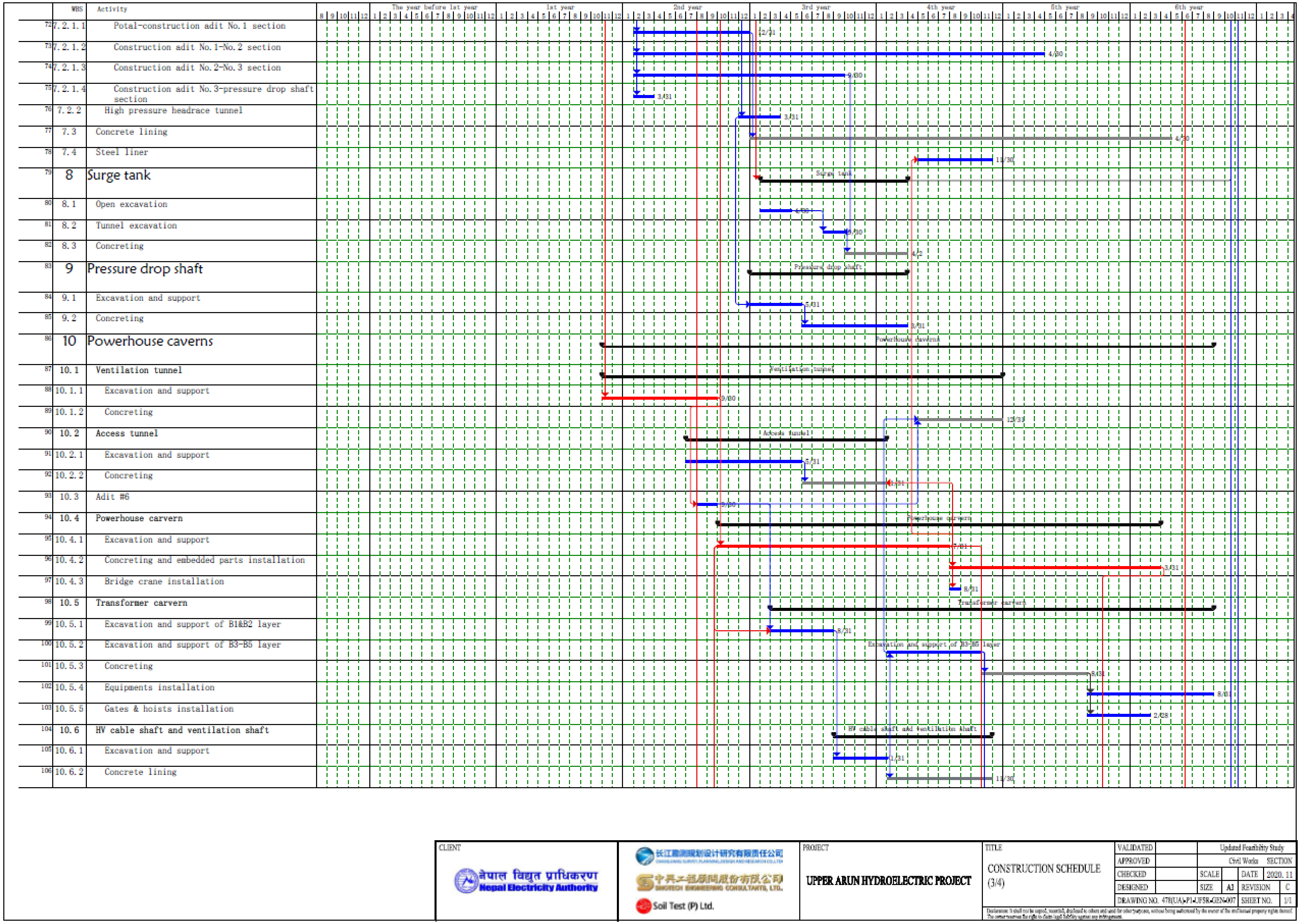
3.5.6 Implementation Schedule

Overall project construction, including the access road, hydropower facility, and the transmission line, is estimated to take approximately 84 months to implement. The project access road needs to be completed first to allow construction access for most of the hydropower facility. The access road is expected to take about 24 months to complete, although some initial hydropower facility construction activities could start before the road is completed, possibly using helicopters to transport equipment and materials and then at least being able to access the powerhouse site upon completion of the Arun River Bridge. The hydropower facility is expected to take about 60 months to complete. The master schedule allows for 24 months to construct the transmission line, although it is expected this work could be completed in less than 12 months and can be scheduled to generally coincide with the completion of the hydropower facility. ***Figure 3.25*** shows the key implementation milestones for the overall completion of the Project, including each of the three components.

Figure 3.25: Project Construction Schedule




WBS
Activity
The year before 1st year
1st year
2nd year
3rd year
4th year
5th year
6th year
36 5.2.2 Concreting
37 5.2.3 Gate & hoists installation
38 5.3 Tunnel
39 5.3.1 Upper near-horizontal tunnel section
40 5.3.1.1 Excavation and support
41 5.3.1.2 Concreting
42 5.3.2 Inclined tunnel section
43 5.3.2.1 Excavation and support
44 5.3.2.2 Concreting
45 5.3.3 Lower near-horizontal tunnel section
46 5.3.3.1 Excavation and support
47 5.3.3.2 Concreting
48 5.4 Outlet
49 5.4.1 Excavation and support
50 5.4.2 Concreting
51 6 Dam and intake
52 6.1 Abutment excavation
53 6.2 Foundation excavation
54 6.3 Clean after 1st flood season
55 6.4 Clean after 2nd flood season
56 6.5 Concreting
57 6.5.1 El. 1550m-El. 1557.5m
58 6.5.2 El. 1557.5m-El. 1590m
59 6.5.3 El. 1590m-El. 1644m
60 6.6 Consolidation grouting
61 6.7 Curtain grouting
62 6.8 Trash rack gates & hoists installation
63 6.9 Drainage tunnels
64 7 Headrace tunnel
65 7.1 Adits
66 7.1.1 Construction adit No.1
67 7.1.2 Construction adit No.2
68 7.1.3 Construction adit No.3
69 7.1.4 Construction adit No.4
70 7.2 Excavation and support
71 7.2.1 Low pressure headrace tunnel
CLIENT
नेपाल विद्युत प्राधिकरण
Nepal Electricity Authority
长江勘测规划设计研究有限责任公司
中国水利电力对外有限公司
Soil Test (P) Ltd.
PROJECT
UPPER ARUN HYDROELECTRIC PROJECT
TITLE
CONSTRUCTION SCHEDULE (2/4)
VALIDATED
Updated Feasibility Study
APPROVED
Civil Works SECTION
CHECKED
SCALE
DATE 2020.11
DESIGNED
SIZE A1
REVISION C
DRAWING NO. 478(UA)-P1-UFSR-GEN-006
SHEET NO. 1/1


WBS
Activity
The year before 1st year
1st year
2nd year
3rd year
4th year
5th year
6th year
72 7.2.1.1 Potal-construction adit No.1 section
73 7.2.1.2 Construction adit No.1-No.2 section
74 7.2.1.3 Construction adit No.2-No.3 section
75 7.2.1.4 Construction adit No.3-pressure drop shaft section
76 7.2.2 High pressure headrace tunnel
77 7.3 Concrete lining
78 7.4 Steel liner
79 8 Surge tank
80 8.1 Open excavation
81 8.2 Tunnel excavation
82 8.3 Concreting
83 9 Pressure drop shaft
84 9.1 Excavation and support
85 9.2 Concreting
86 10 Powerhouse caverns
87 10.1 Ventilation tunnel
88 10.1.1 Excavation and support
89 10.1.2 Concreting
90 10.2 Access tunnel
91 10.2.1 Excavation and support
92 10.2.2 Concreting
93 10.3 Adit #6
94 10.4 Powerhouse carvern
95 10.4.1 Excavation and support
96 10.4.2 Concreting and embedded parts installation
97 10.4.3 Bridge crane installation
98 10.5 Transformer carvern
99 10.5.1 Excavation and support of B1&B2 layer
100 10.5.2 Excavation and support of B3-B5 layer
101 10.5.3 Concreting
102 10.5.4 Equipments installation
103 10.5.5 Gates & hoists installation
104 10.6 HV cable shaft and ventilation shaft
105 10.6.1 Excavation and support
106 10.6.2 Concrete lining
CLIENT
नेपाल विद्युत प्राधिकरण
Nepal Electricity Authority
长江勘测规划设计研究有限责任公司
Soil Test (P) Ltd.
PROJECT
UPPER ARUN HYDROELECTRIC PROJECT
TITLE
CONSTRUCTION SCHEDULE
(3/4)
VALIDATED
APPROVED
CHECKED
DESIGNED
Updated Feasibility Study
Civil Works
SECTION
SCALE
DATE
2020. 11
SIZE
A3
REVISION
C
DRAWING NO.
SHEET NO.
1/1

	WBS	Activity
107	11	Tailrace tunnels
108	11.1	Excavation and support
109	11.2	Concrete lining
110	12	Tailrace platform and outlet
111	12.1	Excavation and support
112	12.2	Concreting
113	12.3	Gates & hoists installation
114	13	Units installation and debugging
115	13.1	1st unit
116	13.1.1	Installation
117	13.1.2	Debugging without water
118	13.1.3	Debugging with water
119	13.2	2nd unit
120	13.2.1	Installation
121	13.2.2	Debugging without water
122	13.2.3	Debugging with water
123	13.3	3rd unit
124	13.3.1	Installation
125	13.3.2	Debugging without water
126	13.3.3	Debugging with water
127	13.4	4th unit
128	13.4.1	Installation
129	13.4.2	Debugging without water
130	13.4.3	Debugging with water
131	13.5	5th unit
132	13.5.1	Installation
133	13.5.2	Debugging without water
134	13.5.3	Debugging with water
135	13.6	6th unit
136	13.6.1	Installation
137	13.6.2	Debugging without water
138	13.6.3	Debugging with water
139	14	Potyard
140	15	Transmission line

CLIENT		PROJECT	TITLE				
नेपाल विद्युत प्राधिकरण Nepal Electricity Authority	长江勘测规划设计研究有限责任公司 / 中国电建集团股份有限公司 SINOTECH ENGINEERING CONSULTANTS, LTD. / Soil Test (P) Ltd.	UPPER ARUN HYDROELECTRIC PROJECT	CONSTRUCTION SCHEDULE (4/4)	VALIDATED		Updated Feasibility Study	
				APPROVED		Civil Works	SECTION
				CHECKED		SCALE	DATE 2020. 11
				DESIGNED		SIZE A3	REVISION C
				DRAWING NO.	478(UA)-P3-UFSR-GEN-008	SHEET NO.	1/1

3.6 Project Commissioning, Operation, and Maintenance Activities

This section describes work activities associated with project commissioning and operation and maintenance (O&M).

3.6.1 Project Commissioning

Construction of the project access road will require pavement testing and inspection of slope stabilization and storm drainage facilities prior to issuance of a construction completion certificate.

- Hydropower facility and transmission line commissioning entails several activities over approximately the last 12 months of the project construction period. These activities include:
- Initiate operation phase, monitoring requirements during this phase to ensure a robust baseline against which to compare project operational performance
- Complete the Project's operation phase Emergency Preparedness and Response Plan
- Notify residents that the Project is entering the commissioning stage and provide appropriate safety briefings
- Ensure all project safety signage is in place
- Clear and remove forest within the reservoir's FSL – this forest should not be cleared until the reservoir is ready to be filled to minimize erosion and slope stability hazards
- Plug the diversion tunnel and incrementally fill the reservoir to the FSL (ideally this should occur during the dry season), including:
  - Conduct wildlife survey and relocate any less mobile wildlife that could be caught in the rising reservoir water level
  - Ensure the required environmental flow is released continuously during reservoir filling
- Install, test, and commission turbine unit No. 1
- Install, test, and commission turbine units No. 2–6
- Monitor all tunnels, penstock, and hydraulic systems
- Test and commission the switchyard and transmission line
- Conduct final audit, after which the Construction Completion Certificate is issued by the Project Engineer

3.6.2 Project Operations

Once project construction, testing, and commissioning is completed, the Construction Contractor will turn the Project over to UAHEL for operation and maintenance.

It is estimated that the UAHEP will produce 4,513 GWh on an average annual basis. As discussed in Section 1.2, the UAHEP is intended to not only help meet Nepal's overall energy needs, but to produce energy during the dry season, and especially during the peak demand period, which is the six hours from 18:00 to 24:00 hours. The Project is predicted to have a dry season energy ratio of nearly 28% (i.e., 28% of total energy generation will occur during the dry season, see ***Table 3.20***).

Table 3.20: UAHEP Power Generation Output

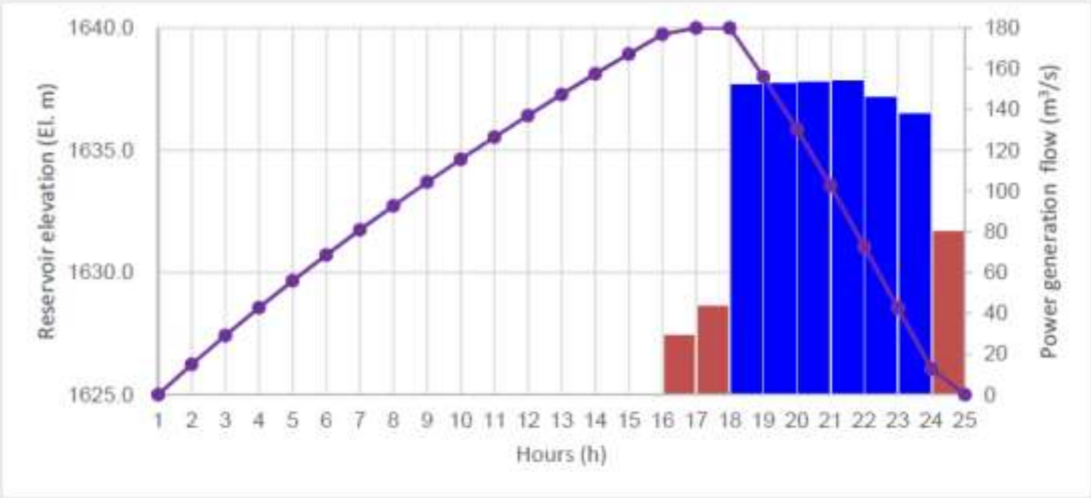
Item	Value
Installed capacity/firm capacity	1,040 MW / 697 MW
Average annual energy	4,513 GWh
Dry season energy - Peak - Off-peak - Dry season energy ratio	 834 GWh 416 GWh 27.7%
Wet season energy - Peak - Off-peak	 956 GWh 2,306 GWh

Typical Project Operations

To meet the energy generation demands, the UAHEP will need to operate in a peaking run-of-river (PRoR) mode, as described below:

- Run-of-River Operation Mode – The Project will generally operate in a RoR mode when river flow exceeds the Project's rated discharge capacity of 235.44 m^3/s, which typically occurs from June to October (i.e., monsoon season). Under RoR operations, the project reservoir elevation will remain relatively constant at its FSL of 1,640 m. When river inflow is larger than the full discharge of the available units, excess water will be routed around the dam via the SBT weir. When river inflow is above 575 m^3/s, then RoR operation will be modified in accordance with the Project's sediment management strategy (which is described in the next sub-section).
- Peaking Operation – The Project will generally operate in a daily peaking mode when river inflow is less than the full discharge of the available turbine units plus the required ecological flow, which typically occurs from November to May (i.e., the dry or lean season). During this period, the Operators will ensure the Project is at FSL at the beginning of the peak period (18:00 hour) and will maximize power generation during this 6-hour peak demand period, while limiting the rate of reservoir drawdown to 2.5 m/h for slope stability reasons and maintaining the minimum operating level (MOL) of 1,625 m. The project reservoir will be drawdown below the FSL to meet this peak demand. Once the peak demand period is over (24:00 hour), the Project Operators will refill the reservoir at the rate of no more than 2.5 m/h until the reservoir water level reaches FSL. Once at FSL, the Project Operators will match power generation discharge with river inflow, essentially operating in a RoR mode until 18:00 hour, when the peaking operation will begin and the process repeats itself. ***Figure 3.25*** presents hourly reservoir levels for a typical day of peaking operations.

Figure 3.26: Hourly UAHEP Reservoir Simulation on a Typical Day



Source: CSPDR 2020

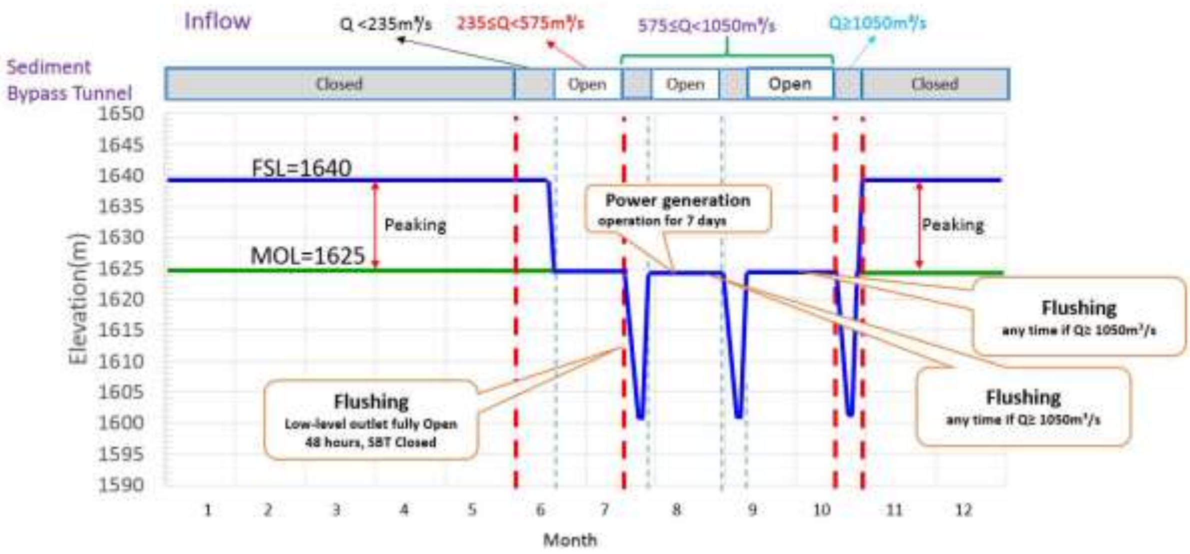
Sediment Management

The Arun River is glacial fed with a high sediment load, so proper management of sediment is critical to ensure a sustainable operation. The NEA, CSPDR, and the Project's Panel of Experts have devised the following sediment management strategy. The vast majority of the river's sediment load movement occurs during the monsoon season, and given the Project's primary purpose of meeting dry season peak energy demand, the relative value of river flow during the dry season is quite high, so the sediment management strategy primarily focuses on the monsoon season (June to October) when both flow and sediment loads are high. The sediment management strategy is as follows:

- Dry Season (November–May) – The Arun River carries very little sediment during this period so the Project will be operated without any specific measures for sediment management. The SBT inlet will be closed.
- Monsoon Season (June–October) – During the monsoon season, the Arun River carries a high sediment load and the Project will be operated in accordance with the following sediment management strategy:
  - When river inflow is larger than 240.5 m^3/s, but less than 575 m^3/s, the available turbine units (235.44 m^3/s) and the required environmental flow (EFlow) (5.41 m^3/s) will run at full discharge and excess water will be discharged via the SBT, which has a capacity of 815 m^3/s.
  - When the river inflow is larger than or equal to 575 m^3/s, but less than 1,050 m^3/s, the Project shut down the turbines in an enforced outage, lower the reservoir level using the mid-level outlet (MLO) gates, with a sill elevation of 1596 m, and then the LLO gates, with a sill elevation of 1590 m, will be opened to allow a free-flow flushing (i.e., reservoir empty) for a duration of 24 hours. The gates will then be closed and the reservoir allowed to refill at a controlled rate of no more than 2.5 m/h. The entire flushing procedure is expected to require about two days. This will occur whenever flows are above 575 m^3/s, but below 1,050 m^3/s, and it has been more than seven days since the last flush event (calculated from the end of the prior event).
  - When the river inflow is greater than 1,050 m^3/s, the Project will follow the same sediment flushing sequence described above, except the flushing will continue for as long as river inflow remains above 1,050 m^3/s. Once flow drops below 1,050 m^3/s, the LLO and MLO gates will gradually close and water levels in the reservoir will rise at a controlled rate of no more than 2.5 m/h.

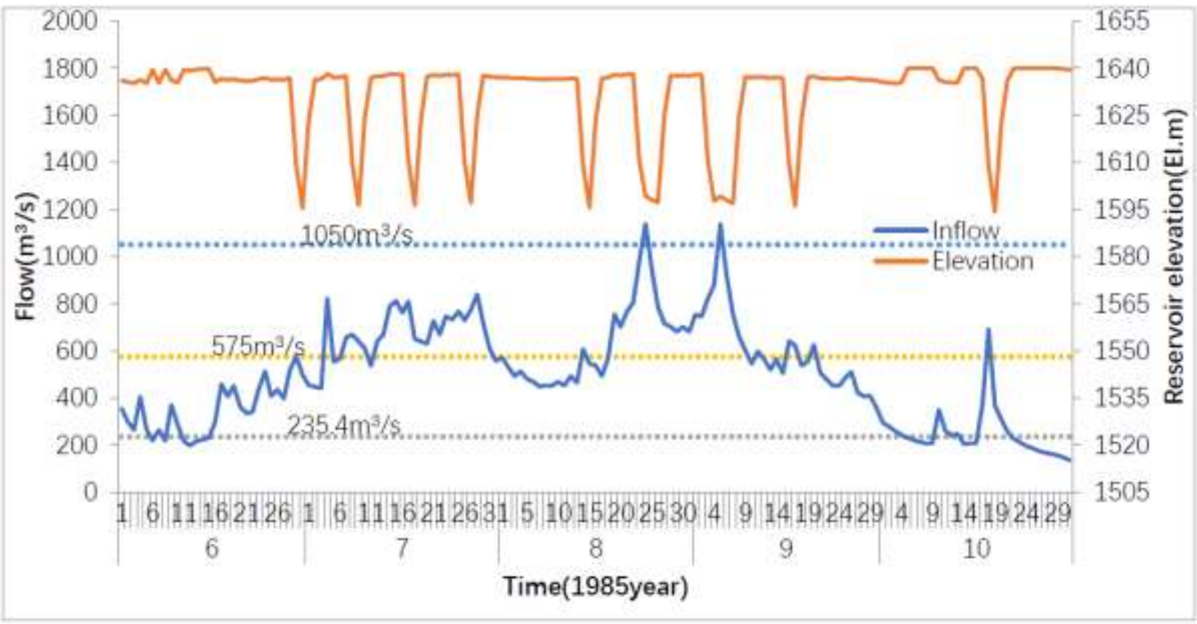
The flushing frequency will vary depending on the characteristics of the monsoon rains, but on average will result in five flushing events per year. ***Figure 3.27*** shows an example sequence of different operating modes, including sediment flushing, over the course of a year. ***Figure 3.28*** presents a simulation of reservoir sediment flushing operations for a representative year (1985).

Figure 3.27: Representative Project Operations



Source: CSPDR 2020, p. 170

Figure 3.28: Simulation of Reservoir Sediment Flushing Operations



Source: CSPDR 2020, p. 171

Environmental Flow Releases

The Project will release a continuous minimum EFlow of 5.41 m^3/s. The release of this environmental flow takes precedence over all other flow requirements or needs (e.g., even under extreme droughts, EFlow takes precedence over flow for power generation). The Project will ensure that the EFlow can be released across the full range of reservoir operating levels.

UAHEL proposes an eco-flow power station so as to generate some additional power from the 5.41 m^3/s EFlow release. The powerhouse will be located on the left bank of the Arun River immediately downstream from the dam and will discharge the EFlow at the toe of the dam. The power station will have a bypass valve to release the EFlow even when the power station is shut down. The EFlow intake will be located on Section No. 3 of the dam with a sill elevation of 1,615.6 m, which is below the reservoir's MOL of 1,625.0. The only time the reservoir will be below the MOL is when the Project has opened its gates to flush sediment, in which case far more water is being released than the EFlow requirement.

Operation Phase Workforce

It is estimated that the Project will employ about 130 workers during the operation phase. These workers will be primarily operating and maintaining the hydropower facility, with only a few workers required to for periodic maintenance on the access road and transmission line. It is estimated that the operations workforce will be about 50% skilled (e.g., Project Operators and management), 25% semi-skilled (e.g., facility maintenance staff), and 25% unskilled (e.g., primarily housekeeping and general maintenance). It is anticipated that initially 75% of the workers could be from Nepal, with this percentage increasing over time as Nepali staff gain more operational experience and can assume more responsibility. Again, the hiring of women and other marginalized/traditionally excluded groups will be encouraged.

3.6.3 Project Maintenance

UAHEL will adopt industry good practice regarding the operation and maintenance of the UAHEP, such that the downtime of individual generating units and plant will be minimized and the operational reliability will be maximized.

CSPDR recommends that turbine maintenance occur at the end of the wet season. This timing reflects the large cumulative effect of sediment abrasion on the units during the wet season and will ensure that the turbines are in good operating condition before peaking operations begin in the dry season. It is proposed that maintenance is conducted on two turbines per month (on average) at the end of the wet season. This will help ensure the efficient and stable operation of all units during the peaking period in the dry season.

The access road and transmission line require routine inspection, especially after the monsoon season, to identify needed repairs.

4. PROJECT ALTERNATIVES AND ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

4.1 Introduction

An alternatives analysis is a fundamental component of the mitigation hierarchy and its objective of avoiding and minimizing environmental and social impacts. The consideration of alternatives is also a key component of documenting that the proposed design is the preferred option for achieving the project purpose, taking into consideration and balancing environmental, social, engineering, and cost considerations. Alternatives analysis is also an essential component of the ESIA that takes into consideration the valid concerns of project-affected people and adjusts the project design accordingly. The World Bank ESS 1 requires a systematic comparison of feasible alternatives to the proposed site/location, design/technology, and operation, as well as consideration of the "without project" situation (World Bank 2017), and is a critical ESIA component, especially for projects deemed by the WB to be of substantial or high risk.

The Importance of alternatives is also reflected in the Nepal EIA regulations, which require the consideration of alternatives. The Hydropower Environmental Impact Assessment Manual (MoFE 2018) recommends considering alternative locations, technologies, modes of operation, ancillary and associated facilities, and project phasing.

Based on the World Bank and MoFE guidance, the following alternatives were considered in finalizing the project design, construction methods, and operational modalities:

- Without project alternative (Section 4.2)
- System alternatives (Section 4.3)
- Location alternatives, including ancillary facilities (Section 4.4)
- Design/technology alternatives (Section 4.5)
- Construction alternatives (Section 4.6)
- Operational alternatives (Section 4.7)
- Decommissioning alternatives (Section 4.8)

These various alternatives to the proposed project configuration are described in the follow sections. Each alternatives was systematically evaluated using the following criteria:

- Technical/engineering criteria
- Economic/financial criteria
- Environmental and social/cultural criteria

For each criterion we indicate whether the alternative is preferred, acceptable, or unacceptable, and which alternative has been adopted as part of the proposed project.

4.2 Without Project Alternative

Under the Without Project Alternative, the UAHEP would not be constructed. This would avoid all of the environmental and social/cultural impacts associated with construction and operation of the Project, as described in Chapter 7 (Environmental and Social Risks, Impacts, and Mitigation). Not constructing the Project, however, would not address the anticipated shortages in meeting Nepal's projected power demand, especially peak demand during the dry season, in the foreseeable future, as described in Section 1.2 (Project Purpose and Need).

Other sources of annual energy that would be required to replace the energy production from the UAHEP would equate to 2,254 tonnes of coal (at 1,100 pounds of coal per MWh) or 5 million barrels of oil (at 1.6 barrels per MWh, both of which would need to be imported from India.

The other way of examining the Without Project Alternative is to consider the likely impacts associated with other “replacement” hydropower projects that would be needed to provide the equivalent annual average energy and dry season peak demand energy that will be provided by the UAHEP. The UAHEP takes advantage of a unique and highly valuable water resource in the Upper Arun River. The Arun River has been recognized since at least the 1980s (see Section 1.1 – Project Background) for its hydropower potential, especially considering its relatively high dry season flow. In fact, the dry season flow in the Arun River is greater in absolute terms than any other river in eastern Nepal with comparable elevation (Kattelmann 1990). The ratio of dry season to wet season flow in the Arun River (0.23) is much higher than other tributaries of the Sapta Koshi (average of about 0.15), which is attributable to flow contributions from snow and glacier melt. Further, the Arun River’s low season discharge also tends to be relatively consistent between years, which further increases its value for hydropower generation in a country subject to extreme dry and wet seasons where flows in most rivers are extremely attenuated during the dry season.

While not without its own risks and impacts, the UAHEP would be considered a high quality project by several key hydropower environmental and social metrics. The World Bank’s *Good Dams and Bad Dams: Environmental Criteria for Site Selection of Hydroelectric Projects* (World Bank 2003) identifies several key indicators of likely environmental and social impacts. Two of the key indicators for which there are comparable metrics provided in the paper are:

- Reservoir Surface Area – This is considered a strong proxy for many environmental and social impacts (Goodland 1997). It is measured as a ratio of surface area flooded per megawatt of capacity (ha/MW), with 60 ha/MW estimated at that time as the global average for large hydroelectric projects. The lower the value the better. The value for UAHEP is 0.2 ha/MW (20.1 ha reservoir surface area/1,040 MW of installed capacity), which would be the best value when compared to the 50 projects for which data are provided in the report (listed projects ranged from <1 to 5,333 ha/MW), and among the best in the world.
- Persons Requiring Physical Resettlement – This is a critical social indicator and is measured as a ratio of the number of people physically displaced per megawatt. The lower the value the better. The value for UAHEP is 0.14 people/MW (152 people physically displaced/1,040 MW of installed capacity), which would be the fifth best value among the 50 projects for which data are provided in the report (listed projects range from 0 to 1,000 persons/MW), and a very low number by international standards for a project of this magnitude. It should be recognized that the physically displaced people from the UAHEP are from especially vulnerable indigenous peoples communities, the impact of which can get lost when just looking at the numbers.

Using these two fundamental environmental and social indicators, combined with the Arun River’s naturally high dry season base flow and available net head, makes the Arun River’s hydrology a highly valued resource. As a result, there are quite likely no other hydropower projects in Nepal that could provide the UAHEP’s average annual energy and dry season energy with similarly low environmental and social impacts, based on these metrics (***Table 4.1***). Since there are relatively few sites available that can support an over 1,000 MW capacity project (e.g., only two have been proposed to date – the 1,902 MW Mugu Karnali HEP in northwest Nepal and the 1,200 MW Budhi Gandaki HEP in central Nepal), it is reasonable to assume that multiple smaller projects would be needed to provide energy equivalent to what will be provided by the UAHEP. Multiple smaller projects would mean additional dams, access roads, and transmission lines, all of which are likely to have worse indicator values than the UAHEP, collectively resulting in significantly more environmental and social impacts.

Table 4.1: Comparison of UAHEP to Other HEPs in Nepal

Hydroelectric Project	Reservoir Surface Area/MW	Physically Displaced Persons/MW	Physically & Economically Displaced Persons/MW
UAHEP*	0.02 (20.1 ha/1,040 MW)	109/1,040 MW= 0.10	1,723/1,040 MW= 1.66
Upper Tama Koshi**	0.05 (21.3 ha/456 MW)	14 HH@4.8 (= 67persons)/ 456 MW) = 0.15	276 HH@4.8 (=1,327 persons)/ 456MW= 2.9
Arun-3 HEP***	0.07 (66.3 ha/900 MW)	24 HH/139 persons#/900 MW= 0.15	1,246/900 MW= 1.38
Budhi Gandaki****	5.25 (6,300 ha/1,200 MW)	20,260 persons/ 1,200 MW: 16.88	45,611 persons/ 1,200 MW): 38.01

* UAHEP-RAP-Final _PA REV final 25 Feb (https://www.nea.org.np/publications?page=4)

** Subash Ghimire: *Assessing the Role of Land Tenure in Hydropower Development for Social And Environmental Effects*, Feb. 2011 (http://essay.utwente.nl/93177/1/Subash%20-Ghimire-23527.pdf). Figures based on Feasibility study & EIA Report, 2005

*** RAP of Arun-3 HEP, Feb. 2017, https://sapdc.com.np/uploads/doc/RAP-Arun3-HEP.pdf

Calculated as 24 HH @ 5.8 persons on average (according to RAP)

**** Sushil Kumar Gyawali: So*cio-Economic Impacts of Hydropower Development: A Case Study of Budhigandaki Hydropower Affected Darbungphaat and Majhitaar Villages of Gorkha and Dhading Districts*, 2019 (http://conference.ioe.edu.np/publications/ioegc2019-winter/IOEGC-2019-Winter-10.pdf)

In summary, the Without Project Alternative would not take advantage of a unique and high value water resource (i.e., Arun River), would not meet Nepal's energy needs, and the construction of alternative projects to provide the needed energy would likely have significantly more environmental and social/cultural impacts. For these reasons, the Without Project Alternative is not preferred.

4.3 System Alternatives

Section 1.2 documents the UAHEP's purpose and Nepal's need for power. This section evaluates alternative energy sources available to meet Nepal's power needs.

Nepal does not have its own reserves of gas, coal, or oil, plus the World Bank states that the projects it finances should reduce their impact on climate by choosing alternatives with lower carbon emissions anyway (World Bank 2023, p. 1). So these options can be are eliminated. Many households in Nepal currently rely on biofuels (e.g., firewood, dung) for cooking and heat, but increasing the use of biofuels to meet Nepal's power needs would threaten the country's valuable forests and biodiversity and raise health concerns due to indoor air pollution, so biofuels are not considered a viable energy source on a national basis.

This leaves the renewable energy sources of hydropower, wind and solar as the most viable for Nepal. Thus far, relatively little wind or solar power generation has been developed in Nepal. Both wind and solar power can contribute to meeting Nepal's power demands, but would struggle to provide the overall average annual energy or meet the peak dry season power demands that the UAHEP is intended to generate. Although Nepal has relatively good wind power potential, including estimates of as much as 3,000 MW of capacity (Alternative Energy Promotion Center 2008), other studies (Upreti and Shakya 2010) estimate the commercially viable wind potential of Nepal at only about 448 MW, or less than half of the UAHEP capacity. Solar would definitely not be able to meet the peak period demand that the UAHEP is targeting, which is primarily night-time hours (i.e., 18:00–24:00 hours).

Nepal has tremendous hydropower potential, estimated at over 83,000 MW, with about 42,000 MW of this considered technically and economically feasible. The Arun River is an especially valuable hydropower water resources, as discussed in Section 4.2. Hydropower is a clean, renewable energy source with extensive application and proven technology in Nepal. Further, the Government of Nepal is committed to reaching 5,000 MW of total hydropower capacity in Nepal within five-year (MoEWRI 2018), and the UAHEP is a key project for achieving this goal. Therefore, for these reasons, hydropower is considered the preferred energy source for meeting the purpose and need of the UAHEP.

4.4 Location Alternatives

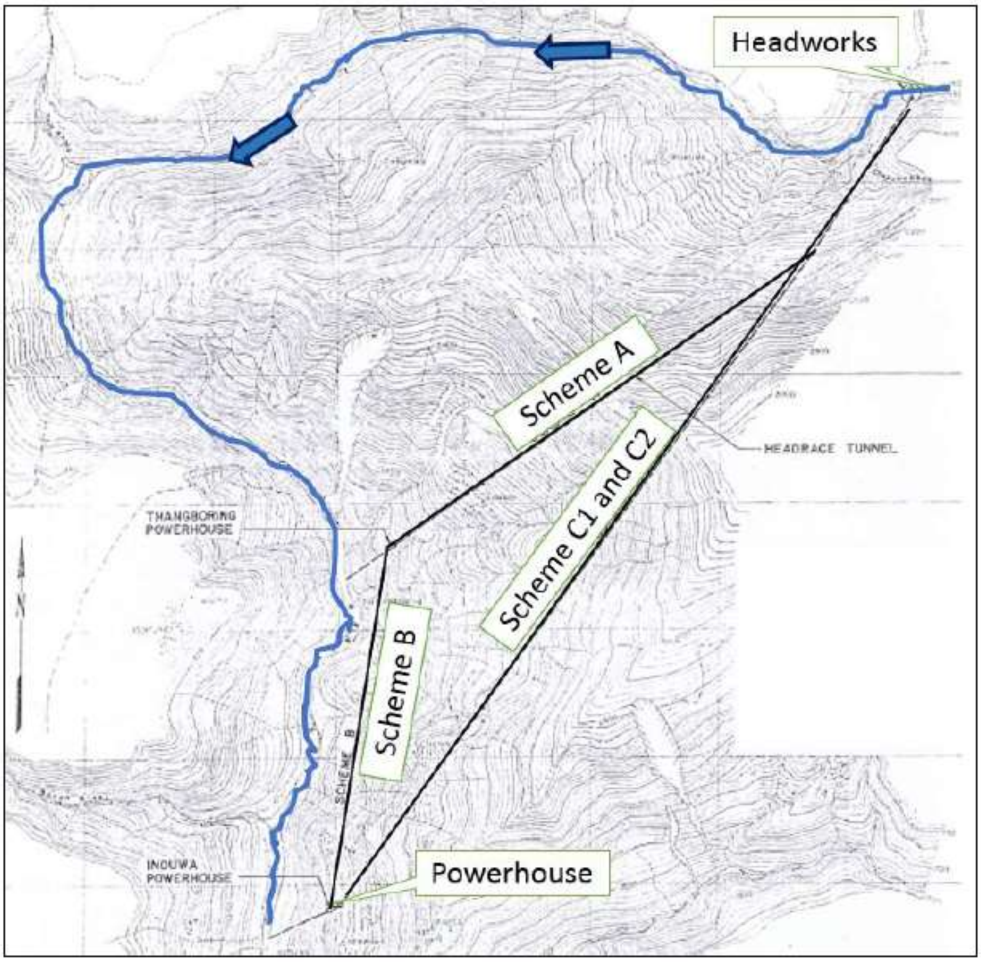
4.4.1 Project Development Alternatives

Two principal alternatives were considered for the UAHEP:

- Cascade development – which would involve a single headworks, but two powerhouses (***Figure 4.1*** – Schemes A and B)
- Integrated development – which would involve a single headworks and a single powerhouse (***Figure 4.1*** – Schemes C1 and C2)

The original 1987 concept contemplated development of the total power potential by two power plants arranged in cascade with the water discharging from the first power plant being captured and piped to the second power plant. Subsequent reviews suggested some modifications of the original plan, in particular, consideration of the integrated development of the total head by a single power plant, as a promising alternative to the original concept. The two alternatives, cascade development and integrated development, are practically identical with respect to installed capacity, energy output, plant operation, and utilization of the power and energy.

Figure 4.1: Project Development Alternatives



Source: CSPDR 2020

Technical/Engineering Considerations

The cascade development alternative would have a relatively complicated operation mode, given that both powerhouses would have PRoR operations.

Financial/Economic Considerations

The construction cost for two powerhouses for the cascade development alternative is higher than for the integrated development alternative

Environmental and Social/Cultural Considerations

The cascade development alternative would have an approximately 8% longer headrace tunnel and two powerhouses, which would generate more spoil, require more land acquisition, disturb more land, and require the clearing of more vegetation.

Summary

The integrated development alternative is preferred based on technical, economic, environmental and social/cultural criteria and was adopted for the project design.

4.4.2 Headworks Location Alternatives

The headworks is composed of the dam, the flood discharge and sediment flushing facilities, the power intake, and the diversion structures required during construction.

Three basic alternatives were considered for the headworks location:

- Upstream alternatives – Upstream options are limited by the proposed Kimathanka hydropower project tailrace, which is proposed less than 1 km upstream from the UAHEP headwaters.
- Chepuwa alternative – The proposed location is located upstream from Chepuwa Khola.
- Downstream alternatives – CSPDR evaluated a site about 1.7 km farther downstream from the Chepuwa alternative. Alternatives farther downstream were not considered viable because the very steep gorge topography would not allow sufficient suitable area for construction activities and it would lower the available head, thereby reducing power generation.

Technical/Engineering Considerations

The proposed Kimathanka HEP tailrace would be located less than 1 km upstream from the UAHEP headwaters, which limits the extent that the UAHEP dam could be shifted upstream without affecting the Kimathanka operations. The downstream alternative site is wider with large deposits of colluvium and slope wash where the left dam abutment would be located, which would increase dam stability and safety risks.

Financial/Economic Considerations

The upstream alternative site would be more difficult to access as it would be located in more of a steep gorge setting, which would increase construction challenges and costs.

The downstream alternative site is wider and would require a larger dam and geotechnical measures to address the colluvium stability risks identified above, both of which would increase the cost of the dam relative to the Chepuwa site. The downstream alternative would also generate less power because of the reduced head.

Environmental and Social/Cultural Considerations

Headworks location alternatives farther upstream or downstream offer no meaningful benefits and several potential disadvantages relative to the Chepuwa alternative. Upstream alternatives would require a longer access road, longer headrace tunnel and more associated spoil, more forest clearing, and a longer diversion reach, relative to the Chepuwa alternative. For these reasons, the Chepuwa alternative is the environmentally and socially preferred site.

Summary

Upstream alternatives are limited by the proposed Kimathanka HEP and would have greater environmental impacts. Downstream headworks alternatives would have a greater impact on Rukma and would generate less power with similar environmental impacts. Therefore, the Chepuwa alternative was adopted for the project design.

4.4.3 Project Waterway Route Alternatives

Two basic alternatives were considered for the headrace tunnel (***Figure 4.2***):

- Straight route alternative
- Curved route alternative

Technical/Engineering Considerations

The lithology and geologic structure along the two routes would be basically the same, but the routes would differ in terms of overlying rock mass. Tunnels with rock depths of greater than 600 m would have high in-situ stresses, which increase the risk of a rock burst. The curved route would have less overlying rock mass (i.e., maximum overlying rock depth of 1,135 m with 2,000 m of tunnel buried at a depth greater than 600 m). The straight route would have more overlying rock (i.e., maximum overlying rock depth of 1,440 m with 4,300 m of tunnel buried at a depth greater than 600 m).

Each of the tunnel alternatives would have three construction adits. The total length of the adits for the curved route would be 460 m, while the total length for the straight route would be 1,395 m.

Financial/Economic Considerations

The curved route would require less total tunnel excavation (tunnel + adits) and would be completed in 54 months, versus 57 months for the straight route, which would result in a US$4.1 million cost savings (US$89.2 million versus US$93.3 million).

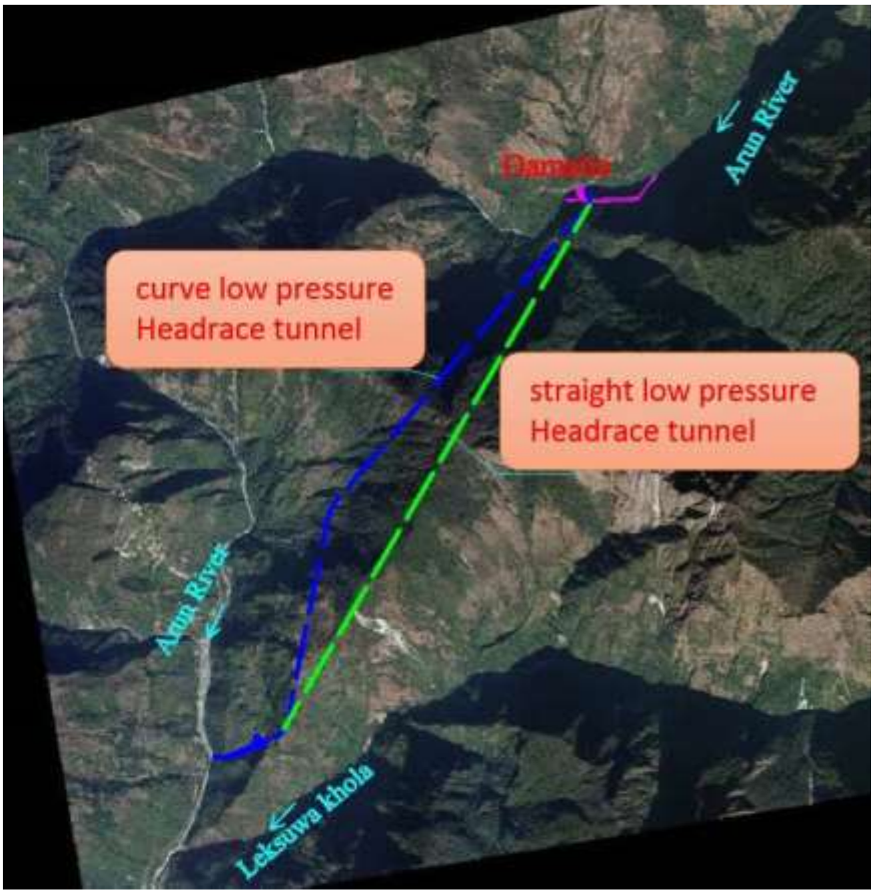
Environmental and Social/Cultural Considerations

Both tunnels would be completely underground, so would have no surface impacts on biodiversity or people, but the curved tunnel (including required adits) would be shorter 708 m shorter (7%) and generate proportionately less spoil, so is preferred.

Summary

The curved route is preferred for technical, cost, environmental, and social reasons, so was adopted for the project design.

Figure 4.2: Waterway Tunnel Route Alternatives



Source: CSPDR 2020

4.4.4 Powerhouse Location Alternatives

Three basic alternatives were considered for the powerhouse location:

- Upstream alternatives – upstream from the Limbutar site to approximately a location across from the Barun River. The Arun River upstream from the confluence with the Barun is located within a steep gorge that is not suitable for hydropower development.
- Limbutar alternative – at the location of the currently proposed UAHEP
- Downstream alternatives – downstream from the Limbutar site

Technical/Engineering Considerations

The upstream alternatives would reduce the Project's net head. The Limbutar alternative maximizes the Project's net head. There are not really any technically feasible downstream alternatives as Leksuwa Khola functions as a barrier to any further extension of the waterway, so this alternative is not discussed further.

Financial/Economic Considerations

The upstream alternatives would reduce the Project's average annual energy generation by reducing the net head. The Limbutar alternative maximizes the Project's energy production and net head.

Environmental and Social/Cultural Considerations

The upstream alternatives would bring the powerhouse and various ancillary facilities closer to the large village of Sibrun, with likely more physical and economic displacement, and closer to the confluence of the Barun River, which is considered a holy river by several faiths. The upstream alternative would have a 1.6 km shorter diversion reach (14.9 km versus 16.5 km) with less impact on aquatic habitat.

The Limbutar alternative would impact on the small settlement of Limbutar, but avoid the large social impacts on the larger village of Sibrun associated with the upstream alternative. The Limbutar alternative would result in a longer diversion reach than the potential upstream alternatives, but would not improve access for upstream migrating fish to any potential spawning streams, as there are none between Leksuwa Khola and the dam.

Summary

The Limbutar location maximizes the economic value of a highly valuable water resource. Locations further downstream are not technically feasible as Leksuwa Khola effectively limits the extent of the headrace tunnel. Locations further upstream are technically viable, but would result in more physical and economic displacement relative to the Limbutar alternative, and greater impact on the cultural significant Barun River. Therefore, a powerhouse location near Limbutar was adopted for the project design.

4.4.5 Tailrace Outlet Location

There are no geologically suitable sites for the tailrace along Leksuwa Khola because it is full of alluvium and colluvium, which are not stable. Therefore, the tailrace outlet needs to be along the Arun River upstream from the confluence with Leksuwa Khola in a geologic zone with gneiss outcrops. Two alternative sites were considered:

- Upstream alternative – located approximately 700 m upstream from the confluence with Leksuwa Khola at approximately elevation 1,095 m
- Downstream alternative – located just upstream from the confluence with Leksuwa Khola at approximately elevation 1,086 m

Technical/Engineering Considerations

The upstream alternative would have a tailrace tunnel of approximately 600 m in length, whereas the downstream alternative would have a tailrace tunnel of approximately 1,300 m. The upstream alternative would be closer to the project access road and the geology is more suitable for a tunnel.

Financial/Economic Considerations

The downstream alternative would have a 9 m larger (1.8%) net head, but would cost US$18 million more (1.9%) relative to the upstream alternative. Both alternatives are considered similar from a financial/economic perspective.

Environmental and Social/Cultural Considerations

The downstream alternative would result in a diversion reach that would be about 700 m longer and would generate more spoil as a result of the much longer tailrace tunnel.

Summary

Both alternatives are considered feasible, but for technical and environmental reasons the upstream alternative was adopted for the project design.

4.4.6 Project Access Road Alignment Alternatives

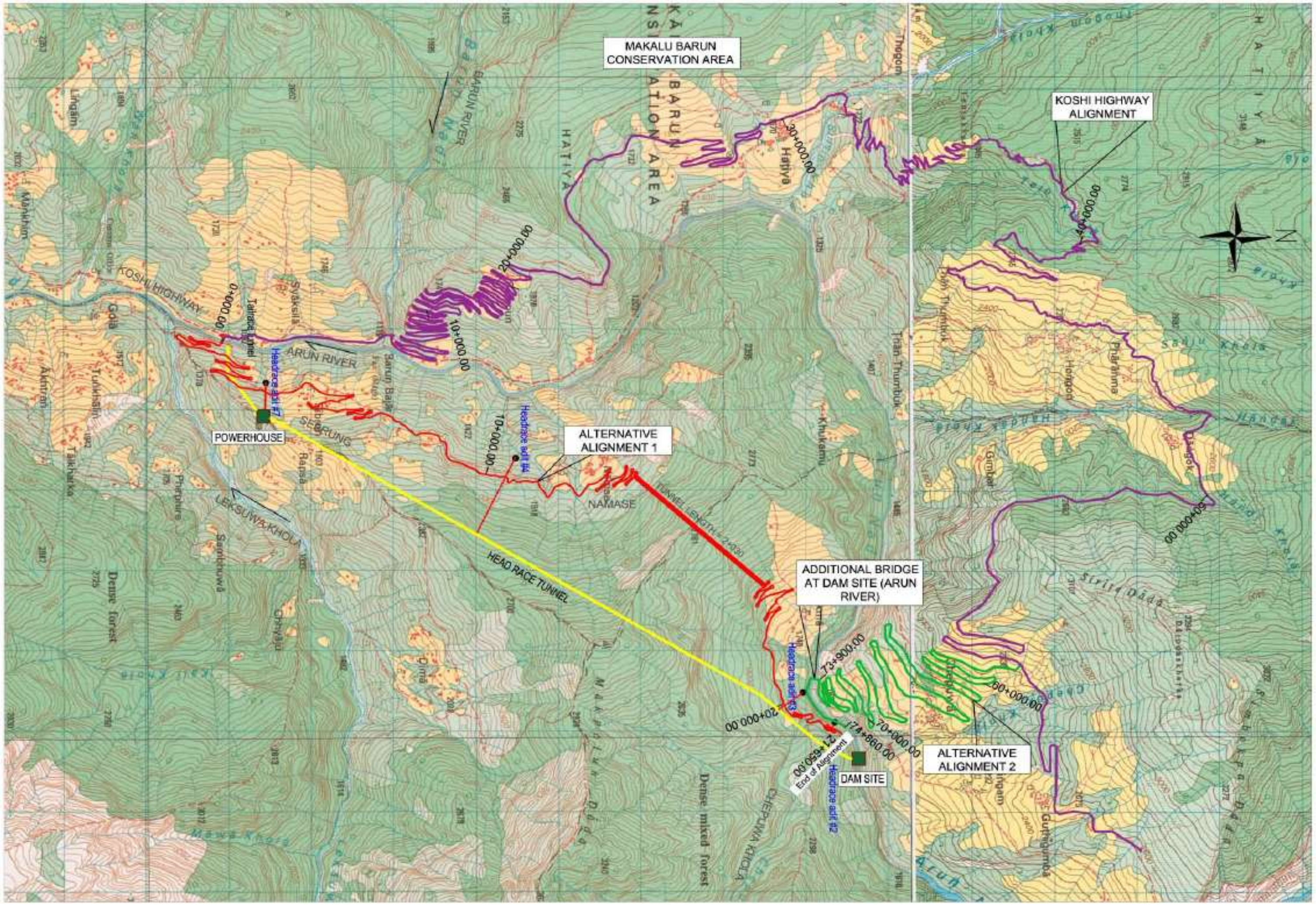
Project access road alternatives were considered at a macro-scale and then subject to more detailed alternative evaluation for road segments through the villages of Limbutar and Sibrun, as well as alternatives for crossing the ridge from Namase to Rukma, as described below. The access road has to provide construction vehicle access to the at least five sites – the UAHEP headworks, powerhouse, and the three headrace tunnel adits (one near the headworks at headrace tunnel station 0+807, one near Hema at station 5+524, and one near the powerhouse at station 8+459).

Macro-Scale Route Alternatives

The initial determination was whether the Project's headworks area should be accessed from the Arun River's left bank or right bank, as facing downstream. Two alternatives were considered, each starting at a point along the Koshi Highway, approximately 2 km north of the village of Gola (***Figure 4.3***), as described below:

- Alternative alignment 1 (left bank route) – Under this alternative, UAHEL would construct a new approximately 21.6 km long access road from this starting point on the Koshi Highway about 2 km north of Gola, which would cross the Arun River with a new bridge, and include a 2.03 km long tunnel, to access the UAHEP headworks from the left bank.
- Alternative alignment 2 (right bank route) – Under this alternative, from the same starting point approximately 2 km north of Gola, the Koshi Highway would be followed for an additional 58 km to reach the village of Chepuwa. This portion of the Koshi Highway is under construction and would still require significant improvement (e.g., construction of a new bridge over the Barun River) before it would be suitable for use by the UAHEP. From Chepuwa, UAHEL would construct a new approximately 14 km long access road to access the UAHEP headworks from the right bank. Under this alternative, UAHEL would also need to construct an access road following the same alignment as the left bank route for the first approximately 6 km, including the Arun River Bridge, to access the UAHEP powerhouse area and the headrace tunnel adit near the village of Hema.

Figure 4.3: UAHEP Macro-Scale Access Road Route Alternatives



Source: KEC 2018

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Technical/Engineering Considerations

Alternative 1 (left bank route) is approximately 50 km shorter, would take less time to travel, avoid higher elevations that are subject to snow in the winter, and crosses fewer bridges. Alternative 2 (right bank route) would follow 58 km of the Koshi Highway, which is still under construction. UAHEL would be dependent on construction of this road being completed in time for the start of UAHEP construction, including the completion of 7 bridges, one of which would be a major crossing of the Barun River. If the road was not completed, or did not meet UAHEP design requirements, then UAHEL would need to assume responsibility for the completion of this road or upgrading it to meet its needs.

Financial/Economic Considerations

Alternative 1 (left bank route) would be less expensive to construct and the operational costs would be less as Alternative 2 (right bank route) would take about four hours longer to reach the headworks construction area.

Environmental and Social/Cultural Considerations

Alternative 1 (left bank route) would affect fewer villages (5 villages – Limbutar, Sibrun, Hema, Namase, and Rukma) relative to Alternative 2 (right bank route) (8 villages – Syaksila, Barun Bagar, Sempun, Hatiya, Than Thumbuk, Hongon, Dangok, and Chepuwa). Although seven of these villages would be affected by the Koshi Highway road construction anyway, these villages would experience increased vehicle traffic if the UAHEP-related traffic followed the right bank route. It is estimated that the right bank route would physically displace approximately 50 households, as compared to approximately 25 for the left bank route. From the point where the two routes diverge, the left bank route would only have about 100 m of its length within the MBNP Buffer Zone, whereas nearly the entire length of the right bank route would affect the MBNP core and buffer area.

Summary

For technical, economic, environmental, and social reasons, as summarized in ***Table 4.2***, the left bank route was adopted for the project design.

Table 4.2: Comparison of Macro-Scale Route Alternatives

Criteria	Left Bank	Right Bank
Existing Koshi Road[1]	0 km	58 km
New road construction	22 km	14 km (Chepuwa) + 6 km (Limbutar)
Total road length	22 km	78 km
# Bridges crossed	2 bridges	7 bridges
# Tunnels	1 tunnel	0 tunnels
Highest elevation	2,050 m at Namase (snow infrequent)	2,600 m at Gimbar (snow common)
Schedule	NEA responsible for construction	Dependent on Koshi Hwy construction
Total construction cost	$44 million	$55 million
Travel time	~1 hour	~ 5 hours
# Villages affected	5 villages	8 villages
Physical resettlement	~25 households	~50 households
MBNP/Buffer length	0.1 km	74.1 km

Source: KEC 2018

[1] Starting point is approximately 2 km north of Gola where the two routes diverge.

Limbutar Route Alternatives

Based on the analysis above, the left bank route was selected. This route would affect the small settlement of Limbutar (six households). An alternatives analysis was conducted to determine if the road could avoid impacting Limbutar (see Appendix D-1). The analysis concluded that for technical reasons, given the steep slopes the access road needs to ascend, the settlement of Limbutar cannot be avoided. Limbutar would also be located in the center of the powerhouse area, which will experience significant construction activity, traffic, noise, vibration, dust, and other impacts. These other activities would impact on the agricultural land that these households rely on for their livelihoods. It was concluded that the physical resettlement of these six households was needed for safety and livelihood reasons. There was no change to the project access road alignment in this area.

Sibrun Route Alternatives

Similar to the settlement of Limbutar described above, the project access road would also impact on the village of Sibrun, so this segment of the access road was also analyzed to determine if the impacts on Sibrun could be avoided or at least reduced. Three alternative routes were evaluated:

- Alternative 1 (Central or Red Route) – proposed alternative
- Alternative 1A (Downslope or Purple Route)
- Alternative 1B (Upslope or Green Route)

See Appendix D-2a (Kyongdong Access Road Alternatives Memo, January 2019) and Appendix D-2b (UAHEP Access Road Alternatives, June 2019), for more details on these alternatives.

A comparison of these alternatives is set out in ***Table 4.3***.

Table 4.3: Access Road Alignment Alternatives – E&S Considerations

Criteria	Alternative 1	Alternative 1A	Alternative 1B
Length	2.8 km	2.9 km	3.5 km
Maximum grade	10%	12%	11%
Cost	US$2.46 million	US$2.55 million	US$3.07 million
# Affected households	1 house	3 houses	0 houses
Other	Near school	Near temple	

Technical/Engineering Considerations

Alternative 1 is the shortest route and the only route that meets Nepal road standards and design criteria. Alternatives 1A and 1B exceed the maximum road grade of 10%.

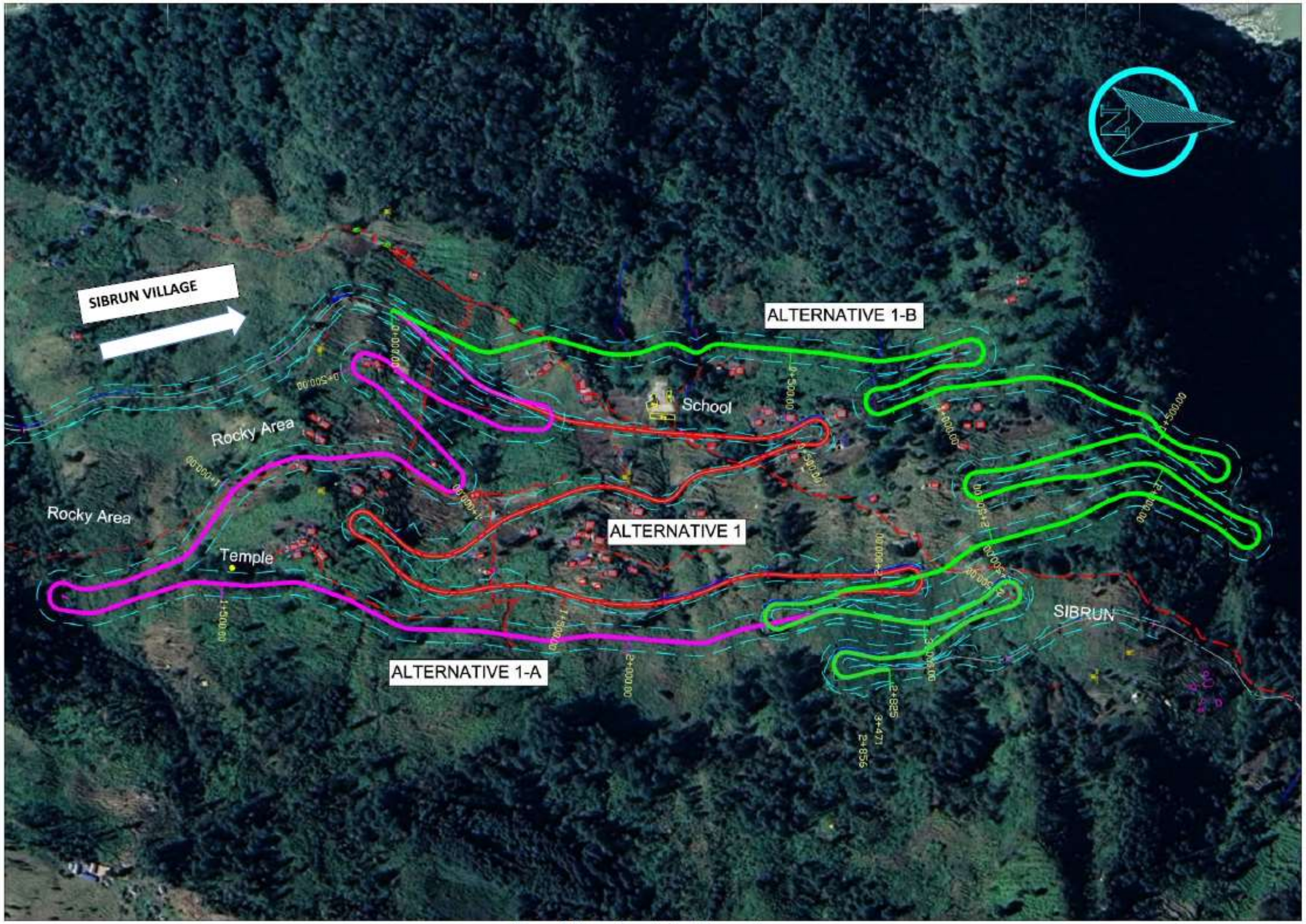
Financial/Economic Considerations

Alternative 1 is the least cost alternative, while Alternative 1A and 1B would incur additional costs, primarily associated with the longer routes.

Environmental and Social/Cultural Considerations

Alternative 1 goes through the center of Sibrun, which was the impetus for evaluating alternatives for this route in the first place, because of the potential social disruption to the village. Routes 1A and 1B were intended to generally represent alternatives going downslope and upslope from Sibrun, rather than through it. The downslope alternative would also result in physical displacement, while the upslope alternative would avoid physical displacement, but increases economic displacement by increasing the amount of agricultural land affected.

Figure 4.4: Sibrun Route Alternatives



Summary

Construction of the access road in this area is technically challenging. None of the alternatives are considered good from an environmental and social/cultural perspective. Technical review of the alternatives concluded that only Alternative 1 meets engineering design standards for the required vehicle loads. From an environmental and social/cultural perspective, this alternative will trigger the need for a robust Resettlement Action Plan, Livelihood Restoration Plan, and Traffic Management Plan, including education and awareness training for local residents about traffic risks. Ultimately, a variation of Alternative 1 was adopted for the project design, which was able to reduce the number of physically displaced households from 16 to 8 households by careful micro-routing of the alignment through the village of Sibrun[5].

Tunnel Alternative

For the project access road to reach the headworks, it needs to go through or around the very steep ridge that separates Namase from Rukma. Two alternatives were considered for this (***Figure 4.5***):

- Tunnel alternative – would involve construction of a 2.03 km long tunnel through the ridge
- Contour alternative – would involve construction of an 8.6 km long surface road generally following the contours around the ridge

Technical/Engineering Considerations

The contour alternative is much longer and would need to cross a large active landslide area that would be difficult to stabilize and maintain. The tunnel alternative would require extensive excavation of the tunnel, but would otherwise not present any technical issues. The contour alternative would also take much longer to travel, about 30 minutes compared to about 7 minutes for the tunnel.

Financial/Economic Considerations

The contour alternative would cost US$15.6 million, compared to US$17.0 million for the Tunnel Alternative, in terms of total project capital expense.

Environmental and Social/Cultural Considerations

The contour alternative would require land acquisition and clearing of approximately 24 ha of forest versus negligible land acquisition and clearing for the tunnel (essentially limited to the tunnel portal areas), and would impact portions of the villages of Khukamu and Rukma.

Summary

Although the tunnel alternative would cost slightly more, it would avoid the risks associated with the landslide area, which could effectively interrupt project access to the headworks area if a landslide was to occur that damages the road. Hence, for technical, operational, environmental and social/cultural reasons, the tunnel alternative was adopted for the project design.

4.4.7 Ancillary Facilities Location Alternatives

The UAHEP will require nearly 30 ancillary facilities (e.g., spoil disposal sites, workers' camps, power plants, water plants, quarries, crushers, batching plants, fabrication shops, fuel depot, and explosives depot). ***Tables 4.4*** and ***4.5*** compare the various alternative facility locations for the headworks and powerhouse areas, and ***Figures 4.6*** ad ***4.7*** show the recommended facility sites. The UAHEP Ancillary Facilities Alternatives Memo (ERM 2 July 2019) provide a detailed description of each facility, alternatives considered, and the recommended facility locations (Appendix D-3).

[5] The World Bank is still reviewing the design of the access road. The Project's Resettlement Action Plan will need to be updated to account for any changes in the road design.

Figure 4.5: Tunnel versus Contour Alternatives

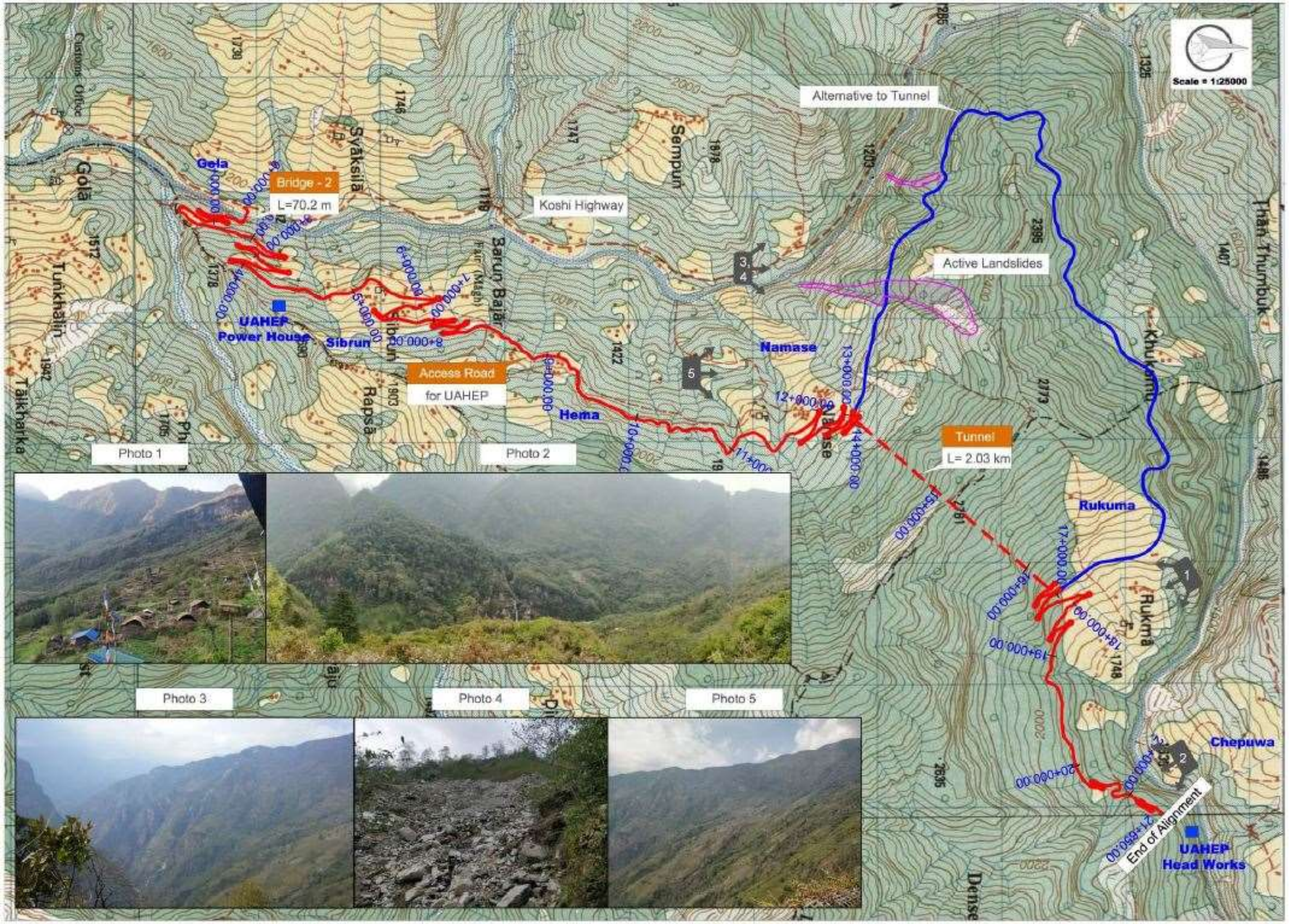


Figure 4.6: UAHEP Headworks Area Proposed Ancillary Facilities

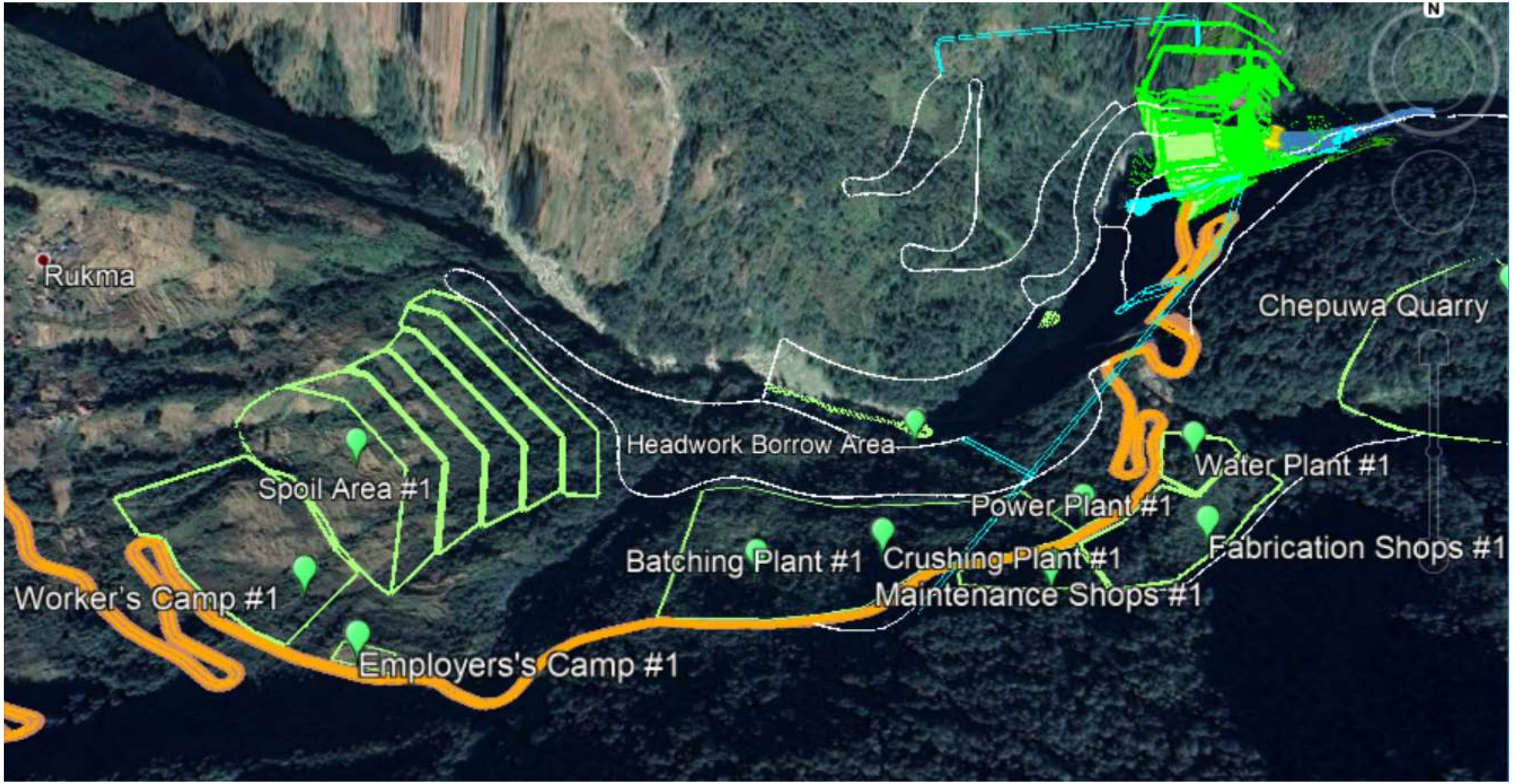


Table 4.4: Comparison of Headworks Area Ancillary Facilities Alternatives

Headworks Area Ancillary Facility	Alternatives (Recommended Alternative)	Facility Area (ha)	Meets Siting Requirements (Y or N)	Buildings Affected (#)	Agricultural Impacts (ha)	Distance to Nearest Village (km)	MBNP (Y or N)	Potential for Noise Impacts (Y or N)	Potential H&S Risks (Y or N)
Headworks Quarry	Chepuwa Quarry	16.9	Yes	3	0.1	1.7	No	No	No
	Rukma Quarry	8.4	Yes	0	1.3	0.2	No	Yes	Yes
Chepuwa Quarry Service Road	South Quarry Service Road	3.1	Yes	0	0.0	1.1	No	No	No
	North Quarry Service Route	0.3	No	0	0.0	1.2	No	No	No
Crushing and Batching Plants #1	North Side of the Access Road	9.9	Yes	0	0.0	1.0	No	No	No
	Within the Chepuwa Quarry	16.9	No	0	0.1	1.2	No	No	Yes
	Right Bank	6.7	Yes	0	0.1	0.8	Yes	Yes	No
Borrow Area #1	Left Bank Alternative	0.5	Yes	0	0.0	1.0	No	No	No
	Right Bank Alternative	0.1	Yes	0	0.0	1.0	Yes	No	No
Spoil Disposal Site #1	Alternative #1 – Left Bank	15.5	Yes	0	6.9	0.3	No	Yes	No
	Alternative #1A – Right Bank	6.7	Yes	0	4.0	0.8	Yes	No	No
Employers Camp #1	Alternative #1	0.4	Yes	0	0.1	0.6	No	No	No
	Alternative #1A	0.4	Yes	0	0.0	0.6	No	No	No
Contractor Camp #1	Alternative #1	4.7	Yes	0	2.8	0.3	No	Yes	No
	Alternative #1A	4.6	Yes	0	3.0	0.1	No	Yes	No
	Alternative #1B	1.0	Yes	0	0.4	0.9	No	No	No
Power Plant #1	Alternative #1	0.3	Yes	0	0.0	1.4	No	No	No
	Alternative #1A	0.5	Yes	0	0.0	0.8	No	No	No
Water Plant #1	Alternative #1	0.8	Yes	0	0.0	1.3	No	No	No
	Alternative #1	1.5	Yes	0	0.0	1.3	No	No	No

Headworks Area Ancillary Facility	Alternatives (Recommended Alternative)	Facility Area (ha)	Meets Siting Requirements (Y or N)	Buildings Affected (#)	Agricultural Impacts (ha)	Distance to Nearest Village (km)	MBNP (Y or N)	Potential for Noise Impacts (Y or N)	Potential H&S Risks (Y or N)
Maintenance Shop #1	Alternative #1A	0.8	Yes	0	0.3	0.3	No	Yes	No
Fabrication Shop #1	Alternative #1	2.8	Yes	0	0.0	1.4	No	No	No
Storage Yard #1	Alternative #1	0.9	Yes	0	0.0	0.9	Yes	No	No
	Alternative #1A	0.2	Yes	0	0.0	0.9	Yes	No	No

Figure 4.7: UAHEP Powerhouse Area Ancillary Facilities Alternatives

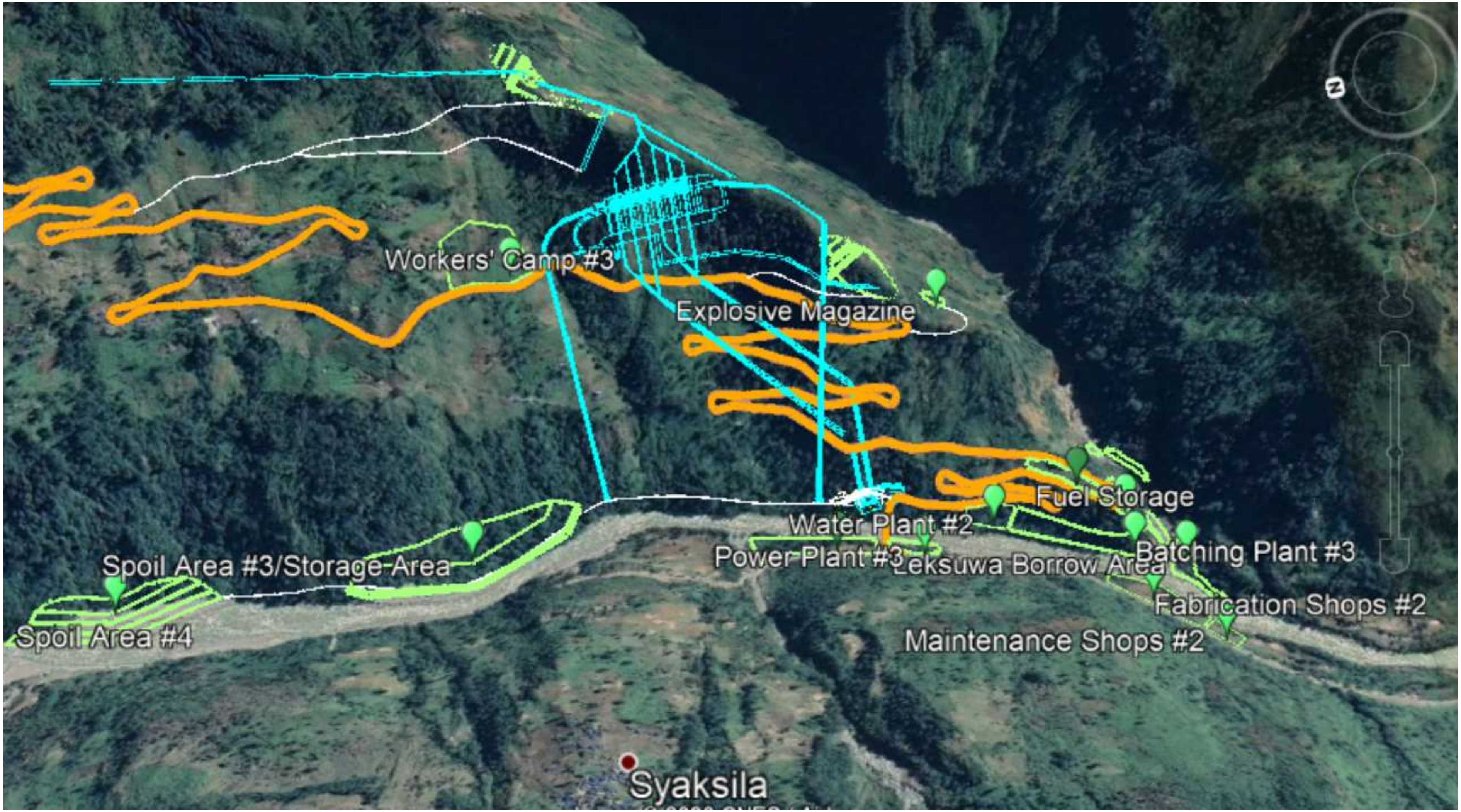


Table 4.5: Comparison of Powerhouse Area Ancillary Facilities Alternatives

Powerhouse Area Ancillary Facility	Alternatives (Recommended Alternative)	Facility Area (ha)	Meets Siting Requirements (Y or N)	Buildings Affected (#)	Agricultural Impacts (ha)	Distance to Nearest Village (km)	MBNP (Y or N)	Potential for Noise Impacts (Y or N)	Potential H&S Risks (Y or N)
Storage Yard	Alternative #2	1.8	Yes	0	0.0	0.3	No	No	No
	Alternative 2A	2.1	Yes	0	1.3	0.1	No	Yes	Yes
Contractor Camp/Office	Alternative #2	1.4	Yes	0	1.4	0.1	No	Yes	No
	At Sibrun Village	1.3	Yes	2	0.9	0.0	No	Yes	Yes
	Alternative #2B	1.4	Yes	0	0.6	0.6	Yes	No	No
Spoil Disposal Area	Alternative #2	2.9	Yes	0	0.0	0.2	No	Yes	No
	Alternative #2A	4.3	Yes	0	1.9	0.4	No	No	Yes
Borrow Area	Alternative #2	1.1	Yes	0	0.0	0.3	No	Yes	No
	Alternative #2A	2.0	No	0	0.1	0.1	Yes	Yes	No
Explosives Depot	Alternative #1	1.3	Yes	0	0.0	0.8	No	No	No
	Alternative #1A	2.1	Yes	0	0.8	0.5	Yes	No	No
Power Plant #2 (Powerhouse Area)	Power Plant #2	0.4	Yes	0	0.0	0.8	Yes	No	No
	Power Plant #2A	0.4	No	0	0.0	0.8	No	No	No
Water Plant #2 (Powerhouse Area)	Water Plant #2	0.4	Yes	0	0.0	0.8	No	No	No
	Water Plant #2A	0.1	Yes	0	0.0	0.8	Yes	No	No
Batching Plant #3 (Powerhouse Area)	Alternative #3	1.6	Yes	0	0.0	0.5	No	No	No
	Alternative #3A	2.1	No	0	0.8	0.5	Yes	No	No
Workers' Camp #3 (Powerhouse Area)	Alternative #3	0.7	Yes	0	0.6	0.1	No	Yes	No
	Alternative #3A	0.8	Yes	0	0.7	0.0	No	Yes	Yes
	Alternative #3B	1.1	Yes	4	0.7	0.0	No	Yes	Yes
Employers Camp #2 (Powerhouse Area)	Alternative #2	0.8	Yes	0	0.3	0.6	No	No	No
	Alternative 2A/B	0.5/1.9	Yes	1/0	0.9	0.5	Yes	No	No
	Alternative #2C/D	1.2/1.5	Yes	5/3	0.4	0.0	No	Yes	Yes
Fabrication Shop #2	Alternative #2	1.4	Yes	1	0.6	0.6	Yes	No	No

Powerhouse Area Ancillary Facility	Alternatives (Recommended Alternative)	Facility Area (ha)	Meets Siting Requirements (Y or N)	Buildings Affected (#)	Agricultural Impacts (ha)	Distance to Nearest Village (km)	MBNP (Y or N)	Potential for Noise Impacts (Y or N)	Potential H&S Risks (Y or N)
	Alternative #2A	1.2	Yes	0	0.6	0.4	Yes	No	No
Fuel Depot #1	Left Bank	0.2	Yes	0	0.1	0.6	No	No	No
	Right Bank	0.3	Yes	0	0.1	0.3	Yes	No	No

There are several challenges facing the siting of ancillary facilities for the UAHEP:

- The right bank is part of the MBNP Buffer Zone, so efforts were made to avoid and minimize the placement of permanent facilities on the right bank, when left bank alternatives were available.
- The topography is very steep in much of the project area and there are unstable soils and landslide prone areas, which together limit the suitability of large areas for many of the ancillary facilities, which generally require gentler slopes, or extensive grading will be required.
- Most of the extremely steep slopes are forested, and these forests help maintain the stability of these slopes, so the clearing of forests, especially on steep slopes, should be minimized.
- Most areas that are not extremely steep tend to be used for residential and agricultural uses, especially growing cardamom and millet, and agricultural lands should be avoided to the extent possible.

Therefore, in nearly all locations, the siting decisions would unavoidably involve impacting the MBNP, extremely steep slopes, forested areas, relatively high value agricultural areas, and/or displacing families. In general, the guiding principles applied in this alternatives analysis were as follows:

- Avoid physical displacement except in the case where critical project infrastructure unavoidably requires resettlement.
- Avoid placing permanent facilities in MBNP.
- Avoid extremely steep slopes and landslide prone areas.
- Avoid placing permanent facilities on agricultural land, except where these impacts are unavoidable.
- The villages of Sibrun, Namase, and Rukma will unavoidably be impacted by the Project. Facilities have been placed to minimize direct impacts and to maximize buffers with the villages.

As indicated above, Appendix D-3 describes the alternatives considered for each ancillary facility, but some key recommendations are listed below:

- MBNP – No permanent ancillary facilities were placed within MBNP core or Buffer Zone, and only the following temporary facilities:
  - Headworks area – Only construction access roads to access the right bank of the dam were adopted for the project design; no other ancillary facilities were located within the MBNP.
  - Powerhouse area – The powerhouse area (note that the powerhouse will be underground) is characterized by very steep slopes, which limit the placement of ancillary facilities in this area. Some limited ancillary facilities are located within the MBNP Buffer Zone, including a workers' camp, power plant, fabrication shop, and maintenance shop. All of these facilities would be temporary and removed at the end of project construction, all would be located on land that would unavoidably be impacted by the project access road ancillary facilities, which need to be within the MBNP Buffer Zone until the Arun River Bridge is completed. These locations would minimize forest clearing and would restore the sites after the completion of construction for agricultural or other purposes in consultation with the property owner.
- Physical displacement – Only a few facilities would require physical displacement.
  - Contractor Camp #4 would displace three households near Chongrak
  - Project Road #4 would displace one household near Chepuwa
- Buffers to villages – 500 m buffers from ancillary facilities to local villages were adopted to the extent possible, as several ancillary facilities were relocated or moved farther away from the villages of Sibrun, Hema, Namase, Rukma, and Chepuwa.

4.4.8 Transmission Line Alignment Alternatives

Two basic alternatives were considered for connecting the UAHEP powerhouse/switchyard with the proposed Arun Hub substation (***Figure 4.8*** and ***Table 4.6***):

- High route
- Low route

Table 4.6: Comparison of Transmission Line Routes

Criteria	High Route	Low Route
Technical Criteria		
Total length	6.4 km	5.8 km
Terrain condition (elevation gain + loss)	1,346 m	1,293 m
Accessibility	No existing access roads	No existing access roads
Operations/maintenance	Similar	Similar
System reliability	Similar	Similar
Financial and Economic Criteria		
Construction cost	US$6.53 M	US$5.95
Environmental Criteria		
Forest within RoW (ha)	21.3	20.1 ha
Number of Arun River crossings (potential for bird collisions)	0	0
MBNP Buffer in row	0	0
Social Criteria		
Agricultural land within RoW (ha)	7.5	6.1
Number of buildings within RoW	2	0
Number of towers in community forest	3	0

Technical/Engineering Considerations

The high route would be slightly longer at 6.4 km, compared to 5.8 km for the low route. Both would need to traverse difficult terrain

Financial/Economic Considerations

The high route is estimated to cost US$6.53 million to construct, as compared to US$5.95 million for the low route.

Environmental and Social/Cultural Considerations

The high route is longer and would result in more forest clearing (21.3 ha), more impacts on agricultural land (7.5 ha), and the physical displacement of two buildings, while the low route would affect less forest (20.1 ha), less agricultural land (6.1 ha), and not affect any households.

Summary

The low route is preferred for technical, cost, environmental, and social reasons, so was adopted for the project design. Appendix D-4 provides more details on this alternatives analysis.

Figure 4.8: UAHEP Transmission Line Alignment Alternatives

Source: Appendix D-4; Notes: green = low route; red = high route

4.5 Design Alternatives

This section presents the design alternatives that were considered that have meaningful differences in potential environmental and social/cultural impacts.

4.5.1 Dam Type

Three basic alternatives were considered

- Concrete arch dam
- Concrete gravity dam
- Rock-filled embankment dam

Technical/Engineering Considerations

The geological conditions at the dam with a high stress relief zone make the site unsuitable for an arch dam. A rock-filled embankment dam is not appropriate either because an embankment dam cannot be overtopped by flow, so would require several large tunnels for passing flood flows. Given the project setting in the Himalaya's with the potential for GLOFs during a period of uncertainty relative to the effects of climate change, an embankment dam poses a higher risk than a concrete gravity dam. The design of these large tunnels in an embankment dam would be of lower sediment flushing efficiency and subject to severe abrasion and potential clogging. Therefore, the arch and rock-filled embankment dam types were both determined to not be technically feasible, and the concrete gravity dam was determined to be the most appropriate and safest design from a technical and engineering perspective.

In terms of concrete gravity dam, both a conventional and a RCC gravity dam were evaluated. The RCC dam would use fly ash with low cement content, which simplifies construction relative to controlling temperature during concrete curing, while the conventional dam would require more complex temperature control measures.

Financial/Economic Considerations

In terms of concrete gravity dam alternatives, the RCC dam is quicker to construct and meets the requirements of reaching elevation 1,590 m by the end of April of Construction Year 4 (see Section 3.4.3), so the conventional dam would increase schedule risk and associated costs.

Environmental and Social/Cultural Considerations

As indicated above, the concrete arch and embankment dams were determined to not be technically acceptable for safety reasons. The arch and embankment dams would also both generate more spoil as a result of greater excavation for the dam footings (arch dam) or more tunnelling (embankment dam). There is no meaningful difference in terms of environmental and social/cultural considerations for a conventional versus an RCC dam.

Summary

A RCC dam was considered the safest, has lower cost, and poses the least schedule risk, so was adopted for the project design.

4.5.2 Dam Axis

The dam axis is the line of the upstream edge of the top of the dam. Two basic dam axis alternatives were considered

- Straight axis
- Arc axis

Technical/Engineering Considerations

The high sediment load in the Arun River will cause abrasion damage to the LLO gates when they are opened to flush sediment in accordance with the Sediment Management Strategy (see Section 3.6.2). The width of the LLOs would be less for the straight axis dam, which means they will be subject to more hydraulic impact and will incur more concrete abrasion. Further, the integrity of the dam with an arc axis is better than with a straight axis in terms of withstanding seismic events.

Financial/Economic Considerations

The gravity dam with the straight axis will require more excavation (940,000 m^3), relative to the gravity dam with the arc axis (854,000 m^3), which will increase costs.

Environmental and Social/Cultural Considerations

The straight axis will require more excavation and poses higher safety risks, therefore, the arc axis design is preferred from an environmental perspective.

Summary

In conclusion, the arc axis design would require less excavation and would be superior to the straight axis in terms of hydraulic conditions, concrete abrasion, and integrity. Therefore, the arc axis dam design was adopted for the Project.

4.5.3 Reservoir Full Supply Level Elevation

Many different dam heights and associated reservoir elevations (FSL) options were evaluated:

- FSL below elevation 1,618 m
- FSL between elevations 1,618–1,640 m
- FSL above elevation 1,640 m

Technical/Engineering Considerations

The geology of the dam and reservoir area has been determined to support a concrete gravity dam of up to 150 m and slope treatments can ensure stability with reservoir drawdowns of up to 15 m over 6-hour period.

Financial/Economic Considerations

The project design was optimized, including dam height, reservoir FSL, and capacity to maximize dry season energy generation and allow for dry season peaking to meet peak demand periods and to improve the reliability of the Nepal electricity grid (CSPDR 2020). Economic alternatives were identified for all three FSL categories, but the design with a FSL of 1,640 m maximized dry season energy production.

Environmental and Social/Cultural Considerations

Smaller dams are usually preferred over larger dams, because of the corresponding size of the reservoir. In this case, a 91 m high dam with a 1,640 m FSL will only create a 20 ha reservoir, which is very small relative to the capacity of the Project (***Table 4.7***). This dam height/FSL was needed to enable the proposed PRoR operation and would not result in any physical resettlement associated with the reservoir. See Appendix D-5, Updated ERM Comments on UAHEP Normal Storage Level Alternatives Memo (ERM March 22, 2019).

FSL above elevation 1,640 m has the potential for economic or physical displacement, but requires the least reservoir fluctuation per hour of peaking operation. FSL below 1,618 m would have the smallest reservoir surface area (approximately 8 ha), but would require the largest water level fluctuation and would still not be able to provide six hours of peaking operation.

Table 4.7: Comparison of Reservoir Elevations

FSL (Elevation in m)	Dam Height (m)	Reservoir Surface Area (ha)	Peaking Duration (hours)	Peaking Drawdown (m)
1,612 m	63 m	8.3 ha	2 hr	10 m
1,631 m	82 m	15.1 ha	6 hr	15 m
1,635 m	86 m	17.2 ha	6 hr	15 m
1,640 m	91 m	20.1 ha	6 hr	15 m
1,645 m	96 m	23.3 ha	6 hr	15 m

Summary

A dam height of 91 m and a reservoir FSL of elevation 1,640 m is proposed. At this dam height/FSL the reservoir surface area is small relative to project capacity (i.e., about 0.02 ha/MW), and 6 hours of peaking will only require about 5 m of reservoir fluctuation under average flow conditions. This dam height and reservoir FSL has few social impacts. FSLs above 1,640 m have the potential for physical and economic displacement and larger reservoir surface area, so are less preferred.

4.5.4 Powerhouse Type

Two basic alternatives were considered

- Surface powerhouse
- Underground powerhouse

Technical/Engineering Considerations

According to the seismic hazard assessment report, the peak ground acceleration, with an exceedance probability of 10%, within the design reference period of 50 years, is 0.21 g for the powerhouse site, and the seismic risk is relatively high. Compared with a surface configuration, an underground powerhouse would have better seismic performance. Similarly, the surface powerhouse would have a surface penstock, which poses a much higher risk during an earthquake then an underground penstock.

The powerhouse area has very steep terrain and a surface powerhouse would require extensive grading and excavation.

Financial/Economic Considerations

The surface powerhouse would have a turbine elevation 6 m higher (1.2%) than the underground powerhouse option, but would cost US$26 million more (2.5%)

Environmental and Social/Cultural Considerations

The underground powerhouse alternative is safer from a landslide/seismic risk perspective, would impact less forest and natural habitat, and would require less land acquisition, but would generate more spoil than a surface powerhouse. The surface powerhouse alternative poses more safety risks and, although it will generate less spoil, will require extensive excavation and blasting to create a suitable construction site.

Summary

The underground powerhouse alternative is preferred for technical, financial, environmental, and social reasons and was adopted for project design.

4.5.5 Sediment Management

The UAHEP is characterized by a high sediment load, small reservoir storage, excessive hardness of sediment particles, and high net head; therefore, sediment management is critical to the Project's overall design. The objectives of the sediment management strategy were to:

Maintain the long-term sustainable live storage volume of the reservoir

Reduce turbine abrasion by sediment

In terms of achieving the first objective of maintaining the sustainability of the reservoir's live storage, it was determined, with guidance from the Project's Expert Panel, to include LLOs and MLOs within the dam body so as to allow the drawdown of the reservoir and flushing of sediment during the monsoon season.

In terms of achieving the second objective of reducing turbine abrasion, three options were considered:

- Sediment bypass tunnel (SBT)
- Underground desanders – an eight bay underground pressure desander located on the left bank
- Reservoir – for settling of sediment particles without a SBT or underground desander, but with more frequent enforced powerhouse outages to release sediment

Technical/Engineering Considerations

The three options perform similarly in terms of sediment accumulation in the reservoir and annual turbine abrasion depths. There are very few precedents for such a large underground desander, which increases the technical uncertainty associated with this option.

Financial/Economic Considerations

The SBT or desander alternative would cost less (~6% less), but would have more average outage time per year (65 days versus 20 for SBT and 13 for desander), generate significantly less average annual energy (~19%), and have a higher levelized cost of energy (4.00 US cents/kWh) versus the SBT (3.43 cents/kWh) and underground desander (3.86 cents/kWh).

Environmental and Social/Cultural Considerations

Effective sediment management is critical for hydropower projects from an environmental and social/cultural perspective. If not properly managed, sediment can either accumulate behind the dam, reducing its storage capacity and peaking power generation, or in the diversion reach, reducing the value of the remaining aquatic habitat, with potential impacts on ecosystem services as well.

The SBT or desander alternative is generally preferred from strictly an environmental and social/cultural perspective, as it would avoid the spoil generated by the SBT or underground desander. The underground desander option would generate more spoils than the SBT.

Summary

The comparison above concludes that each option is technically feasible, and the degree of sediments accumulated in the reservoir and the annual turbine abrasion depths are nearly the same for all three options. The reservoir option is preferred from an environmental perspective, as it would avoid the generation of spoils resulting from the SBT and underground desander excavation. This option, however, would result in significant generation outages, a reduction in energy generation, and result in a higher cost/kWh for the Project. The 293,500 m^3 of spoil generated by the SBT would only represent about 5% of the total spoil from the Project. Therefore, the SBT option was adopted for the project design.

4.5.6 Transmission Tower Alternatives

Transmission towers can be constructed in various designs, which must reflect local climatic, topographic, geologic, and seismic conditions. The following alternatives were considered (***Figure 4.9***):

- Lattice – generally constructed with a steel frame
- Tubular pole (monopole) – generally constructed of steel tubes

Figure 4.9: Transmission Tower Alternatives

Lattice tower

Tubular pole (monopole) tower

Technical/Engineering Considerations

Lattice style towers can be erected easily in difficult to access areas as the tower members are generally light and can be easily transported and assembled at the site. The monopole design can be constructed quickly, but is heavier, more difficult to transport, and requires a much larger foundation.

Financial/Economic Considerations

The lattice style towers are cost-effective to construct, but require a larger RoW, whereas the monopole towers are more expensive, but require less RoW.

Environmental and Social/Cultural Considerations

The lattice towers require slightly more land for RoW that are subject to use restrictions, but can be easily transported in parts and assembled at the tower site, without the need to construct access roads. The monopoles are much heavier and would likely require vehicular access to transport the material to the tower site, which would require the acquisition of land and construction of access roads to each of the tower sites.

The lattice towers pose slightly greater risk of bird collisions, but the primary risk for bird collisions is the transmission lines, which are less visible to the birds.

Summary

Given the remote location and the desire to construct the transmission line without constructing new access roads, the lighter weight and more easily transported lattice towers are recommended, which are also preferred from a technical and economic perspective as well.

4.5.7 Transmission Tower Foundation Alternatives

Foundation alternatives considered included (CSPDR, 2020)

- Excavated foundations – column type foundations made of reinforced concrete with an expanded base; foundation is hand dug, does not require heavy machinery, and is well suited for mountainous terrain
- Pad and chimney foundation – consists of a base mat/pad and a square chimney, which are constructed of reinforced concrete with anchor bolts
- Rock anchor foundation – consists of deformed bars securely grouted in holes pre-drilled in the underlying rock; typically used where good quality rock is encountered at or near the ground surface
- Micro-pile foundation – generally used in areas with very loose soil and/or where scouring by flowing water is a concern
- Special foundations – used in areas with very low bearing capacity of the underlying soils; specifically designed for the geotechnical conditions of the tower site
- The selection of the appropriate foundation will be made based on site specific topography, geology, and seismic conditions. It is anticipated that excavated foundations will be the most commonly used foundation type, with the others used as site conditions dictate.

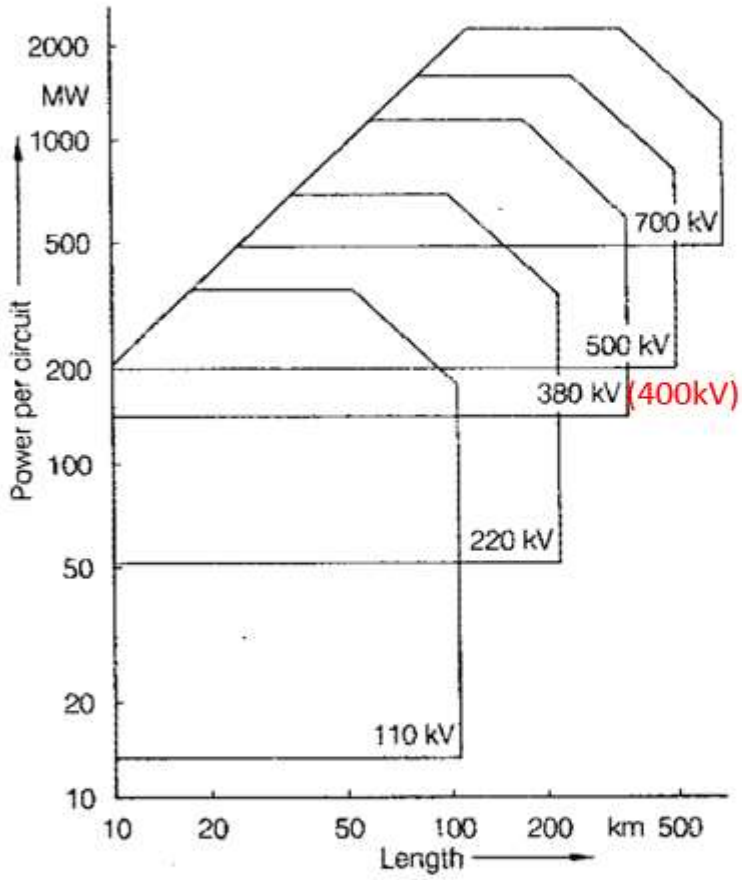
4.5.8 Transmission Tower Design Alternatives

Transmission towers and conductors can present electrocution and collision risks for birds, especially large birds. The towers for a 400 kV transmission line are large enough that the conductors can be separated enough to effectively eliminate the potential for electrocution. The towers will be designed in accordance with international standards (e.g., APLIC 2006; APLIC 2012). These standards include the provision of visibility enhancement measures to help birds avoid collision by placing marker balls or bird diverters on the shield wires. The 400 kV conductors are considered large enough to be visible to birds.

4.5.9 Transmission Line Voltage

The UAHEP is proposed with a 1,040 MW installed capacity. A project of this capacity requires a 400 kV transmission line (***Figure 4.10***; and CSPDR 2020).

Figure 4.10: Voltage Selection for Transmission of Electricity



Source: Kiessling *et al.* 2003

4.5.10 No Forest Clearing Alternative

It is not possible to achieve no forest clearing with the UAHEP. As described under the Location Alternatives (Section 4.4), the dam location was selected taking into consideration technical, environmental, and social criteria. The selected location, and really any location along the Upper Arun River, will unavoidably result in the clearing of some forest to construct the dam and reservoir. The only areas not under native forest cover in the project impact area are villages and associated agricultural land. Further reducing forest clearing would have unavoidably resulted in more significant social impacts.

4.6 Construction Alternatives

4.6.1 River Diversion Alternatives

Two river diversion alternatives were considered:

- Right-bank diversion tunnel
- Left-bank diversion tunnel

Technical/Engineering Considerations

The left bank alternative is preferred in terms of geological conditions at the tunnel outlet, as the right bank alternative would have an overhanging rock mass at the outlet. The left bank alternative would require less slope treatment.

Financial/Economic Considerations

The left bank alternative would cost less, because the tunnel is shorter and less slope treatment would be required.

Environmental and Social/Cultural Considerations

The left bank alternative would avoid the MBNP Buffer Zone, whereas the right bank alternative would be entirely located within the Buffer Zone.

Summary

The left bank alternative is preferred for technical, economic, and environmental reasons and was adopted for the project design.

4.6.2 Tunnelling Alternatives

The Project requires extensive tunnel construction, including the diversion, sediment bypass, headrace, adit, and tailrace tunnels, among others. Two tunneling alternatives were considered

- Use of drill and blast method – the controlled use of explosives, which are placed in drilled holes and detonated to break rock for excavation; and
- Combined approach – which would use drill and blast and a tunnel boring machine (TBM) in different tunnel sections

Technical/Engineering Considerations

The drill and blast method would take about 54 months to complete tunnel construction, while the combined method would take about 48 months. Both methods are subject to high pressure seepage water, rock falls, and rock deformations.

Financial/Economic Considerations

The drill and blast method is current estimated as less expensive than the combined approach (US$89 million versus US$101 million, respectively), but the cost of TBM has been rapidly decreasing and is anticipated to be similar to drill and blast costs by the time project construction would begin.

Environmental and Social/Cultural Considerations

The TBM typically results in less noise, vibration, and occupational health and safety (OHS) risks, but the spoils are finer and more difficult to manage and the operation generates a wastewater that may require treatment. The drill and blast method will generate more noise and vibration, but most of this will be well below ground and have very limited impacts on communities, perhaps with the exception of the areas near the tunnel/adit portals. In Nepal, the Army manages the use of explosives, so the staff involved with drill and blast will have significant experience, which should reduce the OHS risks. The spoil from drill and blast tends to be coarser and easier to manage.

Summary

The combined approach is preferred from a technical and economic perspective, while both approaches have advantages and disadvantages from an environmental and social cultural perspective. The combined approach was adopted for the project design.

4.6.3 Transmission Tower Construction Access Alternatives

The project transmission line traverses a roadless area. Construction of the transmission towers will require transport of steel lattice frame, cement, rebar, aggregate, and other construction materials to each of the 19 tower sites. Several options for providing construction access to the tower sites were considered:

- Construction of access roads – This would involve the construction of at least 10 km of access roads and potentially a temporary bridge across Leksuwa Khola.
- Use of helicopters – Helicopters could be used to transport some or all of the construction materials to all or some of the tower sites. The helicopters could either land, which would require clearing and leveling of a landing pad, or hover over the tower site and lower the materials to the ground.
- Use of pack animals, porters, and small portable mechanized equipment – This alternative would use existing, or create new, paths to access the tower sites without clearing any trees. The steel for the lattice tower can be designed such that it can be transported in pieces and assembled at the site.

Technical/Engineering Considerations

Construction of an access road to reach each of the tower sites would present significant engineering and construction challenges, given the steep slopes found along the entire length of the transmission line. Use of helicopters poses the least engineering challenges, but helicopter use may be limited by weather conditions. The transmission line would be constructed during the dry season regardless. Use of pack animals, porters, and small equipment would present challenges in transporting the heaviest of the construction materials and accessing the towers on the steepest slopes.

Financial/Economic Considerations

Construction of an access road would be the most expensive option, although daily rental of a helicopter is also expensive. The use of pack animals, porters, and small equipment is the least expensive alternative.

Environmental and Social/Cultural Considerations

The access road alternative would involve additional land acquisition, forest clearing, and land disturbance and would compound any habitat fragmentation impacts associated with the transmission line. The use of helicopters would avoid additional land acquisition and forest clearing impacts, but would result in short term noise impacts for local residents and wildlife. The use of pack animals, porters, and possibly small portable mechanized equipment (e.g., motorcycles, all-terrain vehicles) would take advantage of existing trails and minimize land acquisition and forest clearing. The use of porters also increases local employment opportunities.

Summary

The Project proposes to transport all construction materials and supplies to the two ends of the line (i.e., UAHEP switchyard and Arun Hub Substation) by truck and then primarily use pack animals, porters, and small portable mechanized equipment, with helicopter use being limited to the more difficult to access tower locations and the heavier construction materials (e.g., tower lattice steel).

4.7 Operational Alternatives

These alternatives relate to how the Project will operate during project operations, specifically relating to operating procedures and water level fluctuations, which are inter-related.

4.7.1 Operating Procedures

Three basic alternatives were considered:

- Peaking – would allow peaking to occur on a daily basis year-round

- Peaking run-of-river (PRoR) – would allow peaking to occur on a daily basis, but limited to the dry season
- Run-of-river (RoR) – would limit flow diverted to the powerhouse to no more than inflow to the reservoir, also accounting for the required Environmental Flow

Technical/Engineering Considerations

One of the UAHEP's primary purposes is to meet Nepal's need for peak demand power during the dry season. A traditional RoR operation would significantly reduce power generation during peak hours in the dry season and would not achieve this purpose, and therefore is not discussed further. The Project has not been designed for year-round peaking operations, as this is not necessary, given the relatively high river flows that occur during the monsoon season.

Financial/Economic Considerations

The Project has been optimized to maximize dry season peak demand power generation. Converting to RoR operations would reduce the value of the energy produced, resulting in weaker financial performance. A peaking operation would not maximize energy production or take best advantage of the valuable Arun River water resource.

Environmental and Social/Cultural Considerations

RoR operations are always preferred from a strictly environmental and social/cultural perspective, as they maintain as close as possible a natural flow regime and have negligible impacts downstream from the tailrace. Peaking operations would likely require a larger reservoir and result in larger and year-round water level fluctuations, both in the reservoir and downstream from the tailrace, which can have impacts on both fish and downstream water users. A PRoR operation is intermediate between these two other operating regimes, and limits the magnitude and timing (dry season only) of peaking impacts. In the case of the UAHEP, the proposed reservoir surface area is small relative to its capacity, so the area affected by reservoir water level fluctuations is small. Further, the presence of the Arun-3 HEP downstream from the UAHEP limits the extent of peaking operation impacts downstream from the tailrace to approximately 11 km.

Summary

The UAHEP was designed to help meet Nepal's dry season peak electricity demand, which requires limited peaking during the dry season. The proposed PRoR operation achieves this goal while keeping reservoir water level fluctuations and downstream flow variation within an acceptable range. Converting the UAHEP to a RoR operation would then require the construction of another hydropower project to meet Nepal's dry season peak demand, which would result in greater environmental and social/cultural impacts than simply operating the UAHEP in a peaking RoR mode. A peaking operation is not necessary, given the relatively high Arun River flows during the monsoon season. Therefore, a PRoR mode of operations was adopted for the project design.

En is determined by the storage volume of the reservoir and the duration/volume of water needed for peaking. The Project is designed to peak for 6 hours during the dry season (October to May), which translates to up to a maximum of 15 m of reservoir water level fluctuation at FSL 1,640 m, depending on reservoir inflow. Once the peaking operation ends, the reservoir would be allowed to refill, again over a six-hour period to maintain riverbank stability.

Water level fluctuations in reservoir can result in regular exposure of the reservoir's littoral, or nearshore, zone, which can in turn degrade aquatic habitat, alter sediment redox gradients, affect nutrient cycling, and raise public safety risks (Hirsch *et al.* 2014). Generally, less water level fluctuation is considered better from an environmental and social/cultural perspective.

The only alternative for reducing the magnitude of water level fluctuations, while still achieving the Project's purpose, would be to raise the reservoir's FSL so there is more volume of water per meter of water depth, so less drawdown would be needed to meet the peaking water demand.

Technical/Engineering Considerations

Reducing water level fluctuations would prevent the Project from generating the planned power. Increasing the reservoir's FSL would require a higher dam. A 10 m increase in the dam/reservoir FSL would only reduce reservoir fluctuation by about 5 m, so an even higher dam would be needed to significantly reduce the magnitude of fluctuation (CSPDR 2020).

Financial/Economic Considerations

Although not quantified, raising the dam height by 10 or more meters would result in a significant increase in the overall project cost.

Environmental and Social/Cultural Considerations

Minimizing water level fluctuations is preferred from an aquatic habitat perspective, but a peaking operation requires reservoir fluctuations. In this case, the reservoir surface area is small for a project of this capacity, so the area subject to water level fluctuations is similarly small. Further, a key impact associated with water level fluctuations is the effect on fish spawning in shallow areas along the margin of the reservoir. In this case, however, the key migratory fish (common snow trout) prefers to spawn in the clear water tributaries, rather than in the main stem of the Arun River, so their spawning would not be affected by the proposed water level fluctuations. Fish could be stranded by reservoir drawdown, but the rate of drawdown is gradual (maximum of 2.5 m/hr) and most fish will move to remain in the water. Alternatives with reduced reservoir water level fluctuation (i.e., <5 m) offer minimal aquatic habitat benefits.

The UAHEP reservoir is located in a gorge with limited accessibility, and drawdown would occur at night, so the public safety risk, with appropriate mitigation (see Appendix C, ESMP) is considered low.

An increase in the dam height/reservoir FSL would require more land acquisition, economic displacement, clearing of more forest, a larger reservoir surface area, and a reservoir that would extend farther upstream.

Overall, the environmental and social/cultural impacts associated with the higher reservoir FSL, which would be needed to reduce the magnitude of reservoir water level fluctuations, more than offset the relatively minor impacts associated with the 15 m water level fluctuation during the dry season. Therefore, the environmental benefits, if any, associated with reduced water level fluctuations would be significantly less than the impacts associated with the higher dam and reservoir water level needed to reduce those fluctuations.

Summary

Reservoir water level fluctuations are an unavoidable impact associated with peaking operations, but the relatively minor environmental benefits of reduced water level fluctuation do not warrant an increase in dam height/reservoir FSL. The 15 m water level fluctuation alternative is preferred for technical, cost, environmental, and social reasons and was adopted for the project design.

4.8 Decommissioning Alternatives

The alternatives analysis did not include a detailed analysis of the decommissioning phase, because the Project has been designed to operate for at least 50 years. Further, the Project is expected to operate for 80 or more years, especially taking into consideration the sediment management strategy, which will minimize sediment deposition in the project reservoir. Therefore, the timeframe for potential decommissioning is so far in the future as to make any impact predictions unreliable. If the Project is decommissioned in the future, a new ESIA will be prepared to address decommissioning alternatives and impacts at that time.

5. METHODOLOGY

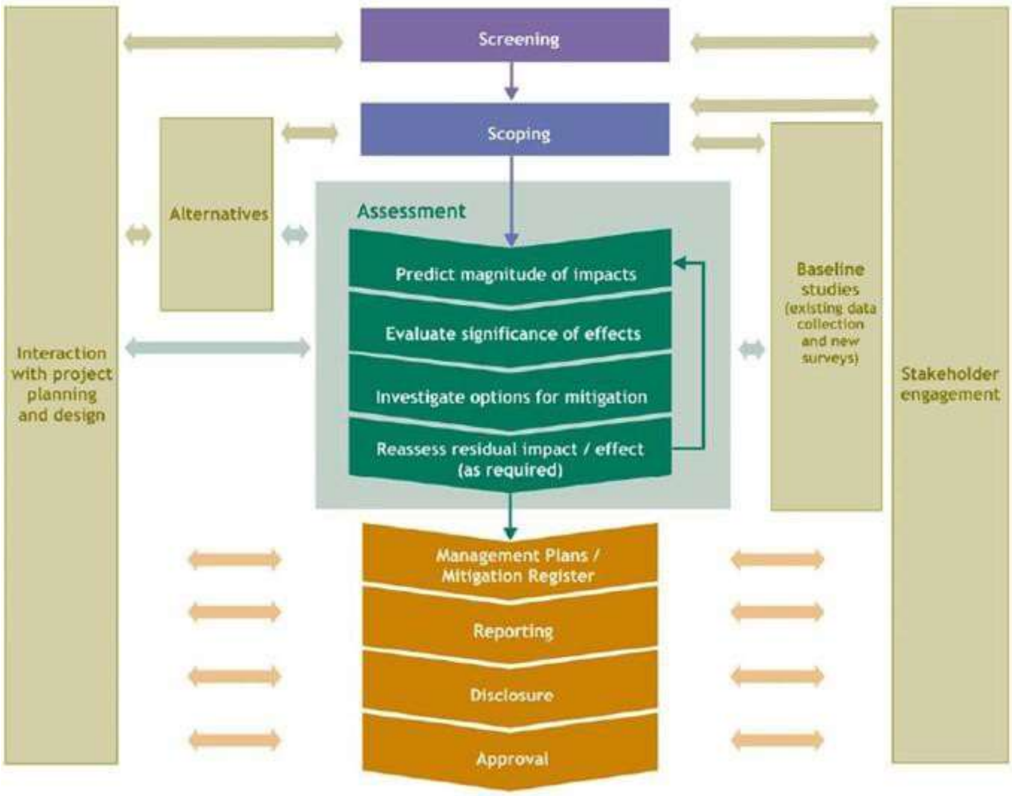
This chapter presents an overview of the methodology used for this ESIA and the parallel Government of Nepal Environmental Impact Assessment. A parallel, but consistent, process and documents were used because of some differences between the World Bank and the Government of Nepal's requirements. The primary purpose of an ESIA is to assess, in an integrated way, all relevant direct, indirect, and cumulative environmental and social risks and impacts throughout the project life cycle, to predict the potential impacts resulting from a proposed project and to identify measures to avoid, reduce, or remedy these potential impacts, in accordance with the mitigation hierarchy.

For the purposes of this ESIA, direct, indirect, and cumulative impacts were defined as follows:

- Direct impact – is an impact that is caused by the Project, and occurs contemporaneously in the location of the Project.
- Indirect impact – is an impact which is caused by the Project and is later in time or farther removed in distance than a direct impact, but is still reasonably foreseeable, and will not include induced impacts.
- Cumulative impact – is the incremental impact of the project when added to impacts from other relevant past, present, and reasonably foreseeable developments, as well as unplanned, but predictable, activities enabled by the Project that may occur later or at a different location. Cumulative impacts can result from individually minor, but collectively significant, activities taking place over a period of time.

This ESIA employed a standard impact assessment methodology, as illustrated in ***Figure 5.1***, which was tailored to meet the requirements of the GoN, for the purposes of the EIA, and the World Bank ESF, for purposes of the ESIA.

Figure 5.1: General ESIA Approach



The ESIA followed a systematic process that evaluated the potential impacts that the Project could have on physical, biological, socioeconomic, and cultural resources/receptors, and identified measures that could be implemented to avoid, eliminate or reduce, compensate or offset those impacts, in accordance with the mitigation hierarchy. The ESIA considered the possibility of direct, indirect, and cumulative impacts from the Project.

The key steps In the ESIA methodology were:

- Conduct project screening and scoping (Section 5.1)
- Determine project impact area (Section 5.2)
- Conduct baseline studies (Section 5.3)
- Analyze alternatives (Section 5.4)
- Assess impact (Section 5.5)
- Prepare environmental and social management plans (Section 5.6)
- Develop an environmental and social commitment plan (Section 5.7)
- Engage with stakeholders through consultation on, and disclosure of, the ESIA (Section 5.8)
- Institutional capacity assessment and strengthening (Section 5.9)

The following sections describe each of these steps.

5.1 Screening and Scoping

5.1.1 UAHEP Screening

The UAHEP was screened based on available information regarding the project design and existing environmental and social conditions in the project impact area. This screening was intended to provide a summary of initial findings on potential project impacts, including an indicative risk classification, to guide development of the ESIA and CIA. ***Table 5.1*** presents the risk classifications used, which follow the WB guidance (World Bank 2017, p. 6). The criteria take into consideration the type, location, sensitivity, and scale of the Project; the nature and magnitude of the potential environmental and social risks and impacts; and the capacity and commitment of the Borrower to manage these risks and impacts. Other considerations include the legal and institutional, nature of the mitigation strategies and technology being proposed; governance structures and legislation; stability, conflict, and security.

Table 5.1: Preliminary Risk Classification

Preliminary Risk Classification	Screening Criteria
High	The resource/receptor would likely experience a large magnitude impact that would endure for a long time, extend over a large area, exceed national/international standards, endanger public health and safety, threaten a species or habitat of national or international significance, and/or exceed a community’s resilience and ability to adapt to change. The Project may have difficulty in complying with the applicable ESF requirement, and significant mitigation would likely be required.
Substantial	The resource/receptor would experience a clearly evident change from baseline conditions and would approach, but not exceed, applicable standards. The Project would comply with the applicable ESF requirement, but mitigation would be required.
Moderate	The resource/receptor would experience a noticeable effect, but the magnitude of the impact is sufficiently small (with or without mitigation) that the overall effect

Preliminary Risk Classification	Screening Criteria
	would remain well within applicable standards. The Project would comply with the applicable ESF requirement, but mitigation may be required.
Low	The resource/receptor will either not be affected or the likely effect would be imperceptible or indistinguishable from natural background variation. The Project would comply with the applicable ESF requirement and mitigation would typically not be required.

A final Screening Report was submitted to the Government of Nepal in November 2019 ***Table 5.2*** identifies the preliminary risks that were classified as Substantial or High for the Project in the Screening Report. It should be noted that these were preliminary risk classifications established at the early stages of the Project and represent pre-mitigation conditions. Chapter 7 (Environmental and Social Risks, Impacts, and Mitigation) presents the final risk classifications based on the completion of baseline studies, availability of the draft Final Project Optimization and Updated Feasibility Study Report (CSPDR 2020), and the findings of this impact assessment.

Table 5.2: UAHEP Preliminary Risk Assessment

ESS Requirement	Phase	Risk Rating
ESS 1: Assessment and Management of Environmental and Social Risks and Impacts		
Cumulative impacts	Operation phase	High
ESS 2: Labor and Working Conditions		
Working conditions	Construction phase	Substantial
Worker accommodation	Construction phase	Substantial
Child labor	Construction phase	Substantial
Forced labor/trafficking in persons	Construction phase	Substantial
Occupational health and safety	Construction phase	Substantial
ESS 3: Resource Efficiency and Pollution Prevention and Management		
Water use	Operation phase	Substantial
Water pollution	Construction phase	Substantial
Sediment transport	Operation phase	Substantial
Waste management	Construction phase	High
Hazardous materials	Construction phase	Substantial
Noise	Construction phase	Substantial
Vibration	Construction phase	Substantial
ESS 4: Community Health and Safety		
Traffic and road safety	Construction phase	High
Ecosystem services	Construction and operation phases	Substantial
Community health/labor influx	Construction phase	High
Emergency preparedness and response	Construction and operation phases	Substantial
SEA/SH	Construction phase	HIgh
ESS 5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement		
Land acquisition	Construction phase	Substantial
Physical resettlement	Construction phase	Substantial
Economic displacement	Construction phase	High

ESS Requirement	Phase	Risk Rating
ESS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources		
Critical habitat	Construction and operation phases	High
Natural habitat	Construction and operation phases	High
Protected areas	Construction phase	Substantial
Endangered/migratory/endemic species	Construction and operation phases	Substantial
Poaching/hunting/fishing/logging/collecting	Construction and operation phases	Substantial
ESS 7: Indigenous Peoples		
Free, prior and informed consent	Construction phase	High
ESS 8: Cultural Heritage		
Intangible heritage	Construction phase	Substantial
ESS 10: Stakeholder Engagement and Information Disclosure		
Stakeholder engagement	Construction and operation phases	High

5.1.2 Scoping

Pursuant to the GoN's regulations, a scoping process was conducted to define the scope of the Nepal EIA, as well as this ESIA. The objectives of the scoping process were to:

- Identify key resources and those project actions having the potential to cause or contribute to significant impacts on physical, biological, and socioeconomic resources/receptors
- Identify potential concept design and technology alternatives for the Project
- Obtain stakeholder views through consultation
- Help inform the scope of the EIA/ESIA through consultation, to aid in focusing the ESIA process and output on the key issues

The scoping process included the following steps:

- Prepared a preliminary scoping document (SD) and EIA terms of reference (ToR)
- Placed notices of the proposed scoping meetings in the newspaper, as well posted them in public buildings in the project impact area such as schools, and municipal buildings 15 days in advance of the public meetings
- Conducted public scoping meetings as indicated in ***Table 5.3***. Appendix G provides the names of all attendees and an official meeting minutes with list of issues and concerns raised at each meeting. A photograph from the meeting held in the Village of Gola is shown in ***Figure 5.2***.
- Held subsequent meetings for government agencies, NGOs, and other interested parties in Kathmandu (national capital) on March 18, 2019 and Khandbari (district headquarters) on March 28, 2019
- Prepared the SD/ToR for the EIA in compliance with the DoED Manual for Preparing Scoping Documents (2001) and the MoFE's Hydropower Environmental Impact Assessment Manual (2018)
- Submitted the SD/ToR for the EIA to DoED on June 10, 2019
- DoED approved the SD/ToR for the EIA and forwarded the documents to MoFE on November 4, 2019
- MoFE approved the SD/ToR for the EIA on August 2, 2020

Figure 5.2: Photograph of Gola Public Scoping Meeting

Table 5.3: UAHEP Public Scoping Meetings

Village Location	Date	Gender		Caste		Total Attendees
		Male	Female	IP	Dalit	
Gola	January 16, 2019	37	6	43	0	43
Syaksila	January 17, 2019	15	2	17	0	17
Sibrun 1	January 17, 2019	12	1	10	3	13
Sibrun 2	January 18, 2019	32	5	33	4	37
Hema	January 18, 2019	2	7	9	0	9
Namase	January 19, 2019	27	6	33	0	33
Rukma	January 20, 2019	16	3	19	0	19
Lingam	January 20, 2019	9	2	11	0	11
Chemtang	January 21, 2019	21	2	23	0	23
Chepuwa	January 22, 2019	22	2	24	0	24
Hongong	January 24, 2019	11	4	15	0	15
Hatiya	January 24, 2019	13	2	14	1	15
Total		217	42	251	8	259

The main stakeholder feedback during scoping consultation include the following (see Appendix G):

- Land acquisition and compensation, and finding suitable replacement land to resettle displaced families within their community
- Engaging with indigenous people to obtain their free, prior, and informed consent to the Project
- Managing the environmental flow of the Arun River to maintain aquatic habitat values and connectivity
- Managing environment impacts such as forest clearance, sediment transport, risks of landsides and impacts on springs used by villages

- Managing social impacts such as in-migration (approximately 3,000 workers at peak construction) and preserving indigenous people's way of life
- Potential impacts on air quality due to excavation, blasting, movement of vehicles and equipment, open piles of topsoil and spoil, and the operation of combustion engines
- Noise, dust, waste generation, hazardous material use, pesticide use and traffic disturbance from construction vehicles and machinery
- Biodiversity impacts, as the Project entails risks to critical and natural flora and fauna habitats, risks of poaching and illegal trading of wildlife, risk of forest land fragmentation
- Potential impacts on the Makalu Barun National Park
- Potential impacts on tangible and intangible cultural heritage
- Health and safety impacts on community, especially on the safety of women
- Community investment and benefit sharing
- Community access to electricity and roads
- Increased demand on social infrastructure and emergency services
- Generation of local income through the recruitment of workers from local communities to the Project
- Cumulative impacts and selection and prioritization of valued environmental and social components (VECs)

The concerns and issues raised informed the further project planning and design.

As a result of the limited number of female attendees at the scoping meeting, a female gender specialist conducted a separate field trip and held a series of focus group discussions (FGDs) with women in the affected communities.

5.2 Project Impact Area

The project impact area is defined as the area that may be affected by a Project's direct, indirect, and cumulative impacts resulting from project construction and operation activities (World Bank 2017, p. 25), and also represents the project study area. For purposes of this ESIA, the direct, indirect, and cumulative impact areas are defined as follows:

- Direct Impact Area (DIA) – includes all areas of direct impact, which are those areas located within the project footprint or area of disturbance, as well as those villages and households directly affected by project construction and operation, as well as the area within which ecosystem services could be affected. The DIA includes the following:
    - The area within 1 km of any project construction or operational facility, including the project access road, hydropower facility, and transmission line, to account for project effects that may extend beyond the project footprint (e.g., noise, vibration, dust, light, and traffic). A 1 km buffer width was selected, because these construction-related effects rarely extend beyond that distance.
    - The area upstream from the headworks to Chhujun Khola[6], extending laterally 1 km on each side of the Arun River to account for impacts on riparian areas and the potential use of river water by nearby villages for various purposes
    - The area downstream from the dam along the 16.5 km long diversion reach to the powerhouse and laterally 1 km on each side of the Arun River to account for impacts on riparian areas and the potential use of river water by nearby villages for various purposes

[6] First major upstream tributary and the approximate location of the Kimathanka HEP powerhouse, approximately two kilometers upstream from the reservoir backwater.

- The area downstream from the powerhouse to the headwaters of the Arun-3 HEP (approximately 11 kilometers downstream from the UAHEP powerhouse) and laterally 200 meters on either side of the river to account for flow modification from peaking operation on the potential use of the river by nearby villages for various purposes
- All land affected by permanent land acquisition, permanent land use restrictions, and temporary access agreements
- The Koshi Highway from the north side of Khandbari to the intersection with the proposed project access road about 2 km north of Gola, including buildings along the road, as this road will be used to transport most of the project construction equipment and supplies. The impacts here are generally limited to air emissions, noise, vibration, and community safety from project-related vehicular traffic.

Figure 5.3 shows the project DIA, which totals approximately 67.2 km^2, and identifies the villages and settlements included within the project DIA.

- Indirect Impact Area (IIA) – includes the areas within the administrative boundaries of Bhotkhola Rural Municipality, and Makalu Rural Municipality, Wards 3 and 4, which total approximately 1,007 km^2 (see ***Figure 5.4***)
- Cumulative impact area – includes the entire Arun River Basin from its headwaters in China to its confluence with the Sapta Koshi River at Triveni, Nepal, which encompasses an area of about 30,400 km^2 (see ***Figure 5.5***), but with a focus on the Upper Arun River between the Lower Arun HEP and the Kimathanka HEP. The CIA also considers potential cumulative impacts in the upstream reach within China, as well as downstream towards the confluence with the Sapta Koshi. See Appendix E for the Cumulative Impact Assessment.

The Project triggers the WB's Operational Policy 7.50, *Projects on International Waterways*, as the Arun River originates in China, drains a portion of Nepal before joining the Sapta Koshi River, which in turns flows into India, where it joins the Ganges River.

Figure 5.3: UAHEP Direct Impact Area

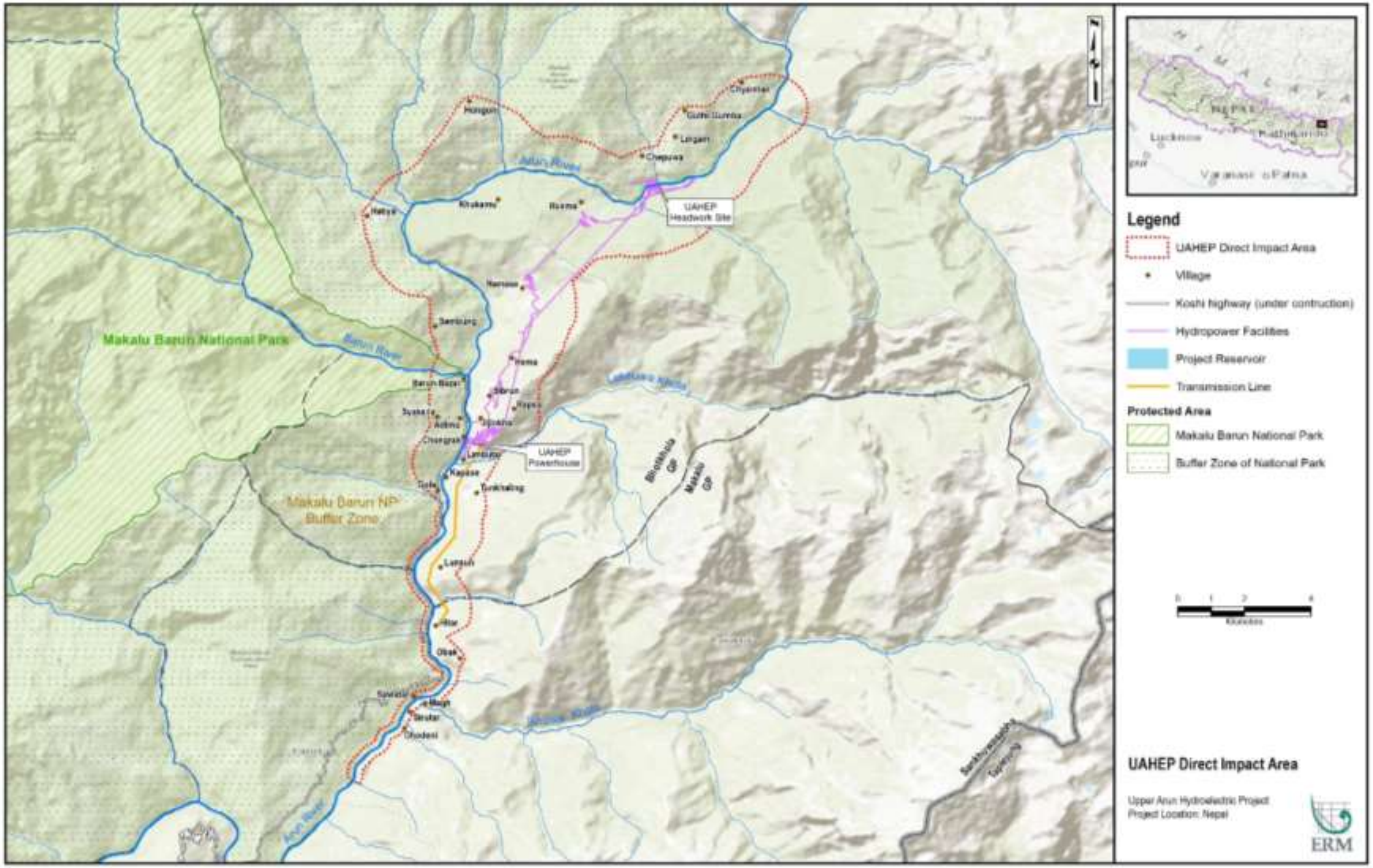
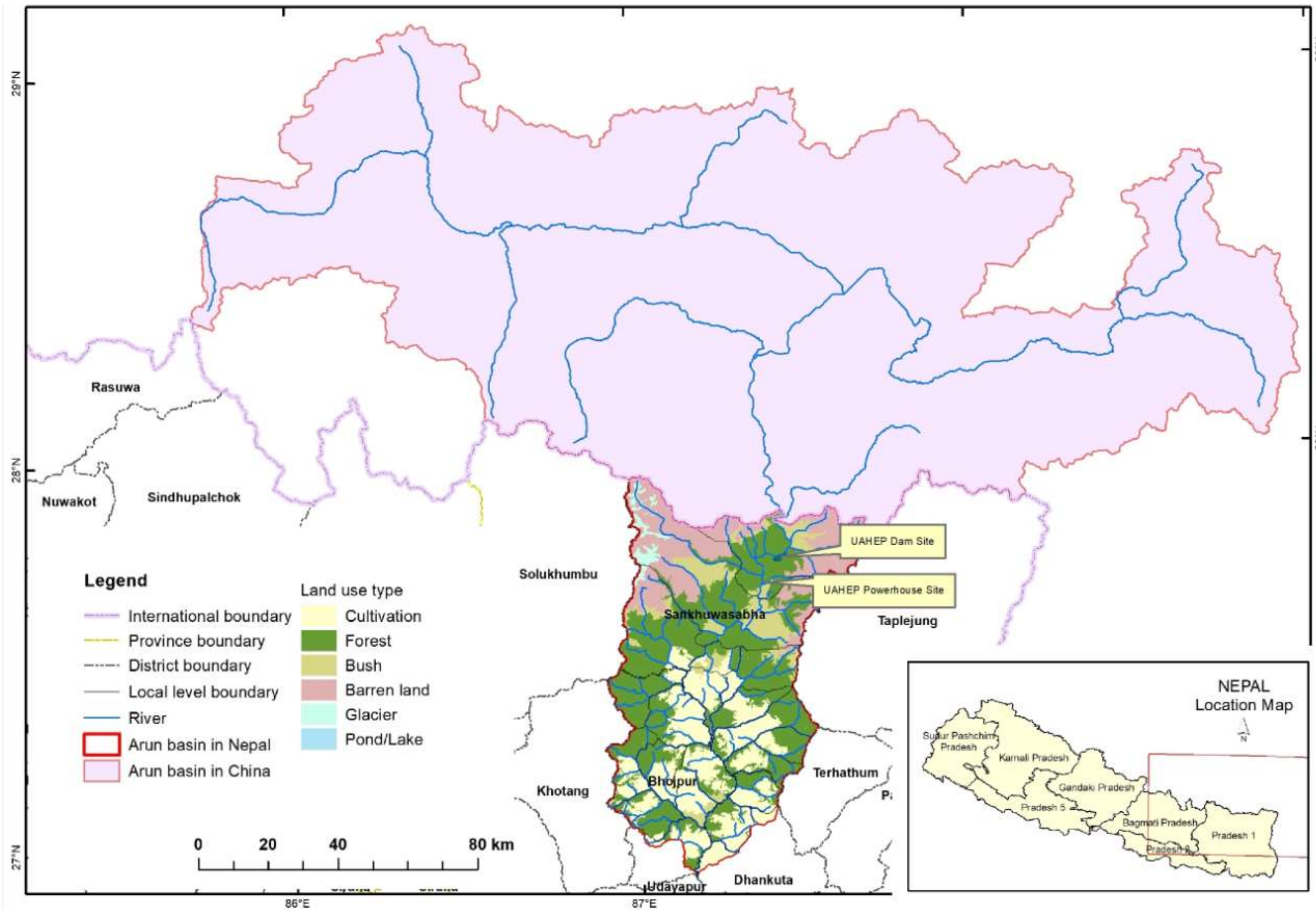


Figure 5.4: UAHEP Indirect Impact Area

Figure 5.5: UAHEP Cumulative Impact Area



5.3 Baseline Data Collection

A critical early step in the ESIA process involves collecting and assembling information to understand and characterize baseline physical, biological, and social conditions within the project impact area. This information is gathered from a review of the available literature and secondary sources, as well as primary data collection through field surveys.

5.3.1 Literature Review

The literature review involved collecting and reviewing secondary sources of information related to the Project and its direct, indirect, and cumulative impact areas. These secondary sources of information are referenced in Chapter 6 (Baseline Conditions) and Chapter 7 (Environmental and Social Risks, Impacts, and Mitigation) and listed in Chapter 9 (References), but in general include published and unpublished literature from the following sources:

- Government agencies, including Nepal Electricity Authority, Department of Electricity Development, Ministry of Forests and Environment, Department of Archaeology, Department of National Parks and Wildlife Conservation, Department of Mines and Geology, Topographic Survey Department, Central Bureau of Statistics, District Coordination Committee Offices, Department of Hydrology and Meteorology, Department of Plant Resources, Ministry of Energy, Water Resource and Irrigation, and concerned rural municipalities
- Universities, including Tribhuvan University (e.g., Central Department of Botany and Central Department of Zoology, Natural History Museum)
- Nepali federations and organizations, including the Federation of Community Forestry Users Nepal (FECOFUN), Nepal Federation of Indigenous Nationalities (NEFIN), and National Foundation for the Development of Indigenous Nationalities(NFDIN), Barun Mela Committee
- International organizations, including the World Bank, Asian Development Bank, United Nations Educational, Scientific and Cultural Organization (UNESCO) Nepal, International Centre for Integrated Mountain Development (ICIMOD), Nepal Sampada Sangh
- National and international conservation organizations, including the Centre for Nepal and Asia Studies (CNAS), Bird Conservation Nepal (BCN), Birdlife International, World Wildlife Fund (WWF), National Trust for Nature Conservation (NTNC), and International Union for Conservation of Nature (IUCN)

The literature review includes information on:

- UAHEP feasibility studies and design drawings for the project access road, hydropower facility, and transmission line
- Other projects – including feasibility studies, and IEE and EIA reports of other roads, transmission lines, and hydropower projects within the project impact area
- Physical baseline conditions in the project impact area:
  - Topographic maps from Department of Survey, Google Maps, Google Earth, and WorldView-2 high resolution (accuracy of 50 cm) aerial imagery
  - Hydrology and meteorology data from the Department of Hydrology and Meteorology
  - Roads data from the Department of Roads
  - Available air quality monitoring data from MoFE
- Biological baseline conditions in the project impact area:
  - Peer reviewed scientific literature on biodiversity

  - Online species distribution maps produced by the Integrated Biodiversity Assessment Tool (IUCN 2019)
  - IUCN Red List Version 2019-1 (IUCN 2019)
  - Red List for Birds of Nepal (Inskipp *et al.* 2016)
  - Red List for Mammals of Nepal (Jnawali *et al.* 2011)
  - Bird Data Zone from Birdlife International (Birdlife International 2019a)
  - Data from Reptile Base and Amphi Base
  - Final Draft Makalu Barun National Park and its Buffer Zone Management Plan (2074–2079 BS) (DNPWC 2020)
- Social/cultural baseline conditions in the project impact area
  - National Population and Housing Census data (CBS 2012)
  - District/municipalities/rural municipalities profiles
  - Existing literature and studies on benefit sharing
  - Annual Household Survey, Nepal Rastra Bank
  - Nepal Living Standards Survey (CBS 2011b)
  - Ethnologies
  - Cadastral property maps for the affected districts and municipalities
  - Municipality plans and policies

5.3.2 Field Baseline Studies

In addition to the literature review, primary data collection was conducted via field surveys to collect project-specific data and fill data gaps from the literature. These field surveys focused on the DIA and, for some resources, included portions of the IIA. The cumulative impact area was primarily characterized by secondary sources, although some fish surveys were conducted downstream from the DIA and IIA. This data collection was conducted in accordance with the Project's approved SD/ToR (ERM 2020). Appendix I of the SD/ToR provides a detailed description of the ESIA methodology. Appendix F provides the baseline data that was collected (Annex FA, Physical Baseline; Annex FB, Biodiversity Baseline; and Annex FC, Social Baseline).

Table 5.4 lists the key methods and sources used for the baseline studies. Several studies (e.g., geology, hydrology) were conducted prior to the ESIA by others, such as the Project Engineer (CSPDR 2020), as part of the project feasibility assessment.

Table 5.4: Summary of Project Baseline Studies

Resource Area	Geographic Scope	Summary of Field Baseline Studies
Physical Resources		
Topography	Direct Impact Area	Conducted 1 m contour interval topographic survey (CSPDR 2020)
Geology	Direct Impact Area	12 boreholes totaling 1,001 m and several exploratory adits (see CSPDR 2020)
Soils	Direct Impact Area	Collected and analyzed soil samples from 9 locations for soil texture, fertility, and physico-chemical parameters
Hydrology	Direct Impact Area and downstream	Installed stream gauges at dam in June 2018 and powerhouse in April 2018; surveyed 48 cross sections across the Arun River from upstream from dam to Arun-3 HEP (CSPDR 2020; see ***Figure 5.6***)

Resource Area	Geographic Scope	Summary of Field Baseline Studies
Sediment	Direct Impact Area	Extensive sampling during all seasons (CSPDR 2020)
Springs	Direct Impact Area	Collected flow data in wet and dry seasons from 32 springs in the project impact area (see ***Figure 6.15***)
Water quality	Direct Impact Area	Collected water quality samples at 12 sites, including 4 seasonal rounds of sampling at 8 sites
Air quality	Direct Impact Area	Collected air quality samples for analysis from 5 sampling locations
Noise	Direct Impact Area	Monitored ambient noise levels at 11 locations
Land cover	Direct and Indirect Impact Area	Mapped land cover from high resolution (i.e., 50 cm resolution) aerial imagery dated November 2017 followed by ground-truthing
Landscape values	Direct Impact Area	Visual survey and photo-documentation
Biological Resources		
Aquatic ecology	Direct Impact Area and downstream	Conducted fish sampling at 12 sites, including four seasonal sampling at 8 sites; one site was located downstream from DIA at confluence of Sankhuwa Khola and Arun River
Terrestrial ecology	Direct Impact Area	Conducted fauna surveys, including 14 line transects and 6 bird vantage point surveys Conducted flora surveys, including 9 line transects
Socioeconomic and Cultural Resources		
Socioeconomics	Direct Impact Area	Household questionnaire, FGDs, key informant interviews (KIIs), cadastral mapping, RAP census survey, RAP land and asset survey
Community health	Direct Impact Area	Household questionnaire, KIIs with community and traditional health practitioners
Indigenous peoples	Direct Impact Area	Household questionnaire, FGDs, KIIs
Labor and influx	Direct Impact Area	KIIs, FGDs
Gender	Direct Impact Area	Household questionnaire, FGDs, and KIIs with women using structured checklists
Cultural heritage	Direct Impact Area	Field walk over, KIIs, FGDs

The following sections provide an overview of the methodology applied for each of these field studies conducted as part of the ESIA process. Further details on the specific methods and sample locations used for the studies are presented in Section 5 Methodology and Chapter 6 (Baseline Conditions). A more detailed description of the engineering field studies conducted as part of the project feasibility study can be found in the Project Optimization and Updated Feasibility Study Report (CSPDR 2020).

Physical Baseline Studies

Soils

Geotechnical and soil quality data collected as part of the project feasibility study were supplemented through targeted soil sampling at nine locations (***Figure 5.7***). Soil sampling was conducted using standard sampling procedures. The soil samples were transported to Kathmandu for laboratory analysis of soil texture, fertility, and physicochemical parameters.

Figure 5.6: Hydrology Cross-Section Locations

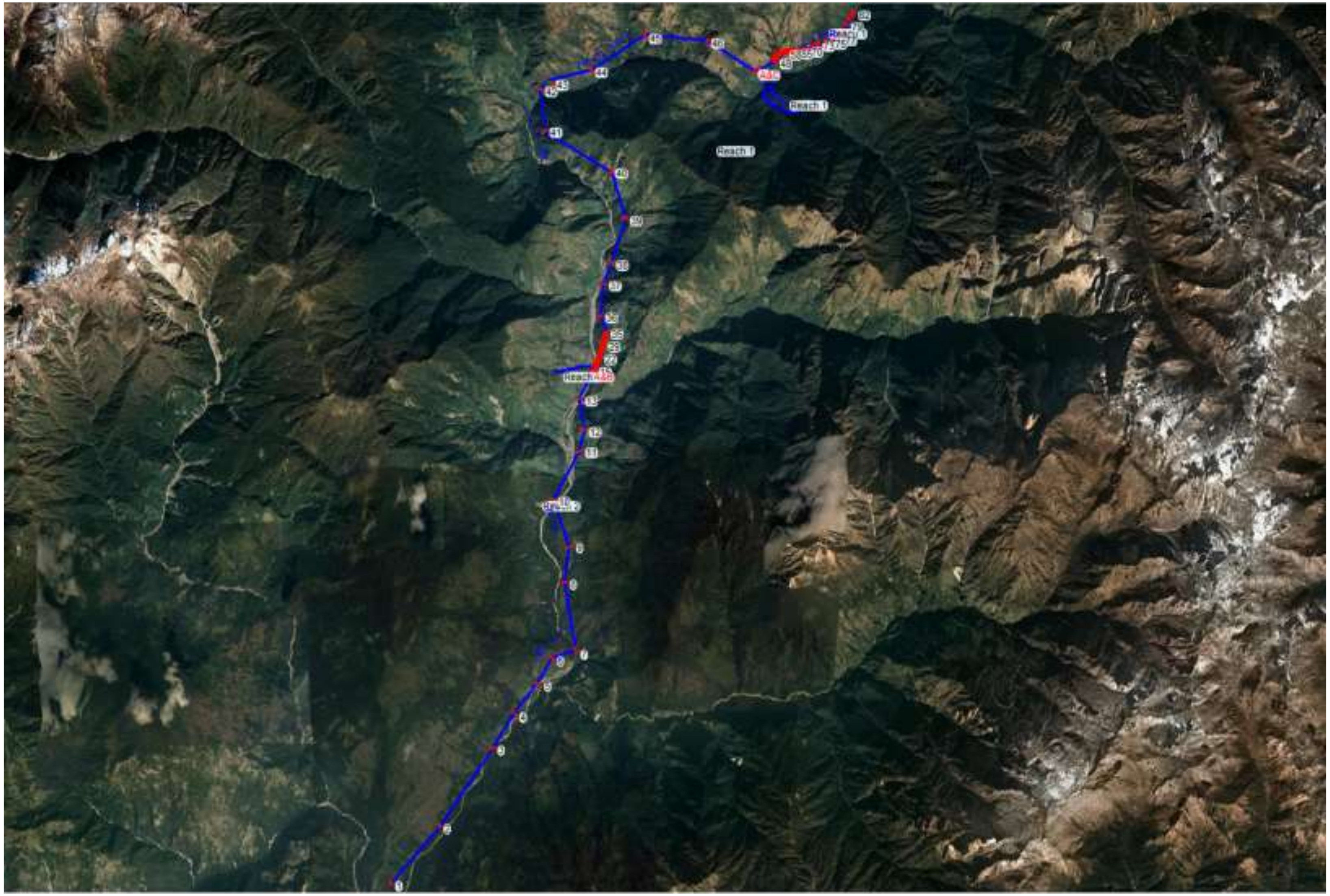
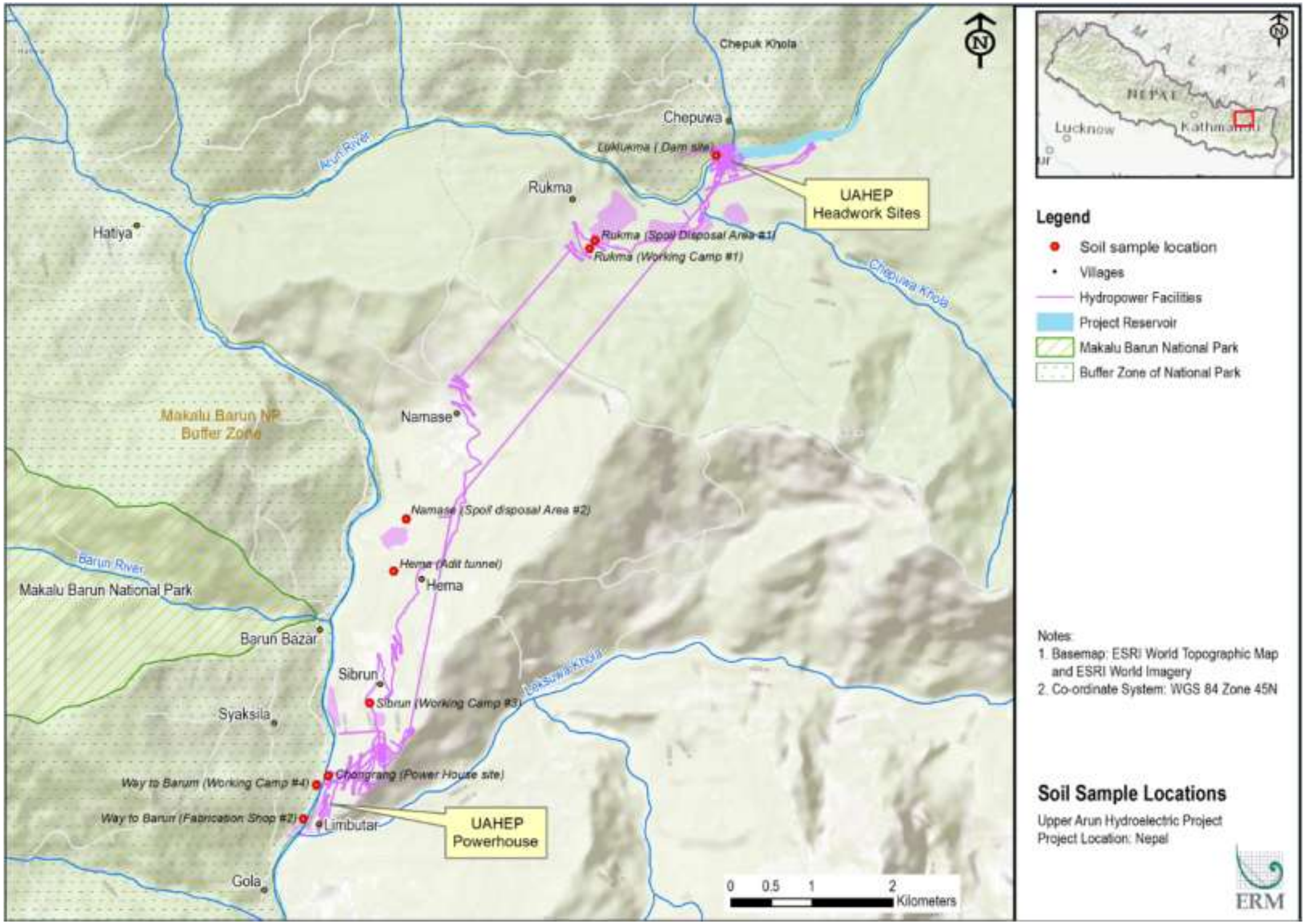


Figure 5.7: Soil Sample Locations



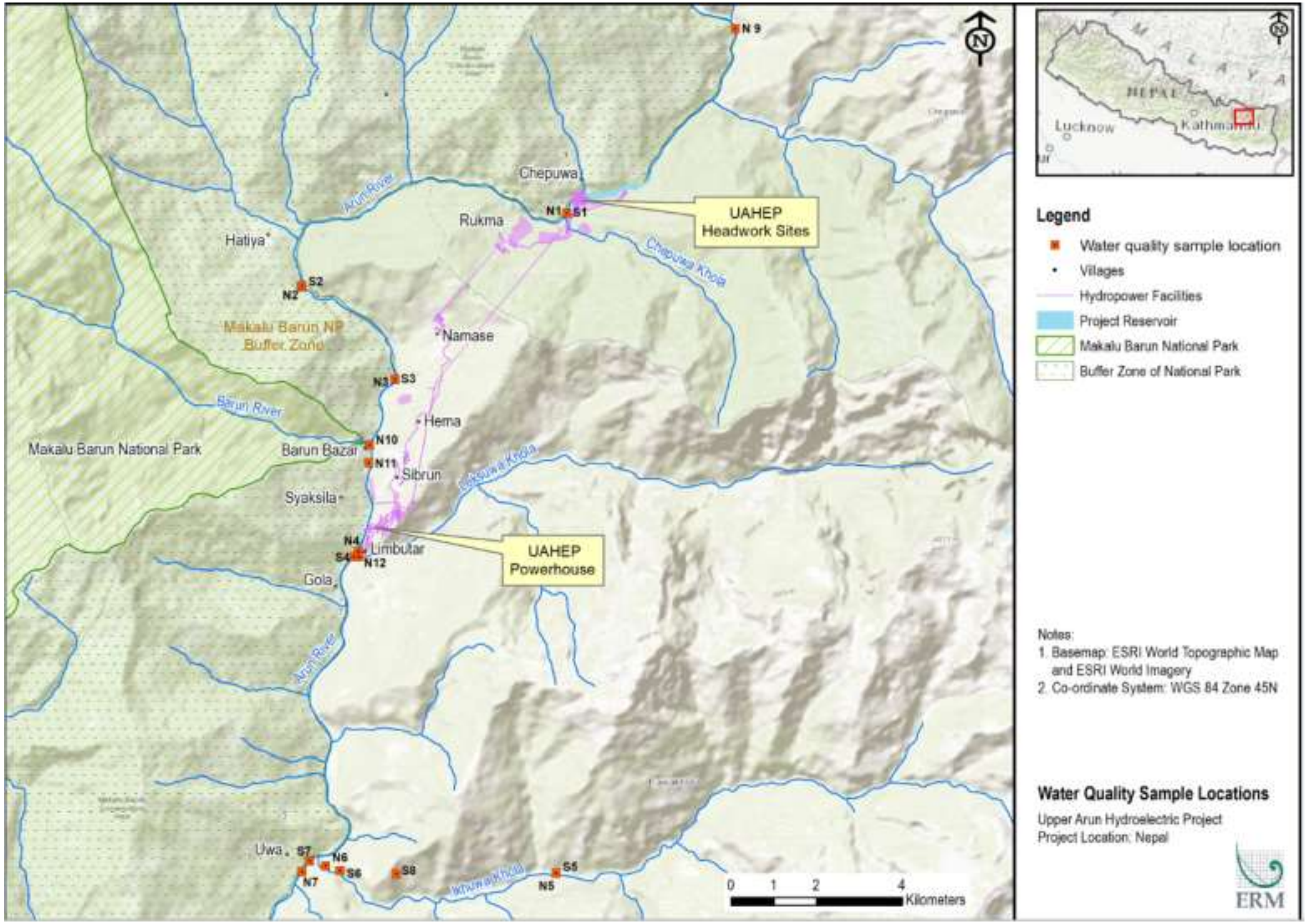
Water Quality

Surface water quality sampling and analysis of the Arun River in the project impact area (upstream from dam, diversion reach, and downstream from powerhouse areas) was conducted four times (December 2017/January 2018, April 2018, July 2018, September/October 2018) (Shah Consult International 2018). An additional water quality sampling event was conducted in April 2019 (NESS 2019).

Figure 5.8 shows the water quality sampling locations, which include the following:

- S1/N1 – reflects existing Arun river water quality in the proposed dam/reservoir area
- S2/N2 – reflects existing Arun River water quality in the upper portion of the diversion reach
- S3/N3 – reflects existing Arun River water quality near the confluence with Barun River
- S4/N4 – reflects existing Arun River water quality near the confluence with Leksuwa Khola
- S5/N5 – reflects existing Ikhuwa Khola water quality near the proposed dam site
- S6/N6 – reflects existing Ikhuwa Khola water quality in the Ikhuwa Khola diversion reach
- S7/N7 – reflects existing Arun River water quality near the confluence with Ikhuwa Khola
- S8 – reflects existing Arun River water quality near the confluence with Sankhuwa Khola
- N9 – reflects existing Arun River water quality upstream from the UAHEP dam near
- N10 – reflects Barun River water quality upstream from the confluence with the Arun River
- N11 – reflects existing Arun River water quality downstream from the confluence with the Barun River
- N12 – reflects existing Leksuwa Khola water quality upstream from the confluence with the Arun River

Figure 5.8: Water Quality Sampling Locations



Surface water samples were analyzed for the following parameters: water temperature, pH, dissolved oxygen, total dissolved gasses, total dissolved solids, total suspended solids, salinity, contaminants (sulphides, selenium, iron and manganese, ions, and organic mercury) and nutrients (phosphate and nitrate), biological oxygen demand, chemical oxygen demand, total and fecal coliform, alkalinity, hardness, chloride, oil and grease, and pesticides.

Continuous temperature loggers were also installed in three locations along the Arun River (near the UAHEP dam site, near the powerhouse site, and downstream from the Arun-3 dam). The logger near the powerhouse was dislodged during a high flow event and lost. The other two were retrieved and provide continuous temperature data from December 2019 to May 2020.

Springs

The flow in 32 springs in the DIA was measured during the dry and wet season to establish natural discharge rates. For each of these natural springs, information regarding the water uses, the water users, and the period of use were documented and the sites were photographed.

Air Quality

Ambient air quality sampling was conducted using air quality samplers (high volume/low volume samplers) at five locations between November 28 and December 2, 2019. The five locations included the UAHEP headworks, a site along the project access road, near the powerhouse, and two sites along the Koshi Highway to represent conditions along the Project's transportation corridor (***Figure 5.9***). Six parameters were measured in accordance with the National Ambient Air Quality Standards (NAAQS) of the Government of Nepal, including total suspended particles (TSP), particulate matter (PM) less than 10 (PM_{10}) and 2.5 ($PM_{2.5}$) microns in diameter, carbon monoxide (CO), nitrogen dioxide (NO_2) and Sulphur dioxide (SO_2).

Noise

Baseline noise sampling was conducted at 11 locations across the project impact area to measure ambient noise levels using sound level meters over a period of 48 hours (***Figure 5.10****).* The key parameters measured were background hourly noise level, minimum noise level, maximum noise level, Leq daytime noise level, and Leq night-time noise level. The sampling locations included:

- Headworks area
- Headrace tunnel adit area
- Project access road
- Powerhouse area
- Transportation corridor from Khandbari

Figure 5.9: Air Monitoring Stations

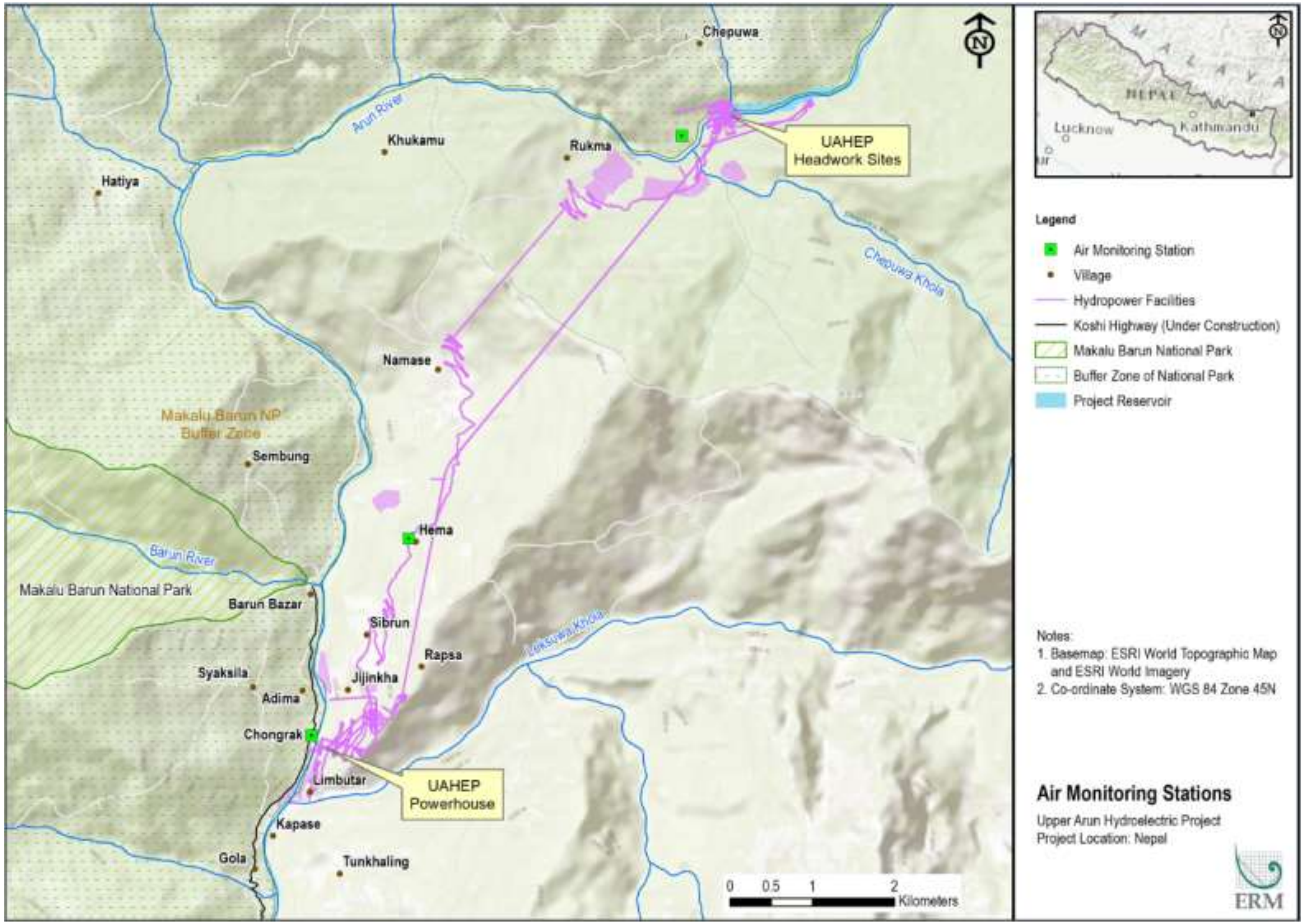
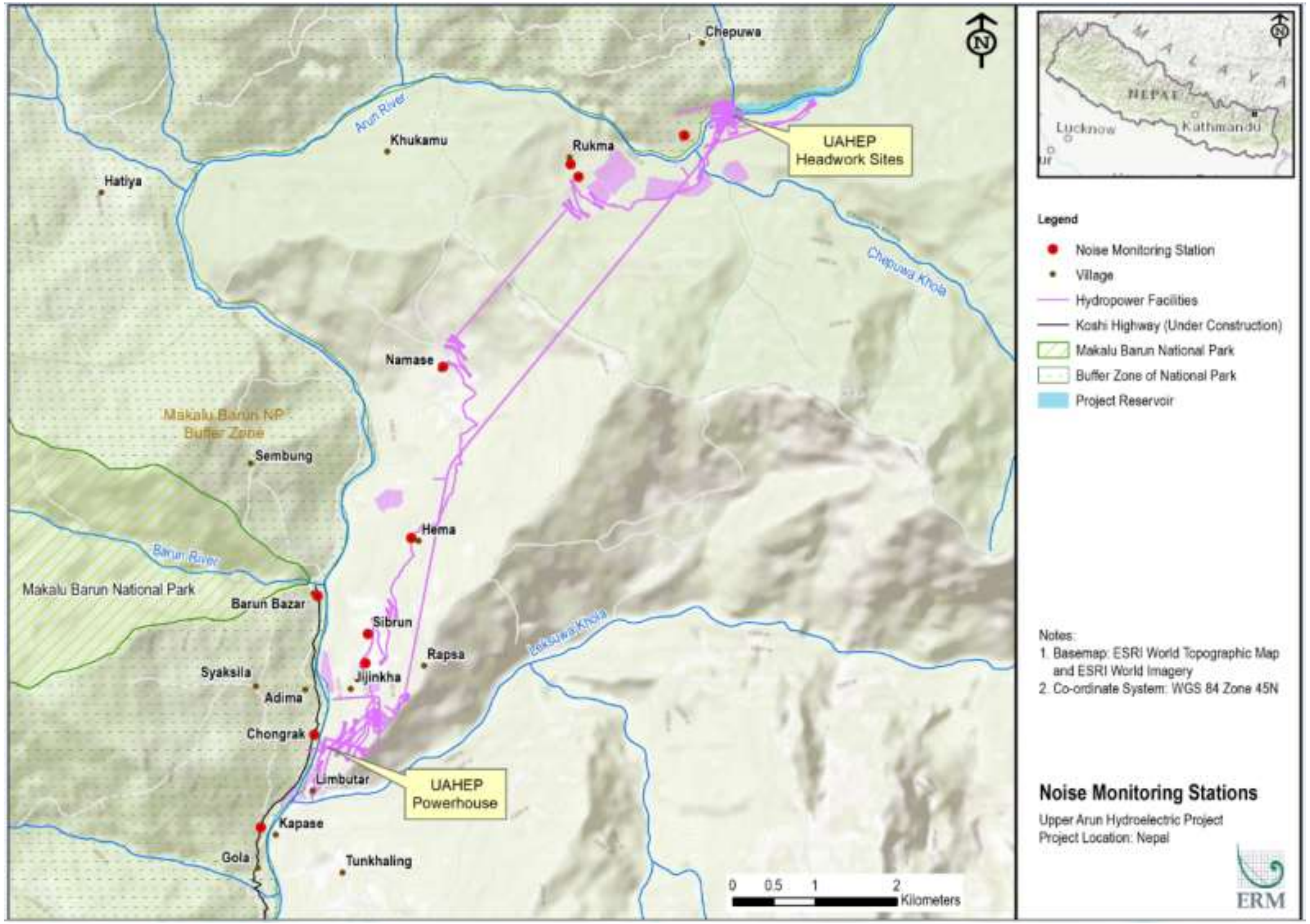


Figure 5.10: Noise Monitoring Stations



Land Use/Land Cover Mapping

A land use/land cover map of the project impact area was developed through analysis and interpretation of what was then the most recent (November 2017) high resolution (50 cm) satellite imagery followed by ground truthing/validation by social specialists and the project surveyors to determine land use patterns of the project impact area and understand the land uses that would be affected by the Project.

Biological Baseline Studies

Aquatic Ecology

A series of aquatic biodiversity field surveys have been conducted on the river reaches potentially affected by the Project to document fish species diversity, the presence of migratory fish species, fish spawning and nursery habitats, aquatic macroinvertebrates, and periphyton. Specifically, Shah Consult International carried out four seasons of aquatic biodiversity field sampling in December 2017, April 2018, July 2018, and September–October 2018. Additional sampling was conducted at several of the same sites and some additional sites in April 2019 by Nepal Environmental and Scientific Services (NESS). These surveys included areas upstream from the UAHEP headworks to the confluence of the Upper Arun River and Ikhuwa Khola (***Figure 5.11***). An additional sampling effort was conducted at the same sites in December 2019 using drift net sampling, specifically to look for Himalayan (Golden) Mahseer (*Tor putitora*) (IUCN EN) and fry/young of year fish. The fish were collected using cast (2–3 cm mesh) and gill nets. For each fish collected, species, length, weight, and sex were recorded, and then the fish were immediately released back into the river in accordance with the permit issued by MBNP. One sample of each fish species caught was preserved in 10% formalin for verification by a senior fisheries expert at Shah Consult International.

Aquatic habitat was classified as pool, riffle, or run and sampling locations were stratified across these habitat types. The same sampling points were used for all survey events to ensure the comparability of data across surveys. FGDs were held with local fishermen and other persons knowledgeable about aquatic biodiversity in the project impact area and to identify preferred fishing locations.

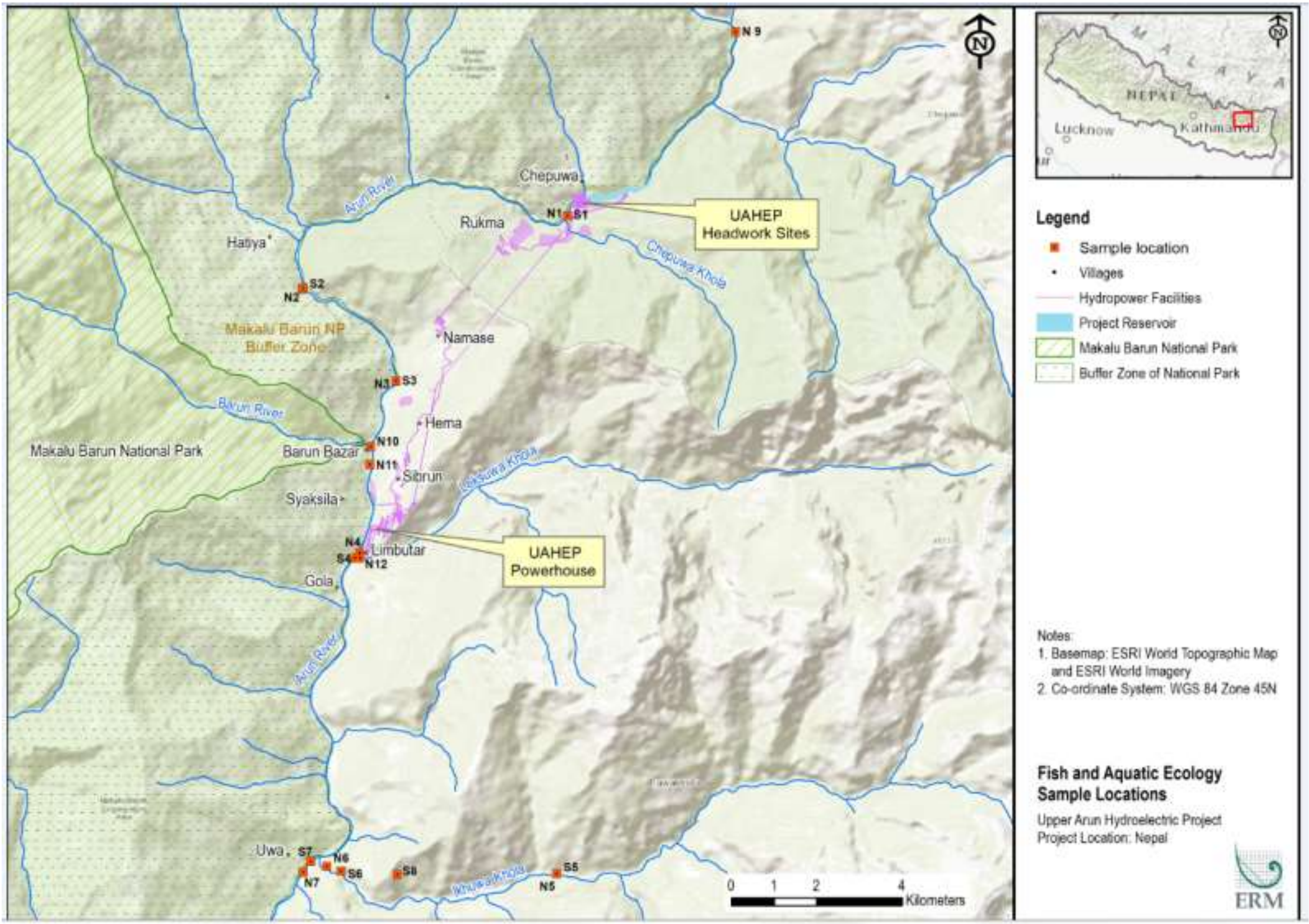
In tandem with the fish surveys, phytoplankton and zooplankton were collected from each of the fish sampling locations using a standard phytoplankton net and one-liter river water samples. The samples were preserved in a 4% un-buffered formalin solution in plastic bottles, which were analyzed at the Central Department of Botany, at Tribhuwan University in Kathmandu. The species were identified using a Leica binocular microscope and consulting relevant monographs. Samples collected from multiple habitats (pool, run, riffle) were combined to obtain a single homogeneous sample for each surveyed river reach. The samples were preserved and brought to a laboratory for identification to the genus level and population density.

Also in tandem with the fish surveys, macroinvertebrate surveys were conducted using kick sampling and drift nets and Surber samplers to collect macroinvertebrates. Samples were collected from the different aquatic habitat types in proportion to the amount of each habitat type in the sampled reach. Sampling was focused in the shallow water portions of the sampled reaches because of the torrent condition of the river, so sampling for aquatic species excluded deep sections of the Arun River. The samples were preserved in a 10% formalin solution and brought to the laboratory of Central Department of Zoology at Tribhuwan University for identification to the genus level and of population density.

Terrestrial Ecology

Terrestrial ecology field studies focused on surveys of flora/vegetation communities and fauna, as described below. In addition to field surveys, structured interviews and community consultations using pictorial guides were conducted to obtain local information regarding flora of ethnobotanical significance, wildlife use of the area, hunting and other traditional practices involving wildlife, and presence of rare and endemic flora and fauna species.

Figure 5.11: Fish and Aquatic Ecological Sampling Locations



Terrestrial Flora

A vegetation and forest assessment, including an inventory of forest stock, was conducted in the DIA. The assessment was conducted following the National Forest Inventory Guideline (2006), in close coordination with the Sankhuwasabha Divisional Forest Office (DFO) and Makalu Barun National Park (MBNP), Buffer Zone Community Forest Users Groups (BZ-CFUGs), and other related stakeholders.

Consultations with the DFO and MBNP were conducted to obtain an overview of the forests types in the project impact area, obtain lists of floral species and BZ-CFUGs within the area, and develop the detailed methodology for the forest assessment (Appendix F, Annex FB-4). Consultations with community forest users group (CFUGs) were conducted to document key features of the community forests and user groups, their major activities, and key forests types and flora species found in the area, including culturally and economically important floral species. These consultations also provided information on the major NTFPs and medicinal plants found in the area.

Forests within the project impact area were identified and mapped using satellite imagery and geographic information system (GIS) tools and in consultation with local communities and BZ-CFUGs, followed by field sampling transects per the National Forest Inventory Guideline (2006) (***Figure 5.12***). The assessment included forests under different ownership and management regimes (e.g., government forests, community forests, BZ-CFUGs, and private forest land) (***Figure 5.13***). Data collected on forest stock included species, density, biomass, and carbon stock.

Figure 5.12: Flora Survey Transects

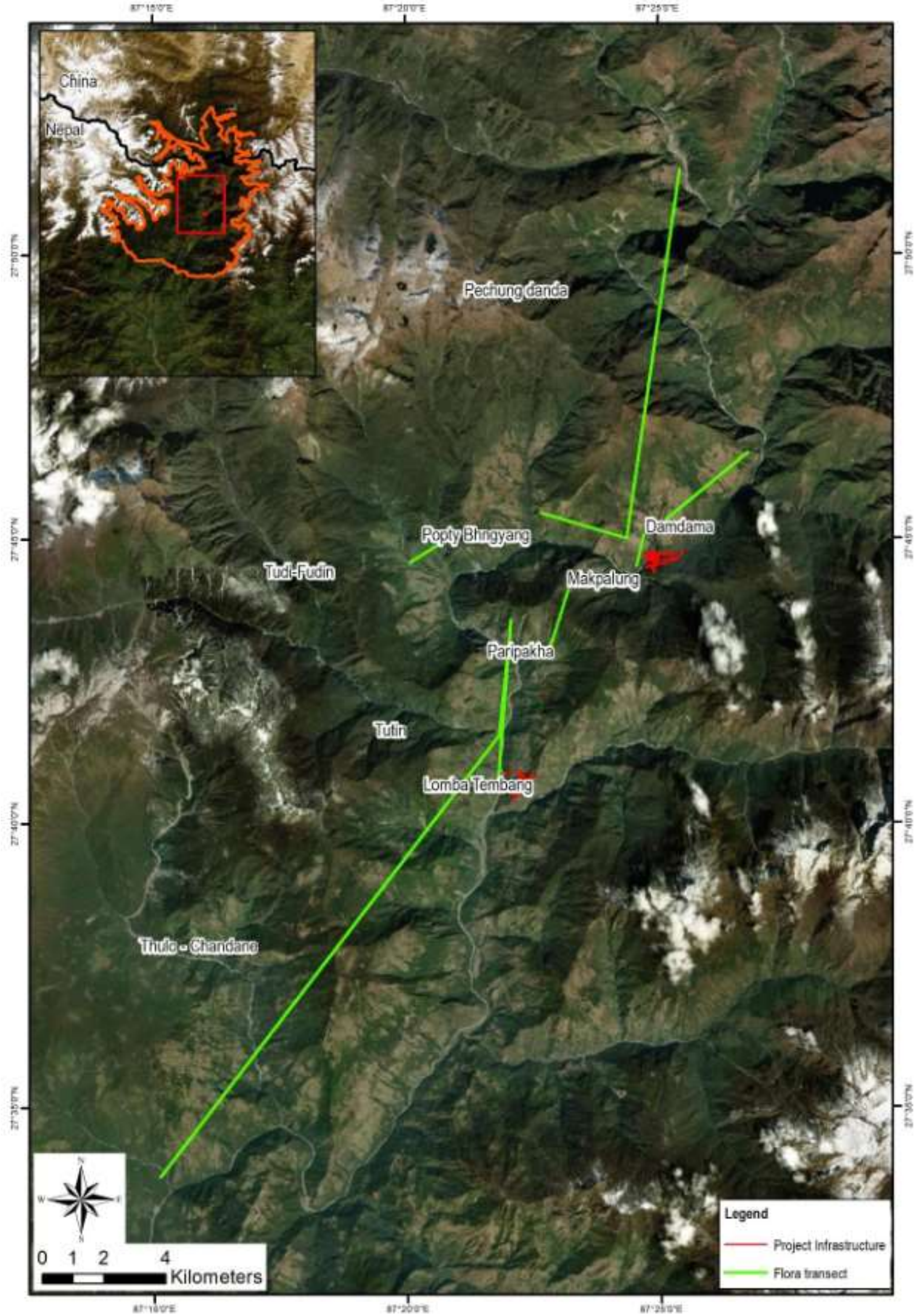
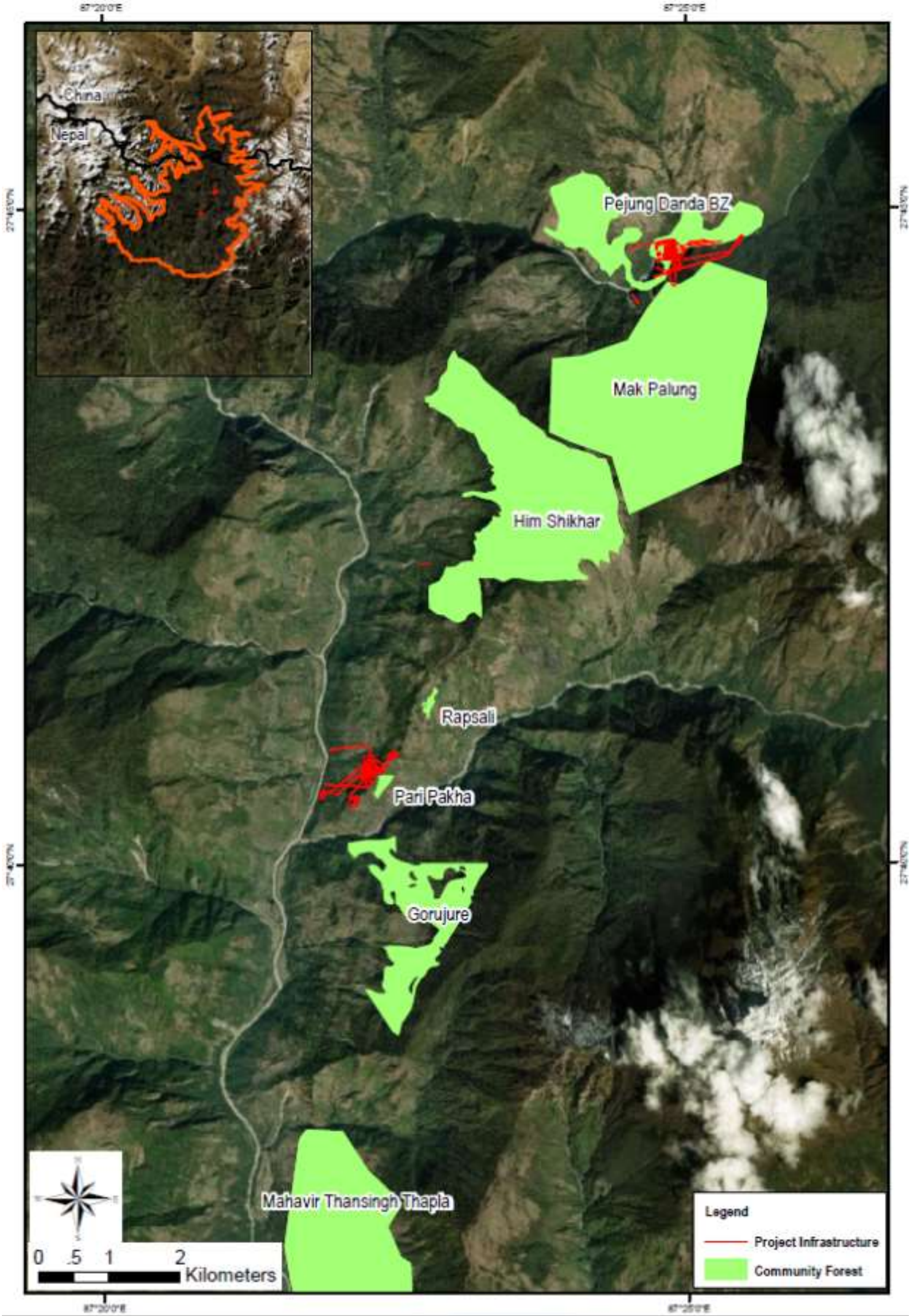


Figure 5.13: Community Forest in the Direct Impact Area



Terrestrial Fauna

Similar to the vegetation and forest assessment, a participatory approach was implemented for fauna surveys (herpetofauna, mammals, and birds), in close coordination with the DFO, MBNP, BZ-CFUGs, and other related stakeholders. Surveys of mammals, herpetofauna, and birds were conducted in the DIA using standard line transect sampling methods within each major habitat type in the area during April and October 2019. In addition, point count surveys of maximum 50-meter radius were conducted along the line transects on days when line transect surveys were not conducted (***Figure 5.14***). During the surveys, all wildlife species seen or heard (in the case of birds) were recorded. All surveys were conducted during the early morning (0600–1000 hours) and early evening (1500–1800 hours) when animals are most active. The line transect survey protocol involved standard distance sampling to estimate herpetofauna and mammal density. Digital auditory recordings using a digital recorder fixed with 20-meter zoom external microphone were collected during transect and pot count surveys and post-processed to further document bird and mammal species occurrence based on their calls.

Vantage point surveys were conducted along the proposed transmission line route to detect bird species that could be impacted by construction activities and the footprint of the transmission line, to detect species with the potential to be impacted by collision with transmission towers and/or collision with or electrocution by the transmission line, and to detect species likely to use the Upper Arun River valley as a flyway. Vantage point surveys were also used to record bird activity within the one kilometer strip on either side of the transmission line (***Figure 5.15***). For these surveys, data was continuously collected over the course of a single day (0530–1830 hours). The vantage point survey locations were selected to provide survey coverage of potential migratory flight paths of birds (e.g., the flyway along the Arun River).

In addition to structured surveys, opportunistic observations (ad libitum sampling[7]) of terrestrial wildlife and wildlife sign encountered during the course of line transect, point count, and other (e.g., vegetation) sampling activities were recorded. Signs indicative of terrestrial wildlife presence included pug marks or footprints, droppings, tree markings, nests, burrows, odors, leftover food items, animal remains, and other evidence. Also, all water sources were opportunistically surveyed during the field work to document wildlife use of waterbodies.

[7] https://icatcare.org/behaviour-described/measuring-behaviour/methods/sampling

Figure 5.14: Fauna Survey Transects

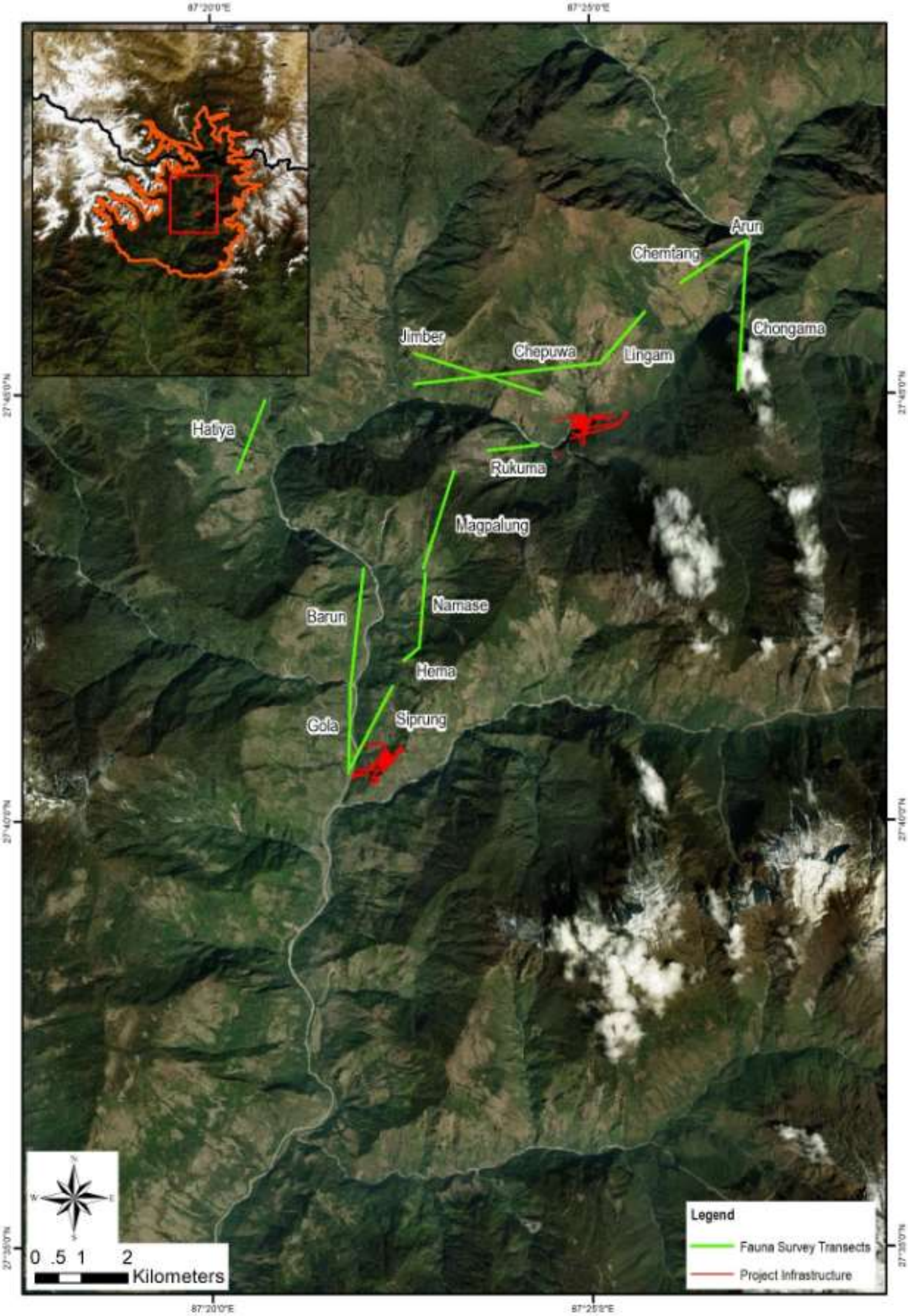
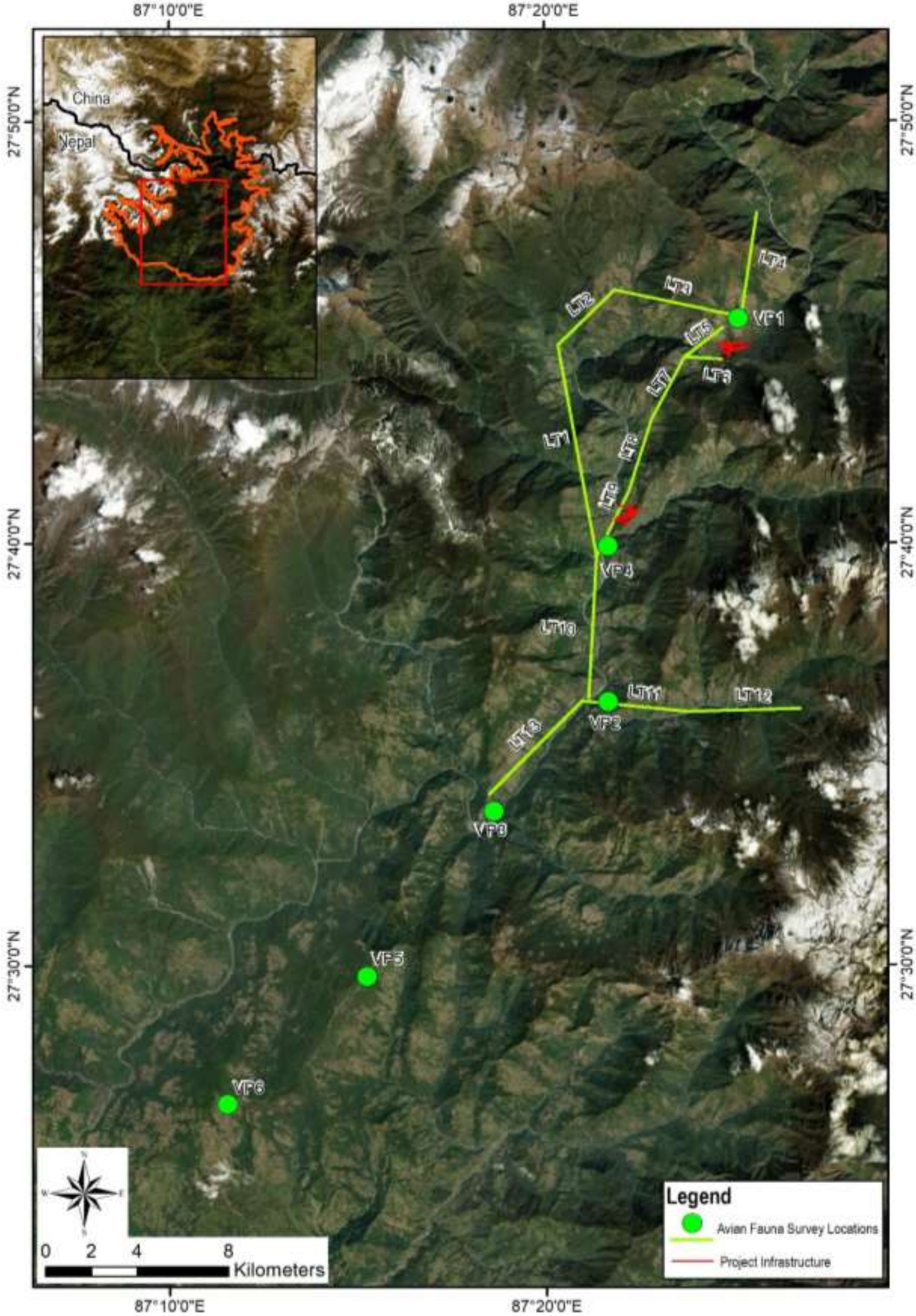


Figure 5.15: Avian Vantage Point Survey Locations



Delineation of Modified, Natural, and Critical Habitat

Modified and natural terrestrial habitats (aquatic and terrestrial) were delineated within an Ecologically Appropriate Area of Analysis (EAAA) using existing habitat mapping and biodiversity data for the region combined with primary data collected during the field surveys.

Following the delineation of modified and natural habitats, a critical habitat (which is a subset of natural and modified habitats) screening was undertaken using the thresholds within WB ESF ESS6 and informed by International Finance Corporation (IFC) Performance Standard (PS)6. Consultation with relevant biodiversity experts informed the critical habitat screening, particularly for key species of concern (e.g., red Panda, Chinese pangolin and other critically endangered species), as these species may not be detected during field surveys. Chapter 6 (Section 6.2.3) contains the critical habitat screening and the no net loss/net gain assessment.

Social Baseline Studies

Several social baseline studies were conducted to characterize the socioeconomic and cultural conditions and aspects of the villages within the DIA and project affected people/families (PAP/PAFs). Most of these surveys involved collection of qualitative and quantitative information using the following data collection methods (***Table 5.5***).

Table 5.5: Overview of Social Data Collection Methods

Data Collection Activity	Unit of Data Collection	Type of Data Collected
Household questionnaire	Household level socioeconomics and related data	Quantitative data collected through questionnaire
Focus group discussion (FGD)	Collection of information from discussion with specific groups (e.g., women, youth, elderly, livelihoods, ethnic groups)	Qualitative information on a range of topics
Key informant interview (KII)	Collection of information from individuals with knowledge on specific topics	Collection of quantitative or qualitative information around a specific topic
Cadastral mapping	Individual parcel basis	Identifies the boundary and ownership of land
Census survey	Project affected people (PAP)	Detailed questionnaire
Land and asset survey	PAP	Inventory of land and assets owned by PAPs

Socioeconomics

A detailed socioeconomic baseline survey was conducted in June 2019 and December 2019 to define the social context of the DIA. The social baseline included 593 detailed household surveys, which were conducted in every village within the DIA (***Table 5.6***), 55 FGDs (see ***Table 5.7***), and 26 KIIs, which were held throughout the project impact area and in Kathmandu (institutional KIIs). The households included in the household survey were randomly selected from a list of households in the village (every 5th household). In villages where multiple ethnic groups reside, a list of households was prepared for each ethnic group and then households within each ethnic group were randomly selected. For the smaller villages and those closer to the project footprint, the survey typically included all households with an adult present on the day of the survey. The FGDs were carried out in June 2019 and January 2020 and were led by an indigenous peoples specialist and/or a female gender specialist. The FGDs were structured and followed checklists that were developed specifically for this Project.

Table 5.6: UAHEP Household Surveys by Village

Name of Village	Total Households (as reported by communities)	Total Number of Households Surveyed	Percentage of Total Households Surveyed
Headworks Area and Upstream Area			
Chyamtan	135	21	16%
Lingam	15	11	73%
Guthi Guba	10	8	80%
Chepuwa	125	105	84%
Rukma	27	27	100%
Diversion Reach			
Hongon	250	41	16%
Hatiya	135	34	25%
Sembung	45	5	11%
Barun Bazar	6	6	100%
Project Access Road			
Namase	71	71	100%
Hema	25	25	100%
Sibrun	75	73	97%
Jijinkha	6	6	100%
Powerhouse Area			
Limbutar	6	6	50%
Rapsa	8	4	80%
Syaksila	135	35	26%
Adima	10	5	50%
Chongrak	5	5	100%
Transmission Line and Downstream Area			
Gola	27	24	89%
Kapase	10	8	80%
Tunkhaling	95	51	54%
Lunsun	25	8	32%
Obak	85	11	13%
Haitar	7	3	43%
Total	**1,343**	**593**	**28%**

Table 5.7: Focus Group Discussions by Village

Name of Village	Total Households	Number of FGD
Headworks Area and Upstream Area		
Chyamtan	135	2
Lingam and Gumba	25	2
Chepuwa	125	3
Rukma	27	3
Diversion Reach		
Khukamu	5	1
Hongon	250	2
Hatiya	135	3
Sembung	45	1
Barun Bazar	6	1
Project Access Road		
Namase	71	2
Hema	25	2
Sibrun	75	2
Jijinkha	6	2
Powerhouse Area		
Limbutar	6	2
Rapsa	8	2
Syaksila	135	2
Chongrak/Adima	5	2
Transmission Line and Downstream Area		
Gola	27	3
Kapase	10	2
Adima	10	1
Tunkhaling	95	2
Lunsun	25	2
Hitar	7	2
Obak	85	2
Transport Route from Khandbari to Gola		

Name of Village	Total Households	Number of FGD
Gadi	Information not collected	1
Num	Information not collected	1
Simma	Information not collected	1
Hedenga	Information not collected	1
Chchila Bazar	Information not collected	2
Chhuyankuti	Information not collected	1
Total[8]		**55**

The list below further details the participants in the KIIs and FGDs (as identified in ***Table 5.7***):

- CFUGs – Mak Palung, Rapsali, Him Sikhar, Pari Pakha, and Gorujure CFUG representatives
- Ward chairpersons
- UAHEP Local Concern Group
- Priests
- Teachers
- Fishermen
- Traditional health practitioners
- Individuals practicing traditional cultivation
- Individuals engaged in collection and trade of herbal medicines or NTFPs
- Cardamom growers
- Traditional Bhote, Rai, and Tamang leaders
- Women – especially to understand their dependence on land and natural resources, ownership and access to natural resources, and indigenous knowledge and skills

The indigenous peoples and gender specialists used semi-structured checklists to guide their discussions, which covered aspects listed in ***Table 5.8***.

[8] Data was not collected on the number of households in villages along the Transport Route as this would be misleading and reflect more households than were actually located along the road itself.

Table 5.8: Topics covered in FGDs

Topics Covered in Mixed Gender Group Discussions	Topics Covered in Women Only Group Discussions
• Ethnic group and demographic description • Ethnic/group identification • Language - similarity and dissimilarity with neighbouring groups • Historical territoriality: ancestral land and its possession • Traditional modes of livelihood and its continuation/ discontinuation and current modes of livelihood and employment patterns • Tradition and practices of indigenous knowledge (IK) systems • Kinships, clan division and custom and marriage practices among kin and clan groups • Political organization, formal and informal institutions • Major festivals and rituals • Religious practices • Customary law and traditional political Institution • Cultural status, marginalization and domination • Agriculture and livestock practices • Use of forest resources • Cultural heritage, archaeological, historical and religious sites • Existing development infrastructure • Local development needs and priority • Likely beneficial and adverse impacts due to project	• Education status • Health condition and services • Livelihood activities (farm and non-farm) • Household roles and responsibilities • Mobility • Migration • Gender discrimination and GBV • Land ownership • Use of natural resources • Financial Institutions • Impact of UAHEP

Community Health

Data on community health and gender-based violence were collected through the socioeconomic baseline study (household survey, including sections regarding sanitation and waste management) and through KIIs using structured surveys and led by a community health specialist. Interviews were conducted with community health practitioners at the two health care facilities within the DIA (Gola Health Post and the Hatiya Health Center), the District Health Office in Khandbari, and traditional health practitioners to document existing health beliefs, practices, and health care systems. The morbidity data for Bhotkhola Rural Municipality for the last three years was collected from the District Health Office.

Indigenous Peoples

Nearly all residents of the DIA are indigenous. Therefore, the information collected from the sample socioeconomic (household) survey, FGD, and KII was used for describing the socioeconomic and cultural practices of potentially affected indigenous peoples. In addition, qualitative data on the sociocultural life of indigenous peoples and their dependence on natural resources (ecosystem services) were collected through FGDs in each village and with CFUG representatives using a structured checklist of important themes.

Labor and Influx

The potential influx of workers, as well as their families and other opportunity seekers, to the project impact area during construction can significantly impact local communities and create social tensions and conflicts. Structured interviews with KIIs and/or FGDs were conducted with the following stakeholders to better understand the risks and issues associated with labor and influx:

- Bhotkhola Rural Municipality elected representatives
- Makalu Rural Municipality elected representatives
- Village women’s groups
- MBNP management
- Department of Labor
- Department of Occupational Safety
- Labor Supply Agency

- Ministry of Women, Children, and Social Welfare
- Udyoga Vaniya Sangha, Sankhuwasabha
- International Labor Organization (ILO) Nepal
- Nepal Police Post – Gola
- Department of Police, Sankhuwasabha
- Nepal Army Post – Gola
- Upper Arun Concern Committee

Gender

A targeted gender assessment was conducted by the gender specialist to collect information on gender issues and practices of importance or special significance to women, including:

- Documenting legitimate rights of women on land (including customary and inheritance rights);
- Understanding the potential risks faced by women associated with labor influx
- Soliciting women's views on compensation methods, use of compensation money, and range of livelihood restoration activities suitable to them
- Encouraging women to be aware about the inventory of losses/asset survey
- Informing women about alternative compensation methods, use of compensation money, and range of livelihood restoration activities
- Assessing the barriers faced by women in accessing resettlement packages and recommending activities accordingly to enable and ease the process for women to receive the benefits

The assessment collected data on women-specific community demographics, education, health and hygiene, waste management, economics, gender status, and culture. Data were collected through the socioeconomic and cultural heritage baseline data collection and through targeted gender assessment-specific FGDs and KIIs.

Several different FGDs were held – with mixed age groups, unmarried girls, older women, Dalit women, CFUG officers, *aama samuhas* (mother's group), women water users, savings credit groups, women small farmers, and a female political leader – totaling 35 women's-only FGD. The household surveys and women FGDs collected information on the division of labor between men and women in a typical household for household chores as well as livelihood/income generating activities.

The 26 KIIs were conducted across all major ethnic groups (i.e., Bhote, Rai, Tamang, and Gurung) and included the following key informants:

- Women spiritual/religious leader
- Women traditional medicine practitioner
- Women cultural performers
- Women community health workers at Gola and Hatiya health posts
- Women development officer in Khandbari
- Women primary and secondary school teachers
- Women elected officials in Bhotkhola Rural Municipality and Khandbari Urban Municipality[9]

[9] There were no women working in police/security forces in the project-affected villages, therefore, no interviews with female police/security forces were conducted.

Cultural Heritage

Field-based cultural heritage baseline surveys were conducted for both tangible and intangible heritage within the DIA, including the reservoir area (***Table 5.9***). The surveys involved pedestrian (surface) surveys in the project footprint, FGDs in each of the major communities that would be affected by land disturbance, and KIIs with knowledgeable persons such as local culture and heritage caretakers/leaders. In addition, consultations with institutional stakeholders, including the Department of Archaeology and UNESCO, were conducted.

As part of the gender KIIs described above, information on cultural and ceremonial sites with special significance to women, intangible traditions passed through women (e.g., food items, recipes, art and cultural performances), spiritual and religious traditions or customs practiced by indigenous women, and the significant role of women as the customary knowledge holders and stewards of cultural and natural heritage were also collected.

Table 5.9: Cultural Heritage Baseline Methods and Tools

Cultural Heritage Type	Approach	Coverage	Tools
Tangible cultural heritage (e.g., temples, gompa, stupa, chorten, historical buildings)	Tangible cultural heritage sites were photographed and a brief profile of the site prepared using Form-A. The key aspects covered include brief history of the site, structural features, rites and rituals, custodians and operation/ management, users, source of income and support.	All directly affected villages, cultural sites abutting the transportation routes from Khandbari to Gola	Cultural Heritage Structure Survey Form-A
Archaeological remains and historical ruins (if any)	The surface observation and exploration of all land parcels to be acquired was carried out during RAP survey. Community feedback of encountering typical artefacts in and around the project land parcels was sought to screen potential sites. All cultural sites within the DIA were recorded.	All land disturbance and land acquisition	Archaeological Remains and Historical Ruins Survey Form-B
Natural heritage (e.g., holy lake, streams, caves, rocks, forests, festival sites)	The ward committee, members of CFUGs, and culture and heritage caretakers/leaders (e.g., Pujari, Lama, Fedangma, Khando/Bijuwa) were interviewed to collect information on natural features and animals that are considered holy or sacred.	DIA Any site abutting transportation route from Khandbari to Gola.	Natural Heritage Survey Form-C
Intangible cultural heritage – rapid ethnographic review	FGDs (conducted by the Project's indigenous peoples specialist) included rapid ethnography focusing on intangible cultural heritages covering: migration history, belief system, social organization, sources of oral traditions, life cycle rites and rituals, performing arts, and craftsmanship.	Each major ethnic group: Tamang, Bhote, Gurung, Rai	Intangible Cultural Heritage and Ethnography Checklist Form-D

5.4 Alternatives Analysis

Consideration of alternatives early in the ESIA and the engineering feasibility study process is the best way to apply the mitigation hierarchy and avoid or minimize project impacts. The ESIA and the engineering teams coordinated closely regarding aspects of the project design with environmental and social implications, including the project access road and transmission line alignments, siting of ancillary facilities, reservoir water levels, environmental flows, fish passage, and transmission tower design, among other things, to minimize impacts and align the Project with the WB ESF. This process of continual improvement and refinement of the project design continued throughout the ESIA process and involved multiple environmental and social specialists as well as the Project Engineers (i.e., CSPDR and KEC), including both face-to-face meetings and conference calls, many of which included NEA staff.

Chapter 4 describes the alternatives assessment undertaken for the Project and how environmental and social considerations were taken into account. This analysis also includes a “without project” alternative. The alternatives analysis did not include the decommissioning phase because the Project has been designed to operate for at least 50 years, and is expected to operate for 80 or more years, especially taking into consideration the sediment management strategy, which will minimize sediment deposition in the project reservoir, so the timeframe for potential decommissioning is so far in the future as to make any impact predictions unreliable. In the event that the Project is decommissioned in the future, a new ESIA will be prepared to address project decommissioning alternatives and impacts at that time.

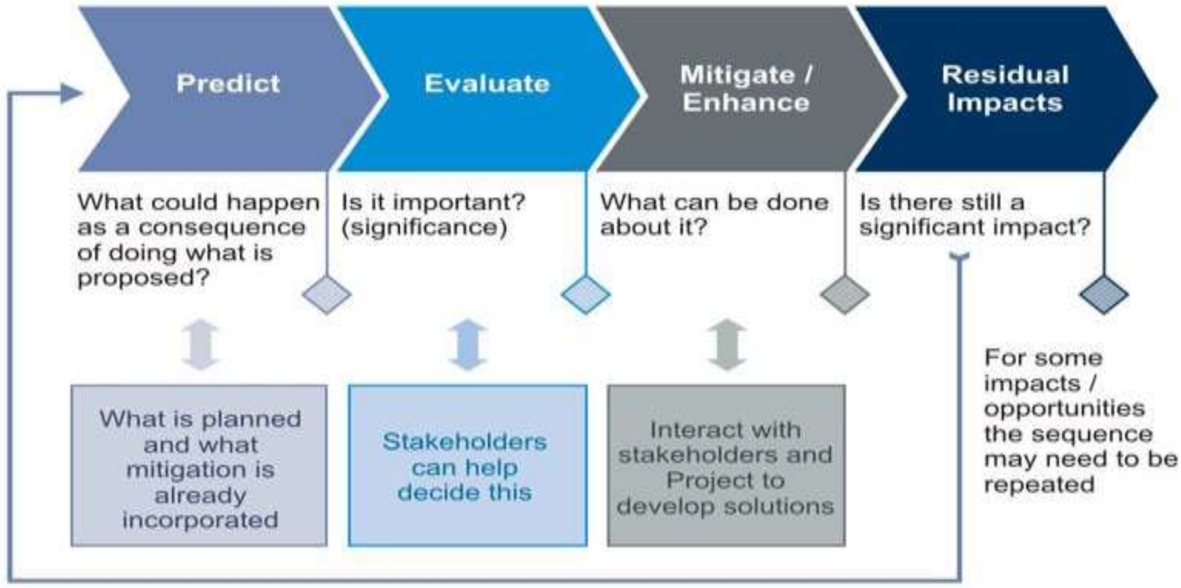
5.5 Impact Assessment Process

The ESIA evaluated the direct, indirect, and cumulative impacts and risks of the Project in both the short-term and the long-term resulting from the construction and operation phase activities of the Project, and recommended mitigation measures to avoid, minimize, mitigate, and compensate for unavoidable impacts per the mitigation hierarchy, as described below:

- Identify and avoid risks and impacts
- Where avoidance is not possible, eliminate, minimize, or reduce impacts to acceptable levels by applying various measures
- Where significant residual impacts remain, compensate or offset them

The impact assessment process includes four steps: predict, evaluate, mitigate/enhance, and determine residual impacts (***Figure 5.16***).

Figure 5.16: Impact Evaluation Process



5.5.1 *Predict Impacts*

The first step in the impact evaluation process involved predicting and quantifying, to the extent possible, the nature, type, magnitude, extent, and duration of the identified impacts on receptors. These terms are defined in ***Table 5.10***.

Table 5.10: Definition of Impact Criteria

Criteria	Definition
Nature of impacts on environment/community	Beneficial – impacts that result in net benefits Adverse – impacts that result in net detriments
Type of impact	Direct – impacts resulting directly from changes caused by the Project Indirect – secondary impacts caused by the Project
Magnitude – the level of impact; takes into consideration importance of the receptor, sensitivity of the receptor to change, likelihood of the impact occurring, and the predicted degree of impact	Low – a small, but measurable, change from the baseline conditions, typically that would not result in an exceedance of any applicable government standards Medium – a noticeable and readily measurable change from the baseline conditions that may result in an exceedance of any applicable government standards High – a substantial change from the baseline conditions that would result in an exceedance of any applicable government standards
Extent – the areal “reach” of the impact	Site-specific – impacts confined to within the RoW or the boundaries of the substations or ancillary facilities (e.g., laydown areas) Local – impacts extend beyond the project footprint area to affect resources up to 5 kilometers away from the Project Regional – impacts observed extending more than 5 km away from the project
Duration	Short-term – less than five years Medium-term – more than five years and less than 10 years Long-term – 10 years or more

Source: Adapted from MoFE 2018

5.5.2 Evaluate Impact Significance

The second step of the impact evaluation process involved determining the significance of each identified impact. The magnitude, extent, and duration criteria each are assigned a numerical value, which are then combined in a risk matrix to characterize the overall impact significance (***Table 5.11***). ***Table 5.12*** provides a decision tree illustrating how the various rating criteria combine to determine the impact significance. ***Table 5.13*** defines each of the levels of impact significance.

Table 5.11: Environmental and Social Impact Rating Criteria and Point Values

Magnitude	Extent	Duration	Significance	Point Range
Low (10)	Site-specific (10)	Short-term (5)	Low	0–40
Medium (20)	Local (20)	Medium-term (10)	Moderate	41–50
High (60)	Regional (60)	Long-term (20)	Substantial	51–89
			High	90–140

Table 5.12: Environmental and Social Impact Point Value and Significance Rating

Magnitude	Extent	Duration	Point Value	Significance
Low	Site-specific	Short-term	25	Low
Low	Site-specific	Medium-term	30	Low
Low	Local	Short-term	35	Low
Medium	Site-specific	Short-term	35	Low
Low	Site-specific	Long-term	40	Low
Low	Local	Medium-term	40	Low
Medium	Site-specific	Medium-term	40	Low
Medium	Local	Short-term	45	Moderate
Low	Local	Long-term	50	Moderate
Medium	Site-specific	Long-term	50	Moderate
Medium	Local	Medium-term	50	Moderate
Medium	Local	Long-term	60	Substantial
Low	Regional	Short-term	75	Substantial
High	Site-specific	Short-term	75	Substantial
Low	Regional	Medium-term	80	Substantial
High	Site-specific	Medium-term	80	Substantial
Medium	Regional	Short-term	85	Substantial
High	Local	Short-term	85	Substantial
Low	Regional	Long-term	90	High
Medium	Regional	Medium-term	90	High
High	Site-specific	Long-term	90	High
High	Local	Medium-term	90	High
Medium	Regional	Long-term	100	High
High	Local	Long-term	100	High
High	Regional	Short-term	125	High
High	Regional	Medium-term	130	High
High	Regional	Long-term	140	High

Table 5.13: Impact Significance Rating Definitions

Impact Rating	Rating Definition
High	The resource/receptor would likely experience a large magnitude impact that would endure for a long time, extend over a large area, exceed national/international standards, endanger public health and safety, threaten a species or habitat of national or international significance, and/or exceed a community's resilience and ability to adapt to change. The Project may have difficulty in complying with the applicable ESF requirement, and significant mitigation would likely be required.
Substantial	The resource/receptor would experience a clearly evident change from baseline conditions and would approach but not exceed applicable standards. The Project would comply with the applicable ESF requirement, but mitigation would be required.
Moderate	The resource/receptor would experience a noticeable effect, but the magnitude of the impact is sufficiently small (with or without mitigation) that the overall effect would remain well within applicable standards. The Project would comply with the applicable ESF requirement, but mitigation may be required.
Low	The resource/receptor would either not be affected or the likely effect would be imperceptible or indistinguishable from natural background variation. The Project would comply with the applicable ESF requirement and mitigation would typically not be required.

5.5.3 Mitigate Impacts

The next step in the process was the identification of measures that could be taken to mitigate, as far as reasonably practicable, the identified potential impacts of the Project, in accordance with the requirements of the WB (see ESS 1 – paragraph 27). The development of mitigation measures followed the mitigation hierarchy of avoidance, minimization, mitigation to the extent feasible, and compensation or offsetting if necessary. Mitigation measures were developed to address the potential impacts identified in the ESIA process and reviewed with affected communities. These measures are described in each resource/receptor-specific discussion in Chapter 7 (Environmental and Social Risks, Impacts, and Mitigation) and included in the Project's ESMP (Appendix C).

5.5.4 Determine Residual Impacts

The final step in the impact evaluation process was the assessment of residual impacts and risks. Residual impacts and risks are those that would remain after all relevant avoidance, minimization, and mitigation measures have been taken. In cases where a residual impact significance rating is High or Substantial, emphasis is applied to reduce the impact/risk to a level that is as low as reasonably practicable. This is typically done by revisiting Steps 1 and 2 in the process (Predict Impacts and Evaluate Impacts, respectively) to identify ways of reducing impact magnitude or by considering implementation of new or additional avoidance or minimization measures aimed at reducing impact significance.

Several other factors that influence the overall project risk and residual significance rating and affect the feasibility of successful implementation of proposed mitigation measures must also be taken into consideration:

- UAHEL and most local Construction Contractors have limited experience in developing projects of this magnitude to international standards.

- Normative context of Nepal – specifically, the presence of prevailing norms may complicate the implementation of mitigation measures (e.g. lack of a stringent health and safety culture, normalization by many of the practice of child marriage).
- Organizational capacity – the organizational capacity of UAHEL and most local Construction Contractors in implementing proposed mitigation measures and successfully delivering a large complicated project to international standards is weak. This consideration is most important in instances where the proposed mitigation measures are particularly arduous/demanding.
- Institutional capacity – the institutional capacity of the Government of Nepal and its applicable ministries to provide construction monitoring and enforce its regulations and project approval conditions. For example, recent studies by the WB in Nepal have found little or no implementation of project requirements such as fish ladders and environmental flows.

To address these considerations, the residual significance rating for certain impacts have been adjusted when it was determined that the implementation of mitigation measures was particularly complex and/or there is a track record of poor implementation in Nepal. The areas in which this has been done are clearly indicated and the reason for the final adjustment rating explicitly noted. Where this occurs, the residual significance rating has been increased to a high significance/risk rating.

Although a standard goal of an impact assessment is to eliminate all significant residual impacts, for some resources/receptors there may be residual High or Substantial impacts/risks, even after all practicable mitigation options have been exhausted. In these situations, and especially where contextual and institutional/organizational risks apply, this ESIA recommends the following measures, in addition to the proposed mitigation measures:

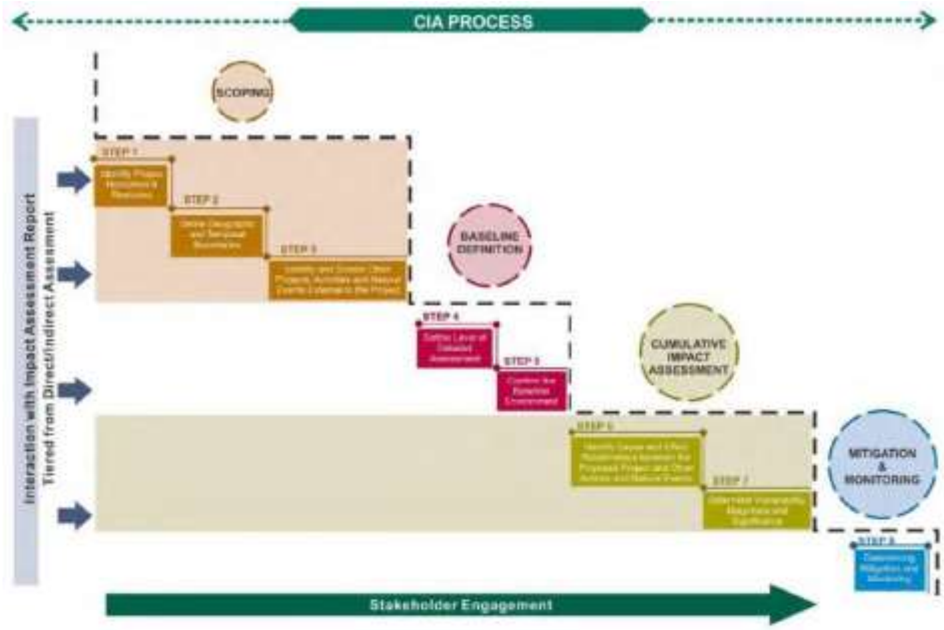
- Implementation of biodiversity offsets
- Provide additional organizational capacity building by implementing the recommendations of the Institutional Capacity Assessment and Strengthening Plan (see Appendix C, ESMP, Annex C4);
- Require independent third-party monitoring and auditing

5.5.5 Cumulative Impact Assessment Process

As part of the impact assessment process, a cumulative impact assessment (CIA) was conducted to determine the effect of the Project, in combination with other existing, planned, and proposed projects, and provide an assessment of the likely significance of any cumulative impacts (Appendix E, CIA). ***Figure 5.17*** depicts the key steps in the CIA process.

The CIA approach focused on VECs, identified in consultation with affected communities and other key stakeholders, that could be affected by the Project and other development activities planned or underway throughout the Arun River Basin, including, but not limited to, the Kimathanka, Barun Khola, Ikhuwa Khola, Arun-4, Arun-3, and Lower Arun HEPs, and the construction of the Koshi Highway, as well as other stressors (e.g., climate change). The outcome of the CIA includes project-level as well as strategic planning level recommendations for minimizing negative impacts and maximizing positive impacts associated with hydropower and other development activities within the Arun River Basin.

Figure 5.17: CIA Process



Source: ERM

5.6 Environmental and Social Management Plans

An overarching Environmental and Social Management Plan (ESMP) was prepared that includes all the mitigation measures included in the ESIA and the procedures for the short and long-term environmental management of the Project. The ESMP identifies the phase of the Project when the mitigation will be applied, the entity responsible for implementing the mitigation measure, and monitoring requirements. The ESMP is included in this ESIA as Appendix C, and includes the following plans:

- Framework Construction Environmental and Social Management and Monitoring Plan (CESMMP), (see Appendix C, ESMP, Annex C1), including:
- Construction Worker Induction Training and Code of Conduct
- Construction Material Sourcing Management Plan
- Water Quality Management Plan
- Air Quality Management Plan
- Waste Management Plan
- Hazardous Materials Management Plan
- Noise and Vibration Management Plan
- Muck/Spoil Management Plan
- Soil Erosion and Sediment Control Management Plan
- Restoration and Revegetation Management Plan
- Landslide and Slope Stabilization Management Plan
- Blasting and Explosives Management Plan
- Occupational Health and Safety Plan
- Community Health and Safety Management Plan
- Traffic Management Plan

- Labor Management Plan
- Influx Management Plan
- Cultural Heritage/Chance Find Plan
- Security Forces Management Plan
- Cardamom Management Plan
- Emergency Preparedness and Response Management Plan
- Project Commissioning and Construction Close Out Management Plan
- Framework Operation Environmental and Social Management and Monitoring Plan (OESMMP) (see Appendix C, ESMP, Annex C2)
- Biodiversity Management Plan (see Appendix C, ESMP, Annex C3)
- Institutional Capacity Assessment and Strengthening Plan (see Appendix C, ESMP, Annex C4)

Each of these individual management plans will:

- State the purpose of the management plan
- Identify key risks and impacts
- Identify required avoidance, minimization and mitigation measures
- Identify roles and responsibilities for management plan implementation
- Specify monitoring to ensure effective implementation

5.7 Environmental and Social Commitment Plan

The Environmental and Social Commitment Plan (ESCP) is a legal document which sets out the environmental and social (E&S) instruments that shall be adopted and implemented under the Project, all of which shall be subject to prior consultation and disclosure, consistent with the ESS, and in form and substance, and in a manner acceptable to the World Bank. Once adopted, it may be revised from time to time with prior written agreement by the World Bank. The ESCP is provided as a separate document prepared jointly by UAHEL and the World Bank and will be part of the financial agreement.

5.8 ESIA Disclosure

Public ESIA disclosure meetings were held in December 2021 with the potentially affected communities, CFUGs, central, district and local government officials, MBNP staff, NGOs, and other interested stakeholders in accordance with the Stakeholder Engagement Plan (SEP) to disclose the findings of the draft ESIA and to receive their input relative to the efficacy of the proposed mitigation and the residual significance of the impacts. Translators were provided at the meetings for residents not fluent in Nepali. Separate women's meetings were also held in Sibrun and Namase. ***Table 5.14*** summarizes the participation at the various disclosure meetings.

Table 5.14: UAHEP Disclosure Meetings and Participation

Meeting Location	Number of Male Participants	Number of Female Participants	Total Participants
Rukma village	23	14	37
Sibrun village	31	8	39
Chepuwa village	42	21	63
Namase village	41	13	54

Gola village	8	11	19
Hatiya village	9	3	12
Khandbari District Office	10	2	12

Table 5.15 summarizes the key stakeholder concerns raised at the disclosure meetings and where these issues are addressed in this ESIA. Appendix G provides details of the disclosure meetings.

Table 5.15: UAHEP Disclosure Meeting Stakeholder Concerns

Stakeholder Concerns	Disclosure Meetings where Concern Raised	Project Response	ESIA Section Reference
Compensation			
Need to receive proper compensation for land and structures	Namase, Chepuwa, Rukma, Sibrun, Hatiya	Compensation will be consistent with World Bank guidelines and Nepal Land Acquisition Act requirements.	Section 7.3.2 – Land Acquisition and RAP
Infrastructure			
Provide local infrastructure (e.g., roads, electricity, schools, health and communication facilities)	Namase, Chepuwa, Rukma, Sibrun, Hatiya	The Project will mitigate impacts on local infrastructure. Enhancements to local infrastructure will be determined as part of the ongoing FPIC consultation.	Draft IPP The IPP will be finalized after completion of the FPIC consultation.
Ensure project access road is available for use by public	Chepuwa	The ESIA has been revised to clarify that the project access road will be a public road once construction is completed.	Section 3.3.1 – Project Access Road
Provide drinking water to affected communities	Namase	ESIA recommends the Project provide drinking water, but only if it affects any village drinking water sources.	Section 7.1.4 – Hydrology
Provide new school for Barun Basic School	Sibrun	ESIA recommends providing a new relocated school for Rukma and alternative safe student access to Sibrun and Namase Basic schools. It does not recommend relocating the Sibrun Basic School	Section 7.1.9 – Noise Section 7.3.11 – Emergencies and Public Safety
Project Benefits			
Provide local residents with opportunities to obtain shares/ ownership of Project	Chepuwa, Sibrun, Gola	The Project is required to provide local residents with the opportunity to receive Project local shares.	Draft IPP The IPP will be finalized after completion of the FPIC consultation.
Give priority to purchasing goods, construction materials,	Gola	ESIA recommends that the Construction Contractor give priority to purchasing local goods, materials, and services.	Section 7.3.14 – Employment, Skill Enhancement and Local Business Opportunities

Stakeholder Concerns	Disclosure Meetings where Concern Raised	Project Response	ESIA Section Reference
and food from local residents			
Give priority to local residents for Project employment	Namase, Chepuwa, Rukma, Sibrun, Gola, Hatiya	The ESIA recommends that the Construction Contractor bid documents encourage the hiring of local residents.	Section 7.3.14 – Employment, Skill Enhancement and Local Business Opportunities
Ensure workers are paid in timely manner	Chepuwa	The ESIA has been revised to include specific language about the timely payment of workers.	Section 7.3.13 – Labor and Working Conditions
Project Impacts			
Preserve the culture, customs, heritage, religious practices, sites, and language of the local indigenous people	Namase, Chepuwa, Sibrun	The ESIA recommends several measures for preserving local cultural heritage.	Section 7.3.15 – Cultural Heritage
Preserve waterfalls near the dam site	Chepuwa	The two waterfalls near the dam site will be preserved and special measures are recommended for Chepuwa Falls.	Section 7.1.12 – Landscape Values and Visual Amenity Section 7.3.15 – Cultural Heritage
Minimize forest clearing to the extent possible	Namase, Rukma, Sibrun	The Project has minimized forest clearing to the extent possible.	Section 7.2.3 – Terrestrial Habitat
Provide security to local residents/women during construction	Namase, Chepuwa	The ESIA recommends a variety of measures to provide enhanced security to local residents and women during construction.	Section 7.3.9 – Gender Section 7.3.12 – Security Personnel
Consider increased traffic and traffic safety and consider providing an alternative route around Gola for heavy truck traffic	Gola	The ESIA recommends implementation of a Traffic Management Plan. There is no feasible alternative route for truck traffic so as to avoid Gola.	Section 7.3.11 – Emergencies and Public Safety Appendix C – ESMP, Annex C1, CESMMP
Provide compensation for any damages caused to private property during construction	Gola, Hatiya	The ESIA recommends that all claims for damages be settled before construction close-out.	Section 3.4.5 – Post-Construction Clean-up and Restoration Appendix C – ESMP, Annex C1, CESMMP – Project Commissioning and Construction Close-out Management Plan
Stakeholder Engagement and Representation			

Stakeholder Concerns	Disclosure Meetings where Concern Raised	Project Response	ESIA Section Reference
Consult with stakeholders before start of construction and throughout construction process	Namase, Chepuwa, Rukma, Sibrun	The ESIA indicates that stakeholder engagement is a continuous process.	Section 5.9 – Stakeholder Engagement and Stakeholder Engagement Plan (SEP)
Provide information to the local residents about the Project	Namase, Chepuwa, Rukma, Sibrun	The ESIA has been revised to clarify that the Project Information Center in Gola will be operational throughout the construction phase.	Section 5.9.6 – Project Information Center and SEP
Consult closely with district officials	Khandbari	District officials are identified as a key project stakeholder in the SEP.	Section 5.9 – Stakeholder Engagement and SEP
Gender			
Ensure women have fair representation on any project-related committees	Namase	The ESIA has been revised to include language requiring gender balance, on the recommended UAHEP Intergovernmental Coordination Committee.	Section 7.3.14 – Employment, Skill Enhancement and Local Business Opportunities
Provide women empowerment, literacy, health and sanitation, and skill development training	Sibrun, Hatiya	The ESIA recommends a wide variety of education and training opportunities for women.	Section 7.3.9 – Gender and Gender Action Plan (GAP)
Give qualified women priority for project employment	Namase	The ESIA recommends that Construction Contractor bid documents encourage the hiring of women.	Section 7.3.14 – Employment, Skill Enhancement and Local Business Opportunities
Form women's cooperative to support income generating opportunities/activities for women	Sibrun	The ESIA recommends measures to support income generating opportunities for women.	Section 7.3.9 – Gender and GAP
Baseline Studies and Impact Assessment			
Conduct detailed geological investigation	Namase, Chepuwa, Rukma	Detailed geological studies have been conducted.	Section 6.1.2 – Geology
Consider direct and indirect impacts on whole Bhotkhola Rural Municipality	Chepuwa	The direct and indirect impacts on entire Bhotkhola Rural Municipality have been considered in this ESIA.	Section 5.2 – Project Impact Area
Capacity Building and Training			
Provide training to local residents (e.g.,	Namase	The ESIA recommends the establishment of an agriculture and livestock support program.	Draft IPP

Stakeholder Concerns	Disclosure Meetings where Concern Raised	Project Response	ESIA Section Reference
agriculture and animal husbandry)			The IPP will be finalized after completion of the FPIC consultation.
Provide training to local residents prior to project construction so they can get jobs or offer services	Namase	The ESIA recommends that training be provided to local residents to help them qualify for employment.	Section 7.3.14 – Employment, Skill Enhancement and Local Business Opportunities
Construction Timing			
Start and complete project construction as quickly as possible	Namase	The Project is committed to completing construction within the designated construction schedule.	Section 3.5.6 – Implementation Schedule

Note: FPIC = free prior and informed consent; IPP = Indigenous Peoples Plan; SEP = Stakeholder Engagement Plan

The NEA and the World Bank will publicly disclose the ESIA in accordance with the World Bank's *Policy on Access to Information* (World Bank 2015) and WB ESF ESS 10.

5.9 Stakeholder Engagement

Stakeholder engagement refers to a process of sharing information and knowledge, seeking to understand and respond to the concerns of stakeholders, and building constructive and responsive relationships that are important for the successful management of a project's environmental and social risks, as well as the sustainability of a project's outcomes.

Stakeholder engagement is fundamental to building trust and relationships with the affected stakeholders and other interested parties. Good industry practice involves engaging with stakeholders throughout the life of a project. ***Figure 5.18*** illustrates the key elements of engagement during the phases of the UAHEP. Each of these phases presents different environmental and social risks and opportunities for the Project, and as such, different objectives and practices in stakeholder engagement must be incorporated into management systems at each stage to ensure ongoing effective engagement.

Figure 5.18: Integrating Stakeholder Engagement within the UAHEP Lifecycle

Source: ERM

5.9.1 Stakeholder Engagement Plan

A Stakeholder Engagement Plan (SEP) was prepared early on in the project planning phase to ensure effective stakeholder engagement during the course of the Project. The approach depicted in ***Figure 5.18*** to maintain engagement through each phase of the Project was incorporated into the SEP. The SEP is a "living" document and will be updated regularly based on the emerging needs and patterns for engagement with various stakeholders.

The objectives of the SEP were:

- To identify and map project stakeholders
- To establish a systematic approach to stakeholder engagement that will help the NEA build and maintain a constructive relationship with stakeholders, especially PAPs
- To assess the level of stakeholder interest and support for the Project and to enable stakeholders' views to be taken into account in the project design, as well as to improve the environmental and social sustainability of the Project
- To provide means for effective and inclusive engagement with PAPs and other interested parties throughout the project life cycle on issues that could potentially affect them
- To ensure the disclosure of appropriate project information on environmental and social risks and impacts on stakeholders in a timely, understandable, accessible, and appropriate manner and format
- To provide PAPs with accessible and inclusive means to raise issues and grievances, and allow NEA to respond to and manage such grievances

The SEP includes the following information:

- Key standards and legislation guiding stakeholder engagement
- Stakeholders identification, analysis, and mapping
- Strategies for information disclosure and consultation at each project phase, strategies for vulnerable groups and the process for obtain free, prior and informed consent (FPIC)
- Stakeholder engagement management system
- Grievance management mechanism
- Monitoring, evaluation, and reporting plans
- Roles, responsibilities, and resources to implement the SEP

5.9.2 Methods for Stakeholder Engagement

The SEP developed for the Project includes a stakeholder mapping matrix to identify the level of engagement required during the ESIA and future phases for each group of stakeholders based on the level of impact and interest in the Project. The mapping presents an initial analysis of stakeholders that will need to proactively engaged with on a regular basis, and others that will need to be kept informed given the impact of the Project. The SEP envisages engagement to be conducted throughout the life of the Project, and clearly outlines project activities and engagement activities and methods that will be undertaken across all project phases, some of which are listed below:

- Regular project updates – disclosure of Project information through various sources including a project information center (PIC), district government offices, local radio and local newspaper, a Project website, and periodic press conferences and interactions with the media to disseminate accurate and timely information
- Monitor community concerns, attitudes, and progress – identify and manage issues via a range of community relation activities including village meetings, FGDs and household visits (vulnerable groups), written correspondence on a regular basis
- Monitor the effectiveness of the ESCP – assess the effectiveness of the ESCP implementation through participatory monitoring and community perception surveys
- Community enquiry line – update the FAQs on a regular basis to respond to community queries and ensure the timely management of grievances/suggestions submitted through drop boxes that is currently placed in all Project villages

5.9.3 Project Stakeholders

The stakeholder identification and analysis process is fundamental to the planning and designing of ongoing future stakeholder engagement activities. The Project's stakeholders, as identified in the SEP, are evaluated in terms of their degree of importance and degree of influence over the Project. The list of stakeholders will be reviewed on a regular basis to account for any stakeholders that may need to be included as the Project progresses.

Stakeholders are defined as individuals, communities, groups, and institutions who:

- Are most likely to experience, at significant levels, any potential negative and/or positive impacts of the Project
- Have the mandate over the various elements of the Project's activities (such as government institutions)
- Are considered vulnerable members of the community within the project impact area

Various consultation methods, including qualitative research approaches (e.g., one-on-one interviews and FGDs with key informants and questionnaires), were used to consult with relevant stakeholders.

5.9.4 Grievance Redressal Mechanism

Grievance redressal is one of the most critical components of effective stakeholder engagement. The IFC Good Practice Note on Addressing Grievances from Project Affected Communities (IFC 2009) defines a grievance as “a concern or complaint raised by an individual or a group within communities affected by company operations. Both concerns and complaints can result from either real or perceived impacts of a company’s operations, and may be filed in the same manner and handled with the same procedure.” There will be separate grievance redressal mechanisms (GRMs) for local communities and project-affected parties, pursuant to ESS 10, and workers (both direct and contracted workers), pursuant to ESS 2. As per the SEA/SH GPN requirement of a separate SEA/SH GRM for high-risk project, the project will also establish SEA/SH GRM solely for redressing SEA/SH related grievances.

The Project has established a GRM based on good international practices, but customized based on learnings from other projects in Nepal. The GRM consists of a system for receiving, recording and responding to complaints and a four-tier mechanism for formal resolution. Details of the GRM are provided in Section 6 of the SEP.

The objectives of the GRM are as follows:

- To address grievances promptly and effectively in a transparent manner resulting in outcomes that are seen as fair, effective, and lasting
- To provide a grievance management process that is culturally appropriate and readily accessible to all PAPs
- To build trust as an integral component of the Project’s community relations activities
- To enable the systematic identification of emerging issues facilitating correcting actions and pre-emptive engagement

As part of the GRM, eight grievance drop boxes were established in the locations listed in ***Table 5.12***. Grievances can be submitted anonymously through these drop boxes, which are located in each village, or can be dropped off at the PIC in Gola. The locations of the drop boxes were established based on discussions with project communities and local government representatives in the project impact area.

UAHEL will require, as part of the bid documents, the Construction Contractor(s) to establish a workers’ GRM.

5.9.5 Communication Materials

To enable effective consultation with the stakeholders, the Project developed various disclosure and communication materials that were culturally appropriate and in Nepali. These materials were made available to stakeholders via the communication channels outlined in the SEP.

While direct engagement is crucial to disseminate project information and establish a relationship with the project communities, communication materials have a greater reach and allow stakeholders to review and discuss project details among a larger audience in greater depth. The following materials were made available in both English and Nepali language.

Project Information Document

The Project Information Document (PID) provides key disclosure and consultation material. This document consists of a non-technical summary of the Project, development timeline and milestones, project updates, consultation program and opportunities for the stakeholders to participate in development of the Project, timeline and venues for engagement activities, and contact details for questions and queries.

Three thousand copies of the PID have been distributed, primarily in the local area, and are available at the PIC. The PID has also been distributed through ward offices, health posts, and during consultation meetings. The PID will be updated at each project milestone to reflect project development and key activities at each stage.

Frequently Asked Questions

A Frequently Asked Questions (FAQ) document was developed for the Project, which provides answers to critical and frequently asked questions from the project communities and other stakeholders. The FAQ is also intended to ensure consistent messaging on critical project-related questions. This enables all project teams to disseminate accurate information. The FAQ provides guidelines for the project team for accurate and consistent messaging during their interactions with the communities and interested stakeholders. The FAQs will be revised and updated regularly to reflect project development and key issues that come to light over the course of the Project.

Grievance Brochure

A document simplifying the grievance process was developed to help project communities understand how to register a grievance and what it may look like. This document also describes in simple language how the Project will respond to registered grievances and different recourses that project communities will have in the grievance process, including contact information for grievance officers.

5.9.6 Project Information Center

In order to maximize regular interactions with the public, a Project Information Centre was established in Gola in September 2019. The PIC welcomes visitors from the local communities and the district to obtain project information, ask questions, raise issues, or log grievances. It has helped ensure two-way communication between local communities and the Project. The PIC will remain open throughout project construction.

5.9.7 Stakeholders Consulted

The ESIA scoping consultation for the Project started in January 2019. Since then, the project team has held regular meetings with various stakeholders responsible for the management of environment and social issues in the hydropower sector in Nepal. The project team has also undertaken extensive engagement with project affected stakeholders and other interested parties, as documented in the SEP.

Consistent with the objective of engaging stakeholders all throughout the life cycle of the Project, stakeholder engagement activities at the ESIA stage focuses on:

- Disclosing project information including alternatives
- Informing stakeholders about the status of the Project
- Seeking stakeholder inputs on various environmental and social issues, management measures, and benefit enhance
- Obtaining stakeholder insights that would help in the evaluation of project alternatives
- Major stakeholders consulted during the ESIA include:
- Ministries/departments – Ministry of Energy, Water, and Irrigation, Department of Electricity Development, Ministry of Forests and Environment, Department of Archaeology, Department of National Parks and Wildlife Conservation, Department of Mines and Geology, Topographic Survey Department, Central Bureau of Statistics, District Coordination Committee Offices, Department of Hydrology and Meteorology, and Department of Plant Resources
- District level offices – Women Children Development Section Office, Water Source and Divisional Irrigation Office, District Coordination Committee (DCC), Agricultural Knowledge Center, Division Forest Office, Drinking Water and Sanitation;
- Local government – Affected municipalities and wards, Khandbari municipality

- Federations – Federation of Community Forestry Users Nepal (FECOFUN), Sankhuwasabha District Chamber of Commerce and Industries (DCCI)
- NGOs – including the WWF Nepal and Bird Conservation Nepal
- Local community – directly and indirectly affected population, as defined in the SEP, women's groups, youth groups, farmers' group, indigenous groups, CFUGs

5.9.8 Stakeholder Engagement Activities

Approximately 160 stakeholder engagement activities have been undertaken to date. The Stakeholder Engagement Plan identifies the key stakeholders, while Appendix G provide details of engagement activities, topics of engagement, and stakeholders participated. ***Table 5.16*** summarizes the key stakeholder engagement activities conducted to date, the engagement activity, and the stakeholder groups that participated in each event.

In addition to the ongoing stakeholder engagement, UAHEP conducted several rounds of meetings as a part of ESIA, RAP, CIA and IPP consultations:

- Scoping meetings – UAHEP conducted EIA scoping meetings in January 2019 to inform potentially affected communities and officials about the Project and to obtain their input on key issues and concerns for the EIA (see Appendix G, Public Hearings).
- Baseline study consultations – UAHEP shared project information and informally responded to stakeholder questions during the execution of project physical, biological and socioeconomic surveys during 2019–2020.
- RAP surveys – UAHEP conducted RAP surveys from December 2019 through January 2020.
- CIA consultations – UAHEP conducted CIA consultations from March 11–14, 2020. During this time, UAHEP conducted 13 consultations including FGDs and KIIs with key stakeholders (see Appendix E).
- Consultation with indigenous people – A total of 41 FGDs with various indigenous, local communities, and members of CFUGs at various locations of the Project were organized and led by an indigenous peoples specialist.

Table 5.16: Stakeholder Engagement Activities Undertaken to Date

Date Period	Engagement Activity/ Topic	Stakeholders Participated
January 2019	Scoping consultation	Directly and indirectly affected stakeholders
May–June 2019	ESIA baseline studies and consultation	Directly and indirectly affected stakeholders
October 2019	ESIA baseline studies and consultation	Directly and indirectly affected stakeholders
December 2019–February 2020	Grievance consultation	Directly and indirectly affected stakeholders
December 2019–January 2020	Social baseline/RAP census and consultation	Directly impacted households
January–February 2020	ESIA	Directly and indirectly affected stakeholders
March 2020	CIA	Directly and indirectly affected stakeholders
November 2020	RAP consultation	Directly impacted households
December 2021	RAP & ESIA Disclosure meetings	Directly and indirectly affected stakeholders

February 2023	GBV Assessment consultation and SEA/SH Action Plan	Directly affected and other local stakeholders
October 2020-December 2023	FPIC consultations and IPP development	IP communities affected by the Project, AJAC and LG

5.9.9 Community Issues and Concerns

Part of the community engagement activities during the planning phase were focused on seeking stakeholder inputs on various environmental and social issues, management measures, and benefit enhancers and obtaining community insights that would help the evaluation of project alternatives.

Community feedback was analyzed by the project team to identify key issues, concerns, and suggestions. These key issues and trends were communicated to UAHEL's Project Director and relevant managers, and the ESIA technical team to help them address the issues that came up during the engagements.

Key issues and trends in stakeholder feedback to date include the following:

- Concerns about land acquisition and compensation
- Impacts on social, cultural, and religious aspects within the project impact area
- Concerns regarding use of child labor during project construction
- Concerns related to increase in accidents
- Impacts on the environment including air pollution, landslides, and impacts on flora and fauna
- Impacts on water sources due to construction of project tunnels
- Impact on river ecology due to construction of the dam
- Expectations of project benefits including support with infrastructural development, job opportunities, agricultural promotion, shareholding, and electricity subsidy
- Consideration of indigenous people for project benefits
- Outbreak of various diseases and weakening of social harmony due to the influx of workers and service providers

5.9.10 Ongoing Engagement

In addition to the consultations discussed above, regular capacity building activities have been provided to the project team on a regular basis to enhance the effectiveness of consultations conducted for the Project. These include workshops with NEA representatives to support with grievance management in March 2020. The World Bank provided training to the NEA on grievance management and gender inclusion on March 17, 2020. ESIA disclosure meetings were held in March 2021. An overview of the UAHEP grievance mechanism implementation is included in Appendix F, Annex FC.

5.10 Institutional Capacity Assessment and Strengthening

The NEA, specifically UAHEL, will be functioning as the Project Sponsor for the UAHEP. The NEA/UAHEL will be responsible for complying with the requirements of the Environmental and Social Commitments Plan, implementing the Environmental and Social Management Plans, monitoring the Construction Contractor's environmental and social performance, engaging with affected communities, and managing the Project's grievance program, among other environmental and social responsibilities. An Institutional Strengthening Management Plan is included in the ESMP, which includes recommended interventions, such as staffing, capacity building, and budget requirements. This Plan was developed in close coordination with the UAHEL staff over a two-year period and based on a professional assessment of the staff's capacity relative to project demands, which identified gaps where additional training or experience would be beneficial to both the staff and the Project.

6. BASELINE CONDITIONS

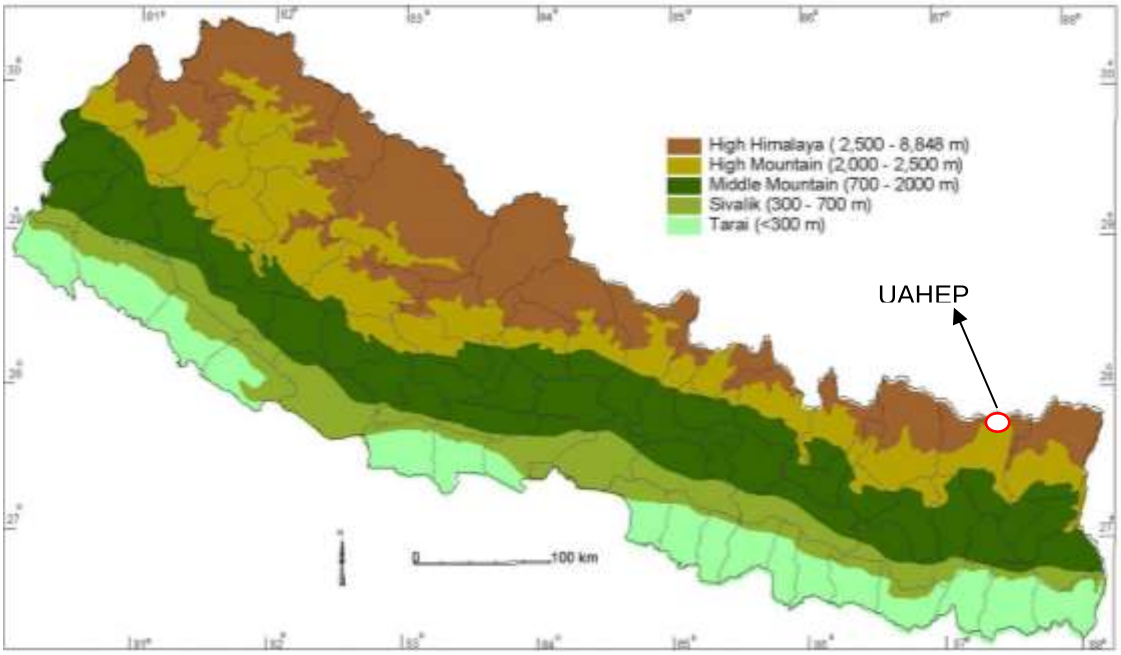
The hydropower potential of the Upper Arun River was recognized during the Master Plan Study of the Koshi River in 1985 (JICA 1985). Since then, there have been several studies conducted to better characterize the physical, biological, and social conditions in the project impact area. This chapter summarizes the existing physical (Section 6.1), biological (Section 6.2) and socioeconomic and cultural (Section 6.3) conditions of the project impact area, with a focus on those areas within the project DIA.

6.1 Physical Environment Baseline

6.1.1 Physiographic Setting and Topography

The UAHEP lies within the High Mountain Physiographic Zone (***Figure 6.1***). The topographic elevations of the project footprint vary between 1,065 m (near the powerhouse tailrace) to about 2,010 m (Chepuwa Quarry near the headworks). Thus, the UAHEP site represents the features of the Middle Mountain Physiographic Zone. This is an area with relatively young geology and an eroding landscape combined with a monsoon climate, which creates high landslide potential and a heavy sediment load within the Arun River.

Figure 6.1: UAHEP Location in the Physiographic Map of Nepal



Source: Topographic Survey Branch, Department of Survey, His Majesty's Government, Nepal, 1983

The Arun River is an antecedent river predating the Himalayan uplift. The landforms and the land units developed in the area are the denudation/erosion effects of the tectonic dynamism modulated under the climatic forces. The deep "V" shaped gorge of the Arun River, which lies between the mountain massif of Everest in the west and Kanchenjunga in the east, is the manifestation of these interacting forces of tectonics and climate. It is this interplay of unique phenomenon that gave rise to the steep longitudinal profile of the Arun River, with a drop of nearly 490 m in elevation between the dam site (1,570 m) and the powerhouse tailrace (1,080 m) over a short span of about 15 km in river length (9 km aerially), that makes the site so promising for hydropower development.

The Arun River itself does not exhibit waterfalls along its course, nevertheless, the side tributaries (large and small) descending from either valley flanks (e.g., Chepuk Khola, Handak Khola, Tejo Khola, Sutsir Khola, and the Barun River along the right bank; and Chepuwa Khola along the left bank) invariably create a series of waterfalls (10 to 60 m height) near their respective confluences with the Arun River.

In other words, the valley flanks rise very steeply from the Arun River bottom to a height of more than 1,500 m within 1.5 km to 3 km laterally, exhibiting high degree of ground relief.

The river valley between the UAHEP dam site and the Barun River confluence is a deeply incised gorge with steep slopes rising directly up from the river banks. The river substratum and the flooded banks are characterized by large boulders mixed with pebbles and cobbles, with little or no sandy admixture. This reflects the Arun River's high sediment transport capacity.

Most of the settlements and agricultural land in the river segment between the UAHEP dam site and powerhouse site are not found along the river, but rather more than 200 m above the valley floor on the eluvium (e.g., Chepuwa, Gimbar, Hongon, Than Thumbuk, Sempun, and Syaksila along the right bank; and Rukma, Khukamu, Namase, Hema, and Sibrun along the left bank) and on a mixture of eluvium/deluvium (e.g., Hatiya, Barun Bazar and Gola along the right bank; and Limbutar along the left bank) deposits of limited spatial coverage. The settlements and agricultural lands represent land units with a relatively gentler slope (20^o to 30^o) surrounded by land units with over 30^o ground slopes. The steeper land units between 30^o to 40^o are covered by vegetation, whereas those above 40^o are bushy, barren, or rocky.

Active landslides and other forms of mass wasting have a limited coverage within the UAHEP (see ***Figure 6.2***). Active landslides of debris flow nature are seen north of Namase and Than Thumbuk. The landscapes of Rukma, Namase, Sibrun and Chepuwa show features of old stabilized landslides. Much of the DIA includes area of colluvium and slope wash, which are considered to be areas of moderate instability and potentially subject to slides. The big blocks of gneisses and schist on the river bed of the Arun River gorge are the result of block toppling in the recent past. Despite all the above features, the landscape hosting the structural components of the UAHEP and its ancillary facilities do not show currently active land instability features.

In terms of land stability, slopes below 30^o in the UAHEP area are relatively stable. Similarly, slopes of up to 50^o with exposed bedrock at the surface are also stable. The colluvium covered slopes above 30^o are naturally unstable slopes. The degree of instability in such regolith covered slope increases with the increase in the slope angle and corresponding decrease in the ground cover.

Figures 6.3 and ***6.4*** present the slope map of the UAHEP area with the overlay of UAHEP infrastructures and project facilities for the headwork and powerhouse area, respectively. The land area with slopes less than 20^o has a very limited coverage (<5%) in the project impact area, limited to the valley bottom and the ridge top sections of the landscape. Nearly 40% of the land area is between 20^o to 30^o sloping land unit, and is where most of the settlement and agricultural lands are clustered. About 45% of the land coverage is between 30^o to 40^o sloping land unit category. This land unit is mostly covered by vegetation or has been extensively used for black cardamom farming. About 15% of the land area is made up of over 40^o sloping land unit. This land unit is mostly confined to along the river gorge or forms rocky scarps on the steeper mountain slopes.

Figure 6.2: Regional Geologic Map of DIA

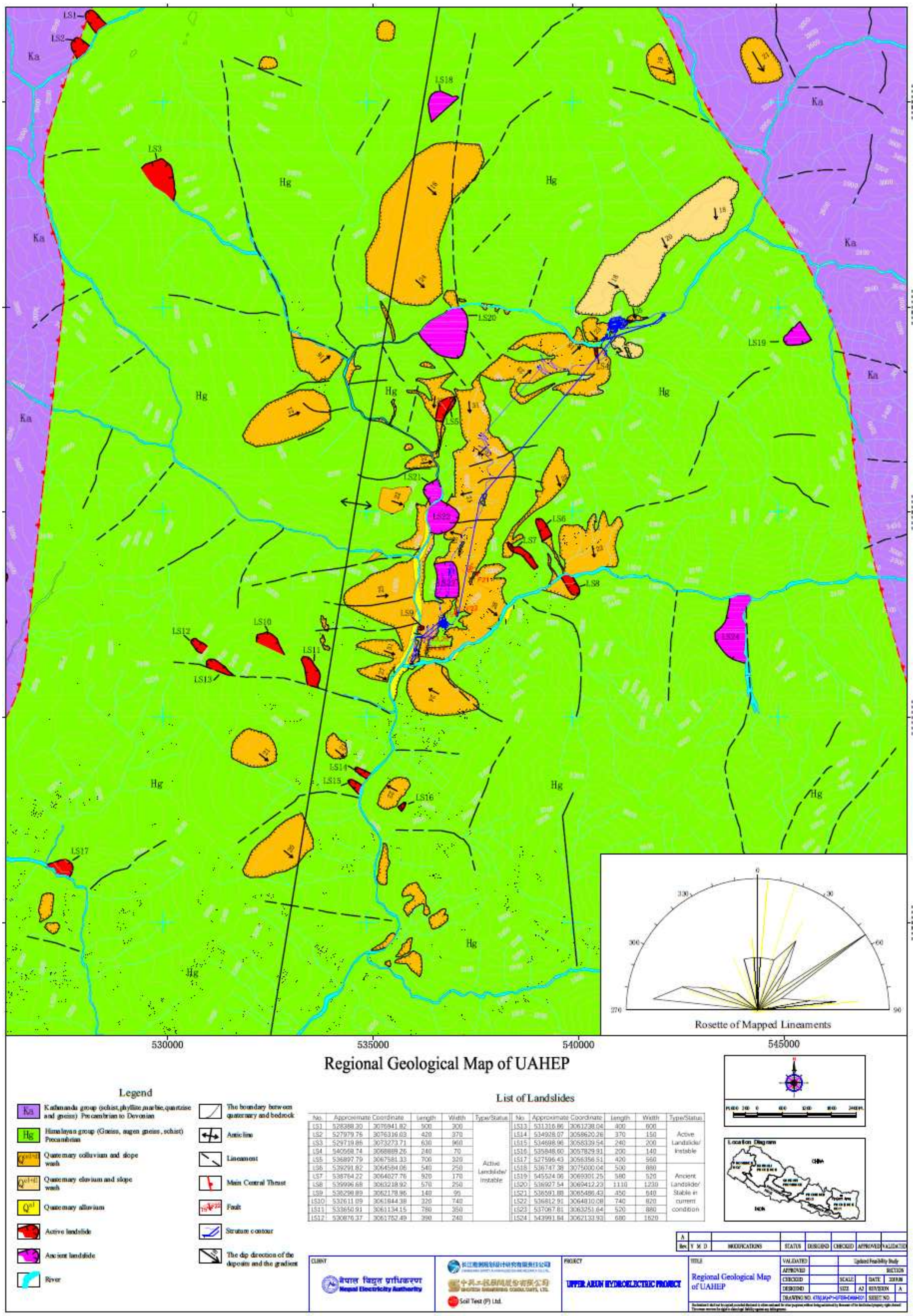


Figure 6.3: UAHEP Headworks Area Slope Map

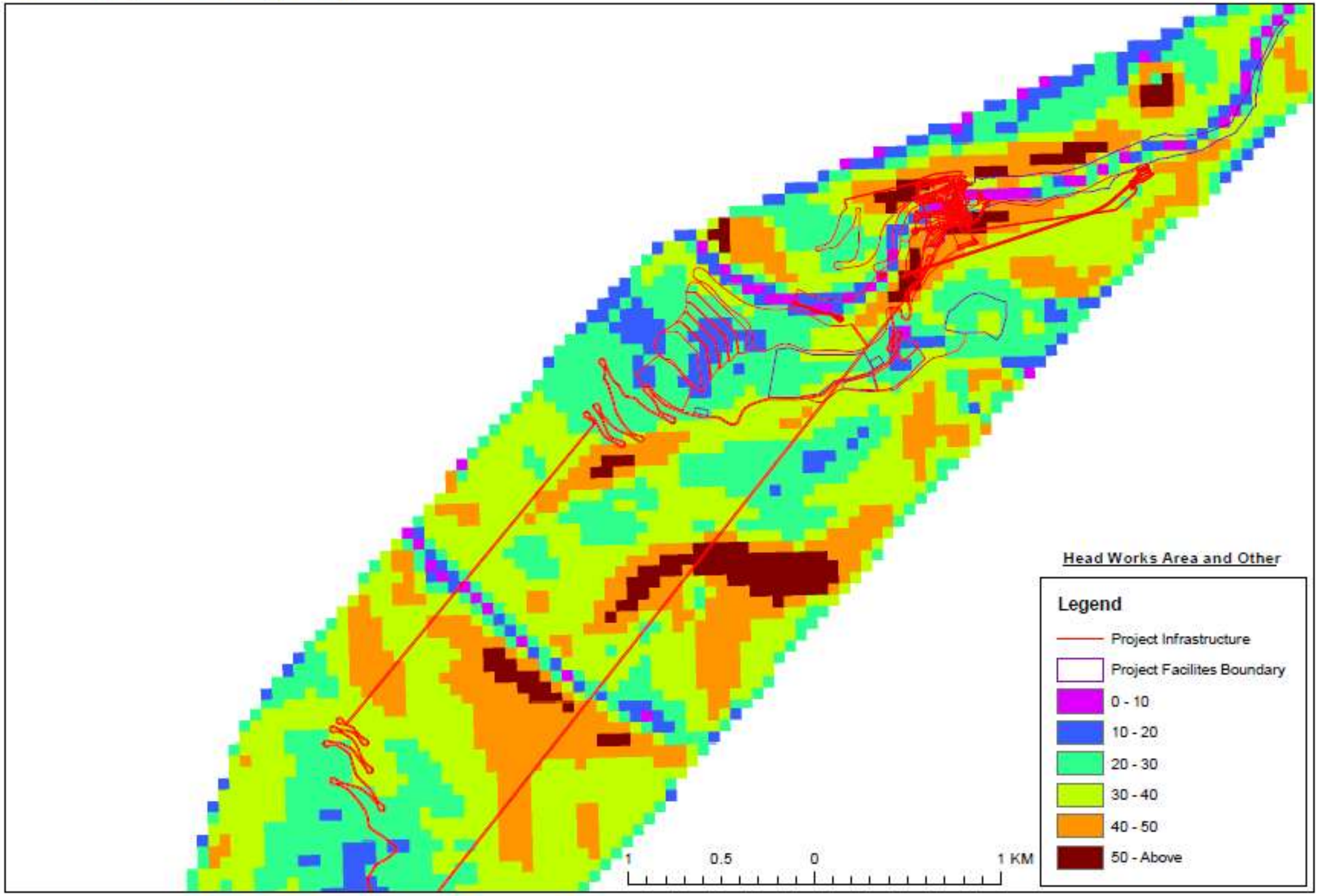
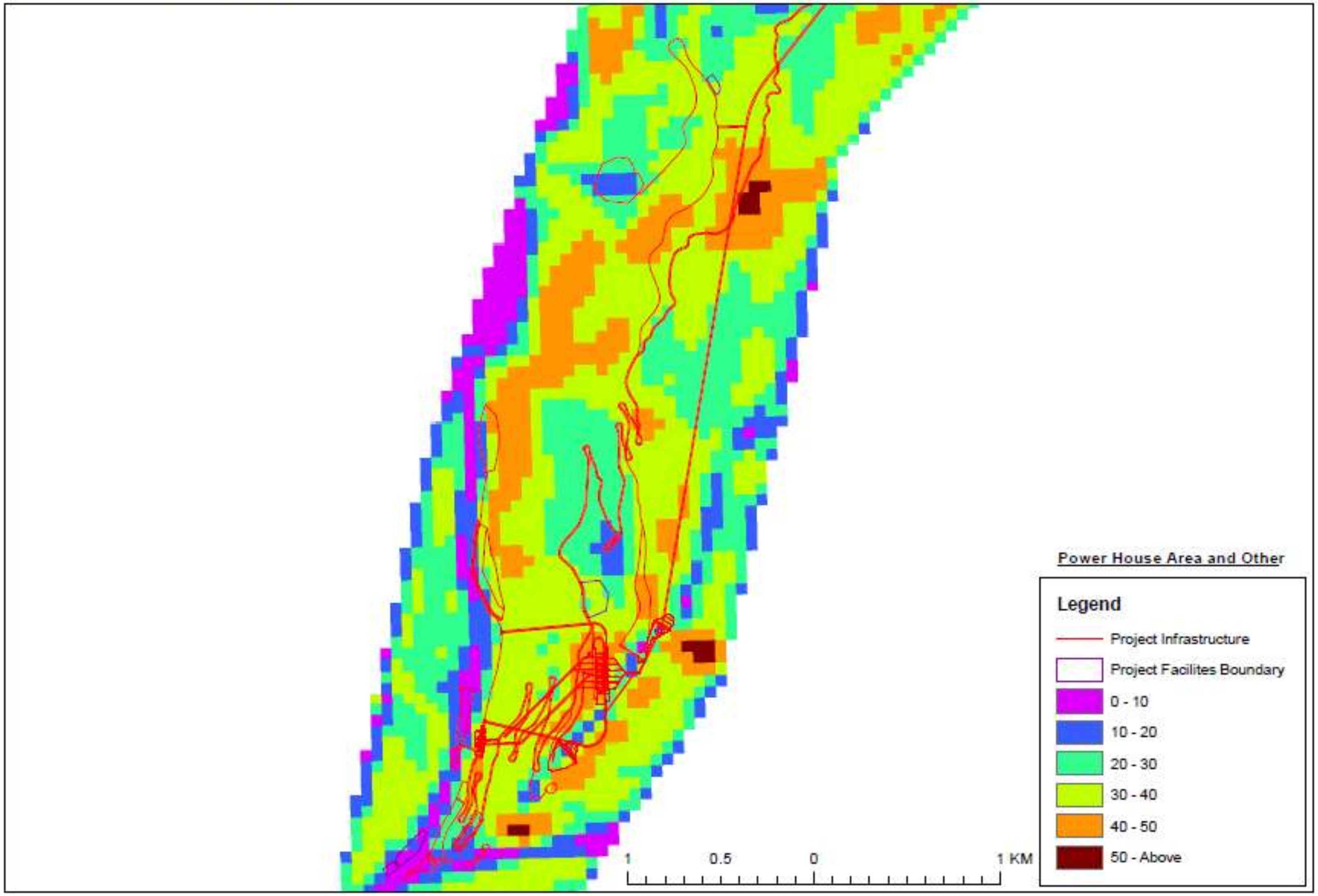


Figure 6.4: UAHEP Powerhouse Area Slope Map



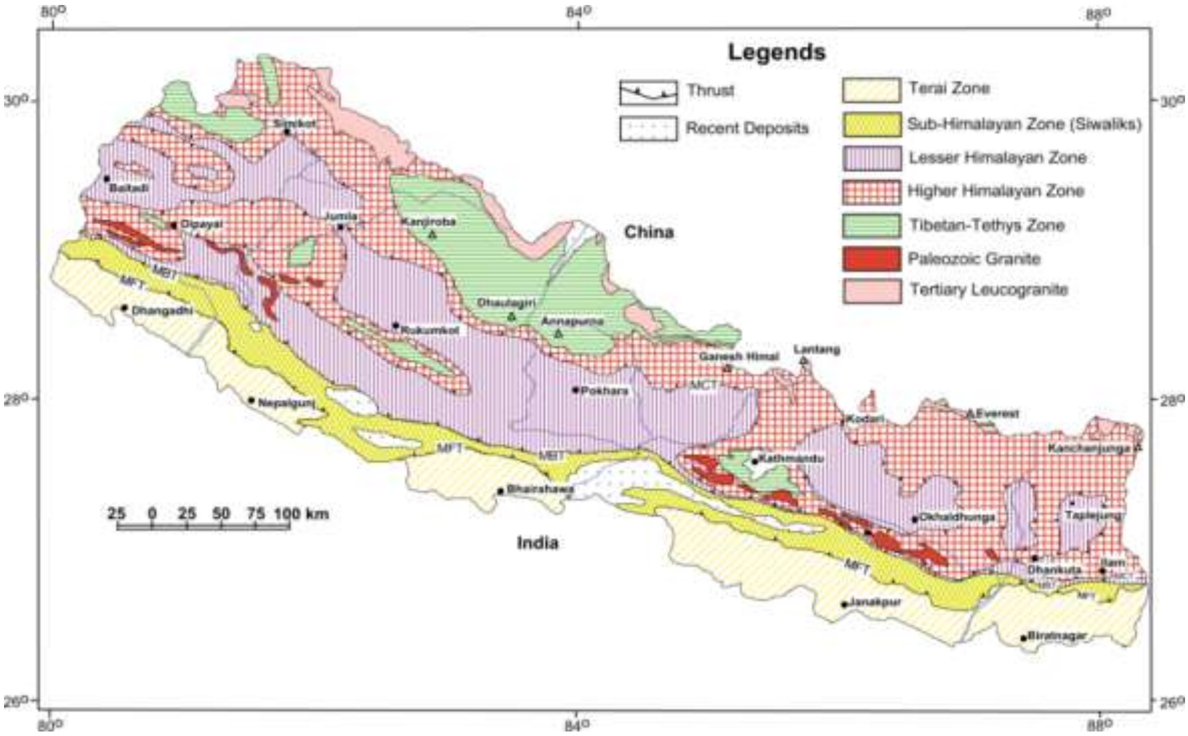
6.1.2 Geology

This section describes the regional, local, and site-specific geology of the project impact area, as well as the presence of any marketable minerals.

Regional Geology

In terms of the regional geologic framework, the Nepal Himalaya is broadly divided into five east west trending tectonic/geologic zones (***Figure 6.5***). ***Table 6.1*** lists them from north to south. These five main tectonic units of the Himalaya are delineated by the regional lineaments (thrust/faults). The South Tibetan Detachment System (STDS) separates Tibetan Tethys Himalaya from the Higher Himalaya tectonic zones; the Main Central Thrust (MCT) separates the Higher Himalaya from the Lesser Himalaya tectonic zones; the Main Boundary Thrust (MBT) separates the Sub-Himalaya from the Lesser Himalaya tectonic zones; and the Main Frontal Thrust (MFT) separates the Sub-Himalaya from the Terai Indo-Gangetic alluvium tectonic zones.

Figure 6.5: Regional Geological Map of Nepal



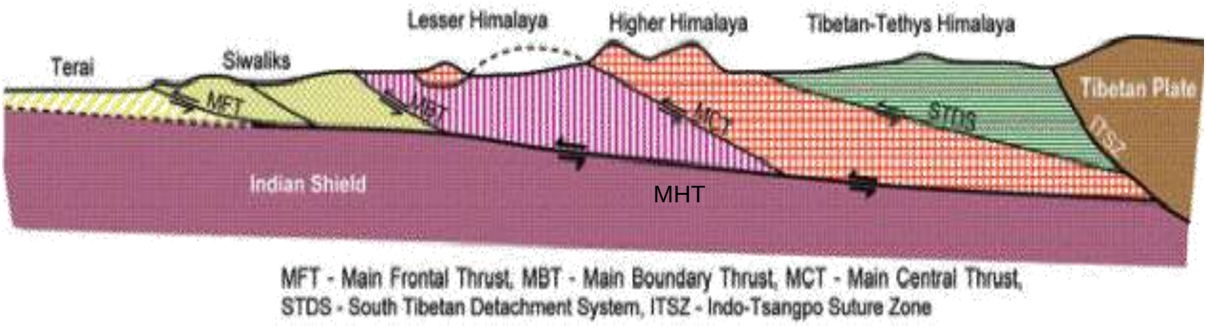
Source: Modified from Dahal 2006

These regional lineaments are the results of the under-thrusting of the Indian Plate beneath the Eurasian Plate. The under-thrust of the Indian Plate at depth is taking place along a gently north-dipping detachment, the Main Himalayan Thrust (MHT). The SDTS, MCT, MBT, and MFT are the surface manifestation of the thrust ramps branching out from the MHT at depths in different geological ages (***Table 6.1*** and ***Figure 6.6***).

Table 6.1: Tectonic/Geological Division of Nepal Himalaya

Tectonic Units	Geological Zones	Geologic Age
Tibetan Tethys Himalaya	Tibetan Tethys Zone	Cambrian to Cretaceous
South Tibetan Detachment System (STDS)		Tertiary
Higher Himalaya	Higher Himalaya Zone	Pre-Cambrian
Main Central Thrust (MCT)		Miocene
Lesser Himalaya	Lesser Himalayan Zone	Precambrian to Palaeozoic
Main Boundary Thrust (MBT)		Pliocene
Sub-Himalaya	Sub-Himalayan Zone (Siwaliks)	Middle Miocene to Early Pleistocene
Main Frontal Thrust (MFT)		Pleistocene
Outer Himalaya	Terai Zone (Gangetic alluvium)	Quaternary

Figure 6.6: Generalized Cross-Section of the Himalayas



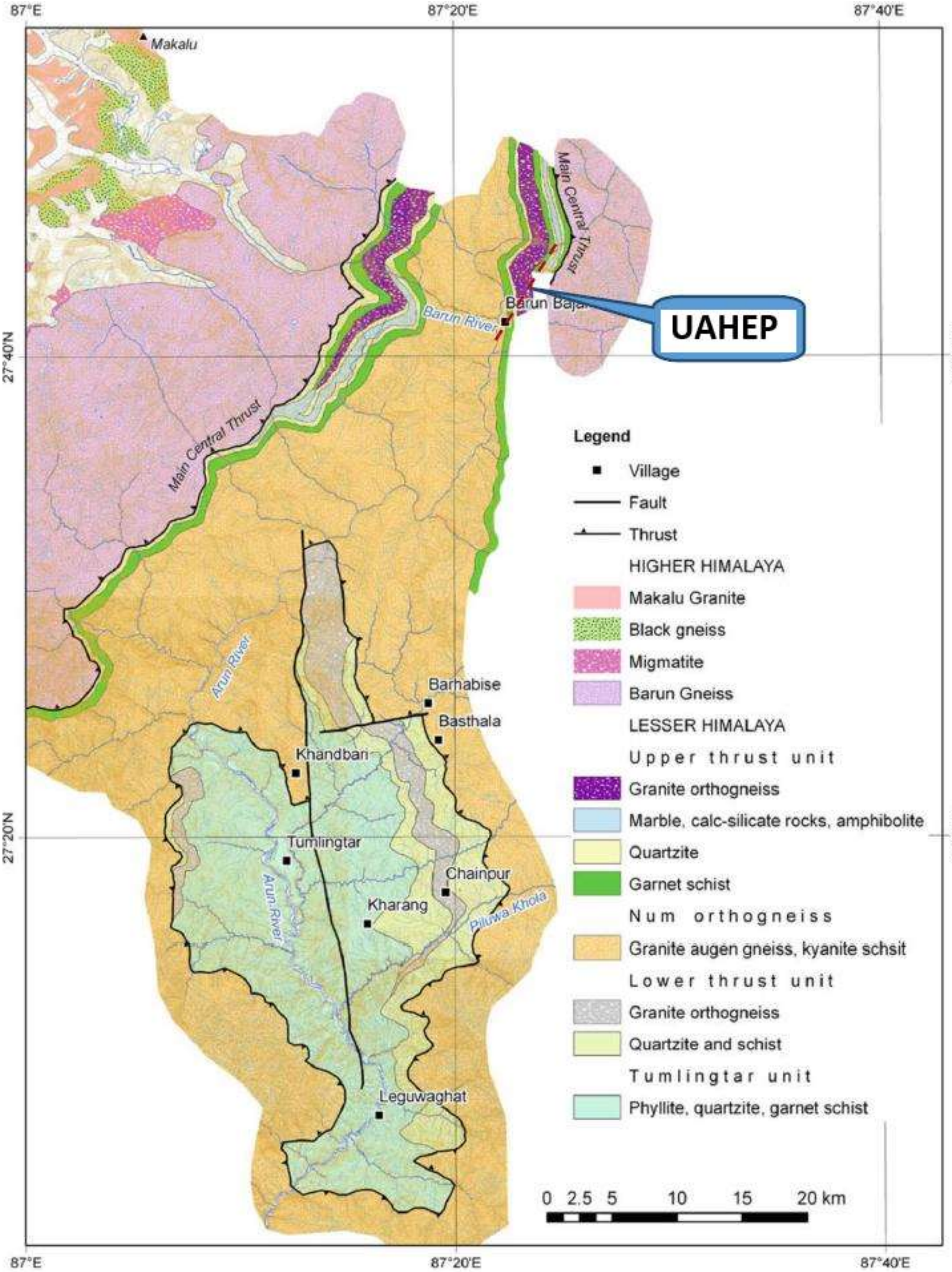
Source: Modified from Dahal 2006.

Under-thrusting of the Indian Plate underneath the Eurasian Plate is still continuing along the MHT, however, the activity of under-thrusting is gradually shifting towards southernmost thrust ramps of MHT. The SDTS and the MCT thrust ramps of the MHT are considered currently inactive (Catlos *et al.* 2001; and Yin 2006) while the MBT and MFT thrust ramps of the MHT are considered to be active (Nakata 1982; Nakata *et al*. 1990).

Local Geology

The UAHEP lies within the Lesser Himalayan zone about 3 to 5 km away from the MCT (***Figure 6.7***). In general, the rock succession in the UAHEP Area can be broadly divided into four units, namely, from bottom to surface, the Tumlingtar Unit, Lower Thrust Unit, Num Orthogneiss, and Upper Thrust Unit. The lowest Tumlingtar Unit is comprised of a sequence of low-grade meta-sediments (phyllite and quartzite). The Lower Thrust Unit sequences, which override the Tumlingtar Unit along a thrust contact, is made up of quartzite, schist, and granite orthogneiss. The succeeding Num Orthogneiss is 3 to 4 km thick granitic augen gneiss with bands of kyanite flogopite schists. The upper most sequence of the Upper Thrust Unit is comprised of the meta-sedimentary rocks with layers of garnet-kyanite-staurolite mica schist, green quartzite, black phyllite and calc-schist with marble layers, and white quartzite. The UAHEP project site is located over the rock sequences of the Num Orthogneiss and the Upper Thrust Unit. About 3 km to the east of the UAHEP site, the MCT brings the Higher Himalayan rock succession, which is comprised of gneiss and migmatites, over the rock sequence of the Upper Thrust Unit.

Figure 6.7: Regional Geological Map Makalu – Arun Area



Source: Modified from Bordet 1961; and Lambardo *et al*.1993

Structurally, the UAHEP is located on the Arun Tectonic Window, exposed at the core of the Arun Anticlinorium, which is a north-south trending anticline plunging gently due north. The UAHEP is located on the eastern flank close to the plunging nose of the anticlinorium. The closest thrust of regional significance (3 to 5 km) to the project site is the MCT, along which the Higher Himalayan Zone overrides the rocks of the Lower Himalayan Zone. It is a ductile deformation zone with no significant shearing of rocks at the project site and is considered to be inactive. The active thrusts and faults, such as the MBT and MFT, are located over 100 km to the south of the Project.

Site Specific Geology

Figure 6.8 presents the engineering geological plan and geological profile of the UAHEP. The main orientation of the rock mass in the project impact area is northeast-southwest, with a dip direction to the southeast. Local changes in the orientation to north-south with dip direction to the east can be observed.

Reservoir Area

The bedrock in the reservoir area is mostly gneiss. The reservoir area, with slightly weathered and fresh rock mass, is expected to be with a low permeability and the Arun River Valley is the lowest drainage point in the regional area. The topographic and geological conditions help create an impervious reservoir. The reservoir slope mainly consists of rock, except for some areas upstream from the dam, which are covered by colluvial and deluvial deposits. After reservoir impounding, the rocky slopes are expected to remain stable as a whole, but the deposits may be subject to failure.

Dam Site

The bedrock at the dam site is made up of slightly weathered and fresh gneiss. Due to the high strength of the rock mass at the dam site, it is suitable for the dam foundation. The joints in the dam foundation have high dip angles. In addition, the spacing of the gentle dip joints is wide with short persistence, which is suitable for dam construction. The permeability of the rock mass in the dam foundation is weak. The permeability value of q<3Lu generally prevails between 15 m to 25 m depths in the river bed and between 25 m to 45 m depths at both the abutments. The slopes above the dam crest are in highly unloading zones with wedge cut by joints that may be unstable at places.

Waterway, Powerhouse and Tailrace

The headrace tunnel passes through alternating layers of quartzite, mica kyanite gneiss, barnet biotite schist, muscovite schist, schistose amphibolite and calcareous rocks, and micaceous quatzite. The headrace tunnel orients more or less parallel to the strike direction and dips at low to moderate angles to the east and southeast. The surge tank is located on carbonate rock. The pressure shaft passes through calcareous rocks, mica schist, and quartzite. The powerhouse cavern is located within gneissic rock and mica schist. The tailrace tunnel passes through gneisses and schist. The thickness of the overlying rock mass, at the crest of the waterway and the powerhouse area, is between 30 m and 1,315 m. More specifically, the thickness of overlying rock mass, on the crest of the powerhouse, is between 370 m to 450 m. The surrounding rock mass is slightly weathered and fresh gneissic rock with laminated schist, which is overall considered to be a good rock mass.

Project Access Road

The bedrock geology of the project access road is dominated by gneiss and schist, with occasional bands of quartzite, carbonaceus schist, and calc gneisses. The rock sequence is a part of the Num Orthogneiss and the gneiss and schist of the Upper Thrust Unit (see ***Figure 6.7***). In general, the attitude of the bed rock varies from north/northwest-south/southeast to east-west and dips gently due east and north. Three to four sets of joints cut across the rock mass. ***Table 6.2*** presents the lithological composition of the project access road across the road length.

Table 6.2: Project Access Road Section Geology

Road Type	Road Stations (m)		Bedrock Type	Formation
Surface	0+000	1+500	Augen gneiss	Num Orthogneiss
	1+500	10+200	Schist	Upper Thrust Unit
	10+200	14+180	Gneiss	Upper Thrust Unit
Tunnel	14+180	14+275	Gneiss	Upper Thrust Unit
	14+275	14+450	Quartzite	Upper Thrust Unit
	14+450	16+210	Gneiss	Upper Thrust Unit
Surface	16+210	19+550	Gneiss	Upper Thrust Unit
	19+550	21+650	Schist	Upper Thrust Unit

Source: KEC 2019a

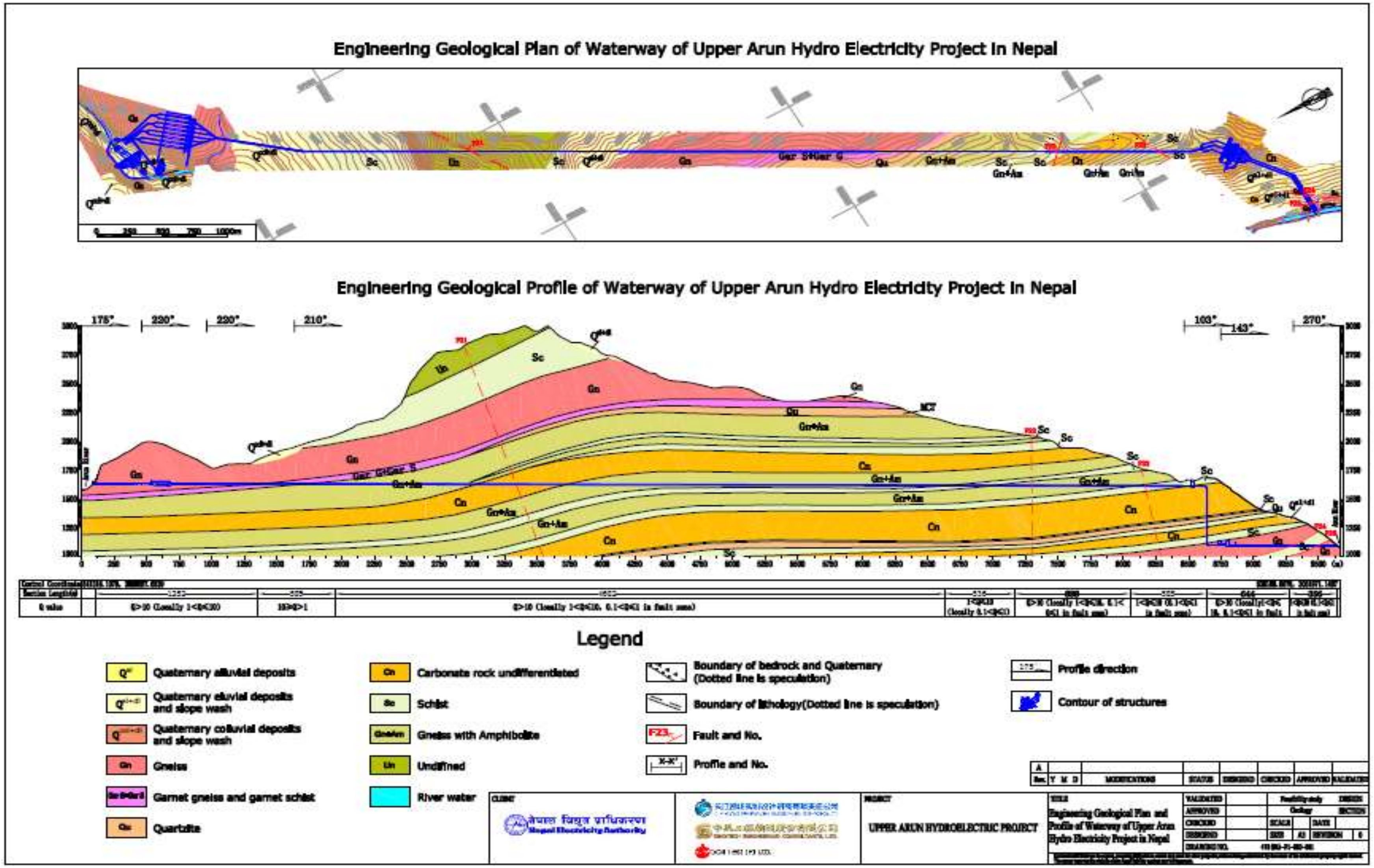
The bedrock is only exposed along about 30% of the project access road alignment. Loose colluvium material, which is comprised of fragments of rocks mixed in a clay to silty matrix, cover the remaining 70% of the bedrock lithology. The thickness of the loose colluvium ranges between 2 m to 10 m. In general, the exposed bedrock is moderately weathered. Estimated weathering depth is about 10 m to 20 m from the surface. In the present slope conditions, the bedrock and the overlying colluvial deposits are relatively stable.

The maximum overburden on the tunnel is about 700 m. The geotechnical investigations of the tunnel portal on the southern and northern sides show structurally stable conditions (KEC 2019a). Similarly, the rocks of the tunnel alignment reveal fair to good rock mass rating values for 95% of the alignment length, however, in the 5% alignment length, the rocks have poor rock mass rating values.

Economic Minerals

Available information (Bordet 1961 and Lambardo *et al.* 1990) and field investigations (CSPDR 2020; Morrison Knudsen Corporation, *et al.* 1991) indicate that the geological formations underlying the Project are devoid of economically mineable non-metallic and metallic deposits.

Figure 6.8: UAHEP Engineering Geological Plan and Geological Profile



Source: CSPDR, 2018

6.1.3 Natural Hazards

This section describes the natural hazards in the project impact area, focusing on seismic and landslide risks. Flood hazards are discussed in Section 6.1.6 (Hydrology).

Seismic Hazards

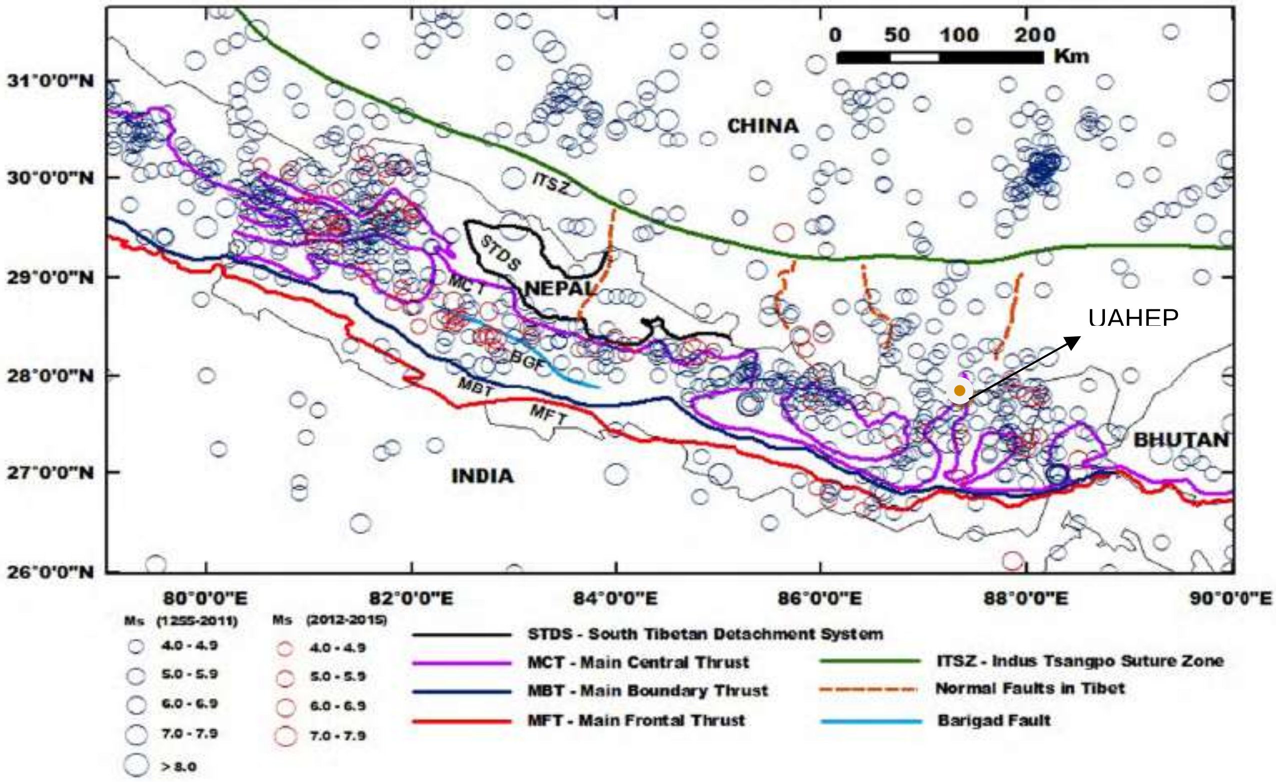
As discussed in the regional geology sub-section above, the Himalayan Arc is the result of a continent-continent collision between the Indian and Eurasian plates, which govern the entire seismicity in the region. The ongoing collision has developed several intra-crustal thrust faults, which run throughout the Himalayas striking along east-west direction. The major tectonic structures are located south of the STDS, including the MCT, MBT and MFT. These thrust faults are generally referred to as splay thrusts of the MHT, which marks the under-thrusting of the Indian Plate (***Figure 6.6***).

Nepal has experienced six known large/great damaging earthquakes (1255, 1408, 1505, 1833, 1934, and 2015) with magnitudes equal to or greater than 7.6 on the Richter Scale (Thapa *et al*. 2017). The latest most destructive earthquake (magnitude 7.8, April 25, 2015, known as the Gorkha Earthquake) and its accompanying aftershocks caused a high toll of casualties (>8,600 deaths and injuries >20,000), damage (>5 million houses) and monetary losses (~ US$7 billion) in Nepal (Government of Nepal 2015). The mapping of active faults clearly shows the earthquake potential in Nepal and the surrounding region (e.g., Nakata 1972, 1982, 1989; Nakata *et al*. 1984; Dasgupta *et al*. 1987; Upreti *et al*. 2000; Nakata and Kumahara 2002; Taylor and Yin 2009; Styron *et al.* 2010).

Figure 6.9 shows the spatial distribution of epicenters of catalogued earthquakes covering the location between latitudes 26°N–31.7°N and longitudes 79°E–90°E for the period from 1255 to 2015. The epicenters of the earthquakes are not evenly distributed and show higher earthquake activity in the eastern and far-western parts of Nepal, compared to the southern portion of the country. The width of this seismic belt is about 150 km in eastern Nepal where the UAHEP site is located. The epicenter points also indicate that earthquakes are aligned parallel to the surface traces of the mapped principle faults (MFT, MBT, MCT, and STDS) in the region. The epicenter locations are mostly concentrated along the MCT Zone compared to MBT and MFT.

Studies of the Central Himalayas suggest that the three major thrust fault systems in Nepal (MCT, MBT, and MFT) branch off at depth from a single, low-angle major décollement (i.e., MHT). The MHT is the principal interface between the Indian Plate being subducted under the Eurasian Plate. The seismogenic depth in the Himalayas is between approximately 10 km and 25 km (Elliott *et al*. 2016, Maggi *et al.* 2000).

Figure 6.9: Spatial Distribution of Known Earthquakes (Ms≥4.0)



Source: Thapa 2018; Notes: Ms = surface wave magnitude

The MHT is a key thrust fault in the Himalaya that contributes a major part of the seismic hazard, compared to the aerial sources (Graben of southern Xizang, northeast Nepal, and southern source) in this region. The MHT has a flat-ramp-flat geometry, where the northern flat is creeping, the southern flat is locked and the ramp itself is a transition zone that can be considered as the geometrical asperity to accumulate the elastic strain in the Himalayan seismic belt. The general dip of the MHT is very shallow, typically less than 10°, with the flats dipping approximately 5° to 7° (Ader *et al*. 2012). The thrust ramp geometry of the MHT produces three primary types of Himalayan earthquakes:

- Moderate and micro earthquakes that occur within the vicinity of the ramp (clustered around the MHT ramp)
- Large blind earthquakes that rupture from the top of the ramp toward the MFT, but do not extend to the surface
- Great earthquakes that extend to the surface, and likely down the ramp approximately 5° to 7°.

The recent Gorkha Earthquake also occurred on the hinge of the mid-crustal ramp, unzipping the lower portion of the locked segment of the MHT (Avouac *et al*. 2015). An earthquake of a similar type has, therefore, the potential to occur in the UAHEP area.

Landslide Risk

An evaluation of the land stability status based on the general ground slopes in the UAHEP area points to the fact that nearly 55% of the land within the project impact area is naturally unstable. The remaining 45% of the land, although stable under the present land use condition, has the potential to become unstable if the land uses are changed or it is subject to landscape modifications.

6.1.4 Soil

Various factors such as topography, geology, climate and vegetation types result in variations in soil development and types. There are no regional soil maps for Nepal and there is very limited research about soils in the DIA. Hence, the soils of the UAHEP sites have been described based on the soil classification system following Carlson *et al*. (1986). ***Table 6.3*** presents the land system, landform, and land unit developed for the UAHEP area, with the corresponding dominant soil type and textural characteristics.

Table 6.3: UAHEP Landforms and Dominant Soil Types

Land System	Landform	Land Unit	Dominant Soil	Dominant slope	Dominant Texture	UAHEP Location
13	Alluvial plains and fans	13.b Recent alluvial plain	Eutrochrepts Dystrochrepts	$<2^0$	Loamy/ bouldary	Gola
		13.c Fans	Eutrochrepts Dystrochrepts	1 to 10^0	Loamy/ bouldary	Barun Bazar and Hatiya
14	Post glaciated mountainous terrain below upper altitudinal limits of arable agriculture	14a Moderate to steep slopes	Anthropic and typic Eutrochrepts Dystrochrepts Hoplumbrepts	$<30^0$	Loamy skeletal	Rukma, Namase and, Sibrun
		14.b Steep to very steep slopes	Lithic Subgroups of 14a and Ustorthents	$>30^0$	Loamy skeletal	Surrounding forested and bush covered areas

Source: Carlson *et al*. 1986

Because of the effects of tectonic dynamism and the exceedingly steep slopes, the area shows levels of denudation and erosion, giving little time for soil development. Most of the soils in the area are either eluvial or deluvial with dominant skeletal texture. The soil thickness is usually less than 50 cm.

Soil samples were collected from nine areas covering the headworks, headrace adit, and powerhouse areas, with a focus on proposed temporary ancillary facilities (e.g., workers' camps, spoil disposal areas) that will be restored after the completion of construction (see Section 5.3.2, sub-section on Physical Baseline Studies and ***Figure 5.7:*** Soil Sample Locations).

The soil samples were tested for texture, fertility, and cation exchange capacity. ***Table 6.4*** presents the laboratory analysis results. As the data indicate, the project impact area soils are acidic, well drained loamy sands with high organic matter content and relatively rich in nutrients.

Table 6.4: UAHEP Soil Characteristics

Parameters	Sampling Locations								
	Headworks Area			Headrace Tunnel Adit Area		Powerhouse Area			
	Dam Site	Workers' Camp #1	Spoil Disposal Area #1	Spoil Disposal Area #2	Adit Tunnel	Fabrication Shop -#2	Power House Site	Workers' Camp #4	Workers' Camp #3
General Characteristics									
pH at 20ºC (1:1)	5.2	4.2	4.8	5.1	6.1	5.3	5.1	4.50	4.3
Electrical conductivity (µS/cm)	493	358	107	80	303	35	535	93	139
Organic matter (%)	25.65	17.50	5.73	3.09	24.23	0.77	19.86	11.09	15.61
Total nitrogen (%)	1.04	0.72	0.25	0.15	0.98	0.06	0.81	0.46	0.64
Available phosphorous (µg/g)	328.20	221.24	66.60	31.90	309.70	1.45	252.24	137	196.40
Available potassium (µg/g)	123.04	41.83	52.90	70.44	118.72	40.38	37.64	41.29	20.92
*Sodium absorption ratio	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Cation Exchange Capacity									
Calcium (meq/100g)	20.66	4.77	3.99	8.40	25.63	2.11	28.52	2.38	2.78
Magnesium (meq/100g)	6.59	2.77	1.99	2.13	4.79	<0.5	7.28	<0.5	<0.5
Sodium (meq/100g)	<4.35	<4.35	<4.35	<4.35	<4.35	<4.35	<4.35	<4.35	<4.35
Potassium (meq/100g)	261.90	89.03	112.60	149.95	252.71	120.35	80.13	87.89	44.52
Soil Texture									
Texture	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loam sand	Loamy sand
Clay (%)	4.80	4.80	6.80	2.80	2.80	4.80	4.80	6.80	2.80
Silt (%)	22.50	22.50	22.50	12.50	12.50	12.50	18.50	24.50	26.50
Sand (%)	72.70	72.70	70.70	84.70	84.70	82.70	76.70	68.70	70.70

Source: NESS Field Survey 2019; Note: meq = milliequivalent

6.1.5 Climate

The climate in Nepal is governed by the east-west trending Himalayan massif and the monsoon-driven wet (June to September) and dry (October to May) seasons, with elevation as the principal influence on climatic zones. Climate in Nepal is strongly correlated with elevation, with substantial differences observed with variations in elevation. The UAHEP is located in the temperate (1,500 to 2,500 m elevation) to mild-temperate (800 to 1,500 m elevation) zones where winter is cool to cold, frost is common, and snowfall may occur at the upper elevations of this range, with warm summers (Ministry of Agricultural Development, undated). Approximately 70% of the annual precipitation falls during the monsoon period between June and September (monsoon).

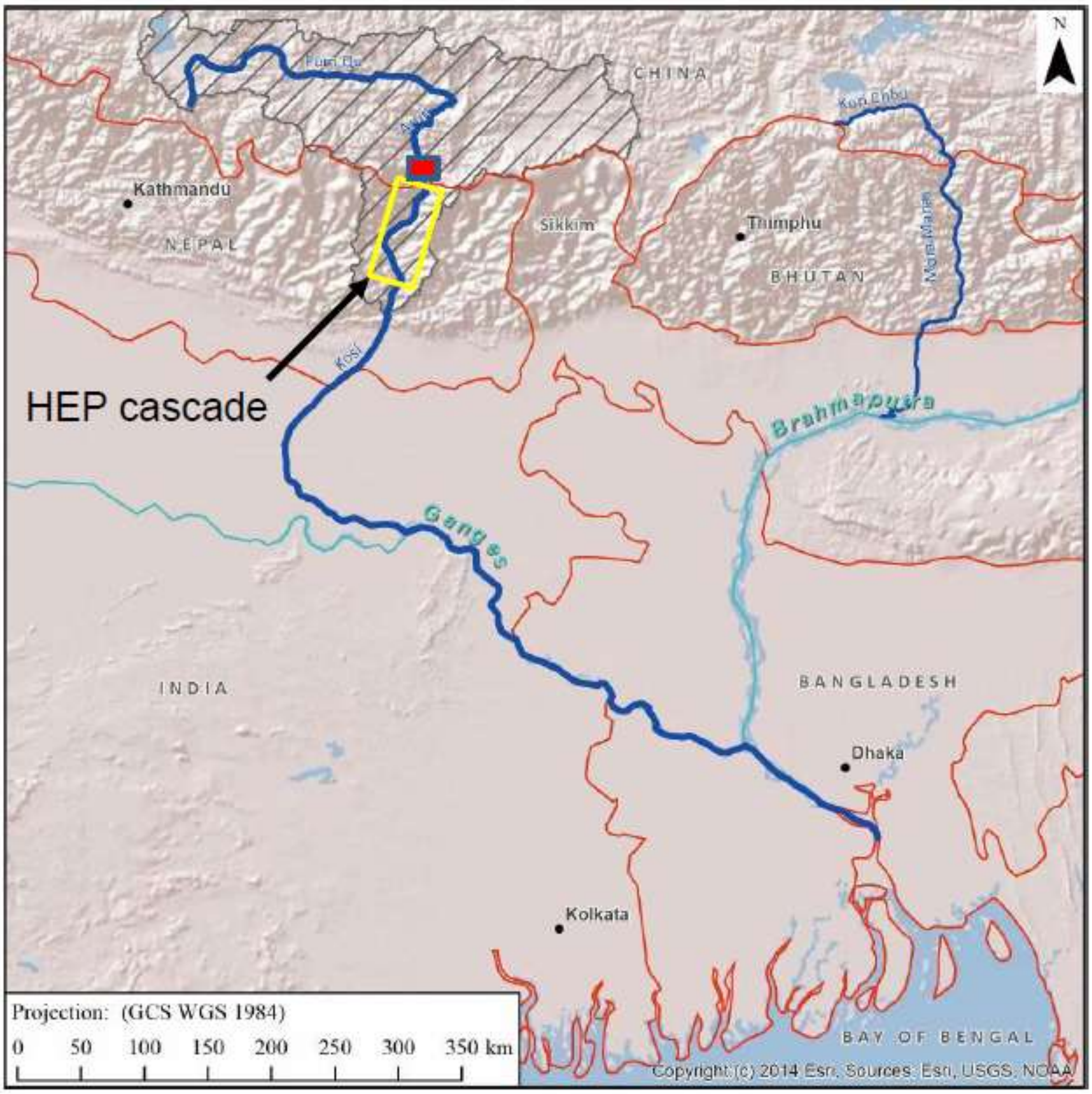
Chepuwa Station is the only meteorological station within the project impact area and it has been recording data since 1959. The annual average rainfall is 2,371 mm, with 67% of the rainfall occurring during the four-month monsoon season. Based on data from the Chepuwa Station, the annual maximum three-day precipitation event was estimated at 683 mm (CSPDR 2020).

Two distinct meteorological regions exist in the river basin, one on the north side of the Himalayan range in the Tibetan Plateau, and the other on the south side of the Himalayan range in Nepal. The portion on the Tibetan Plateau is a cold and arid zone with less precipitation, because of the rain shadow of the Himalayan range. The Nepalese portion belongs to a mild climatic zone. The climate changes with elevation from the subtropical zone in the midland area to the alpine zone in the highlands. The precipitation is generally much higher in the Nepalese portion, because of the effects of the monsoon. A small part (about 150 km^2) of the Tibetan portion near the Nepal border, up to about elevation 3,600 m, exhibits the milder and wetter climatic conditions generally characteristic of the Nepal portion.

6.1.6 Hydrology

The UAHEP is located on the Arun River, which is a tributary of the Sapta Koshi River, which in turn is a tributary of the Ganges River in India, which ultimately discharges to the Bay of Bengal in the Indian Ocean (see ***Figure 6.10***). The river originates from a glacier on the north slope of Mount Xixabangma (elevation 8,012 m) and the southern part of the Tibetan Plateau in China. The upper reach of the river flows eastward, almost parallel to the Himalayan range, for a distance of about 280 km. At the confluence with the Yeyuzangbu River, the Arun makes a sharp turn to the southwest, forming a large bend, after which it flows southward crossing the Himalayan range into Nepal.

Figure 6.10: Arun River Drainage

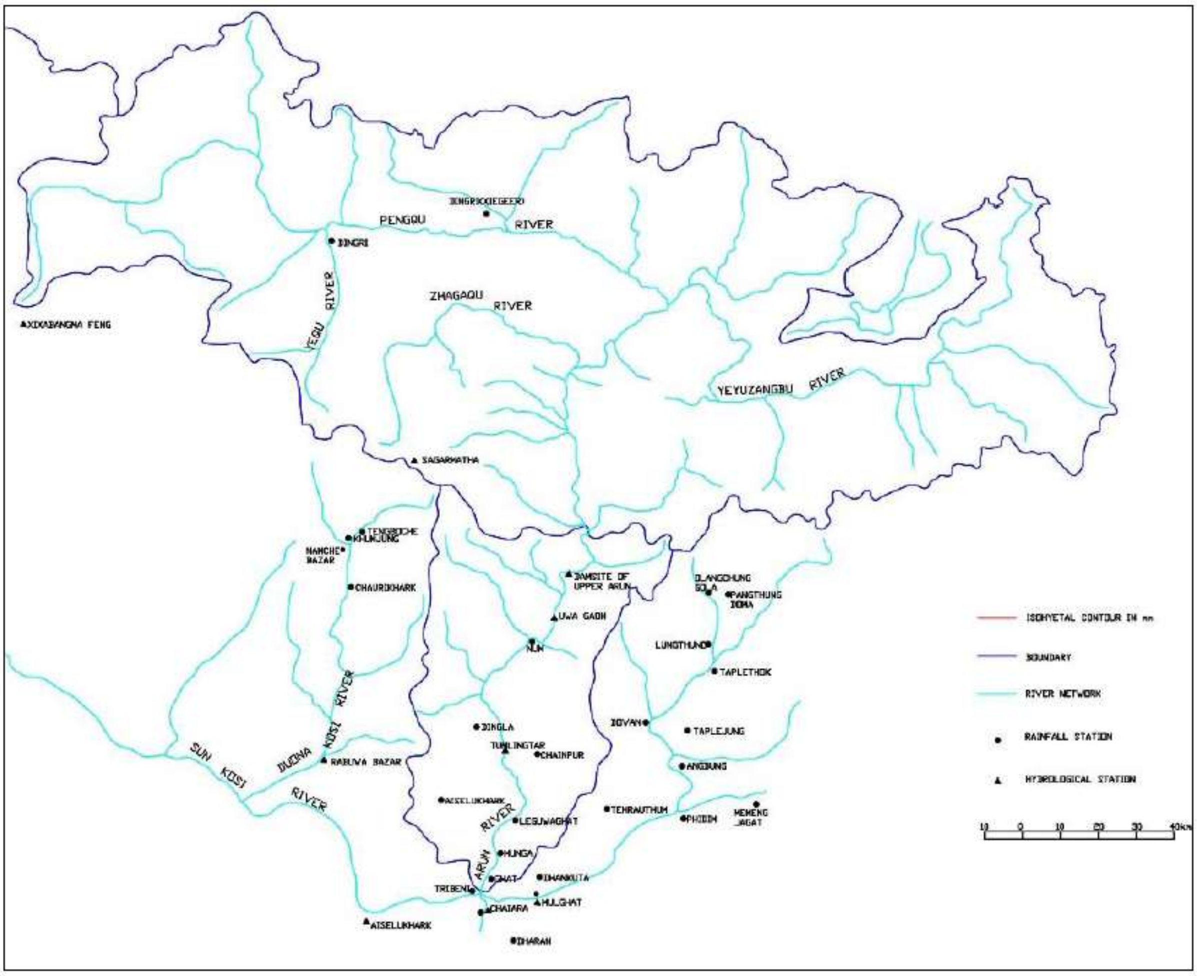


Source: Reynolds 2020

At the headworks site, which is about 14 km by river downstream from the Nepal-China border, the Arun River has a drainage area of 25,700 km^2, with approximately 98% of that draining from China (***Figure 6.11***). The Arun River drainage areas at key locations are listed below:

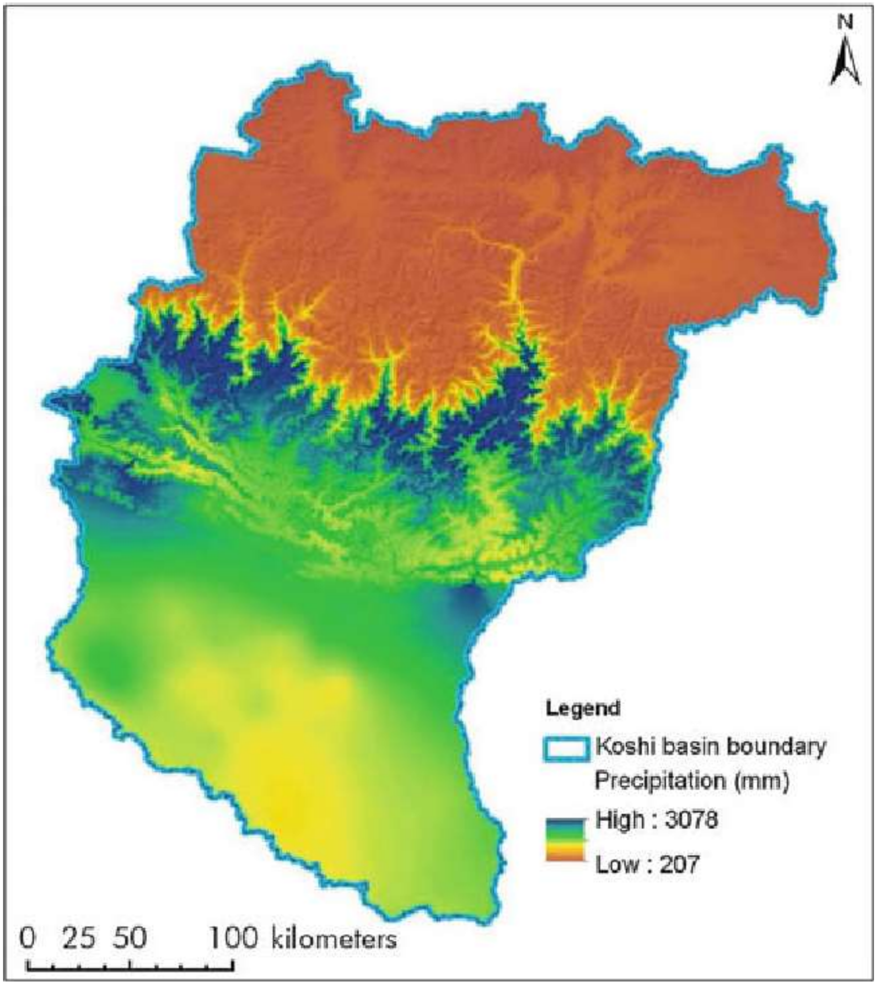
- Drainage area at China border – 25,307 km2
- Drainage area at UAHEP dam – 25,700 km2
- Drainage area at UAHEP powerhouse – 26,300 km2
- Drainage area near Tumlingtar – 28,150 km2
- Drainage area at confluence with Sapta Koshi River – 30,400 km^2

Figure 6.11: Arun River Basin



The Arun River is the largest trans-Himalayan river passing through Nepal and has the greatest snow- and ice-covered area of any Nepali river basin (Kattelmann 1990). The force of its accumulated waters carves its way south of Drengtrang through the main chain of the Himalayas directly between the mountain massifs of Makalu and Kangchenjunga into Nepal. The Arun River drains more than half of the overall Sapta Koshi River Basin, but provides only about a quarter of the total flow, which is attributable to the fact that more than 80% of the Arun's drainage area is within the Himalaya rain shadow in Xizang (the Tibetan Plateau), where average annual precipitation is less than about 300 mm, as compared to about 2,400 mm in the project impact area (***Figure 6.12***).

Figure 6.12: Average Annual Rainfall in the Koshi Basin



Source: Neupane *et al*. 2014

Arun River Flow Characteristics

The Arun River is a relatively high volume, high gradient/high velocity, glacier-fed (i.e., cold with high sediment load) river. In terms of flow, there are five Nepal Department of Hydrology and Meteorology (DHM) gauging stations along the Arun River, as summarized in ***Table 6.5***. The Uwa Gaon gauging station, which is located just downstream from the UAHEP powerhouse, is the closest gauge to the project impact area and provides about 25 years of consecutive flow data. Three staff gauges were installed in April 2018 at the confluence of the Arun River with Chepuwa Khola, the powerhouse site, and Leksuwa Khola, and an automatic gauging station was installed at the dam site in June 2018.

Table 6.5: Nepal DHM Flow Gauging Stations along the Arun River

Station No.	Location	Longitude	Latitude	Catchment Area (km^2)	Flow Series
600.1	Uwa Gaon	27°35’21”	27°35’21”	26,620	1985–2010
604.5	Turkeghat	87°11’30”	87°11’30”	28,200	1975–2014
606	Simle	26°55’42”	26°55’42”	30,380	1986–2010, 2012–2016
602	Tumlingtar	87°12’45”	87°12’45”	409	1974–2016
602.5	Pipletar	87°17’45”	87°17’45”	148.5	1974–1976, 1984–2016

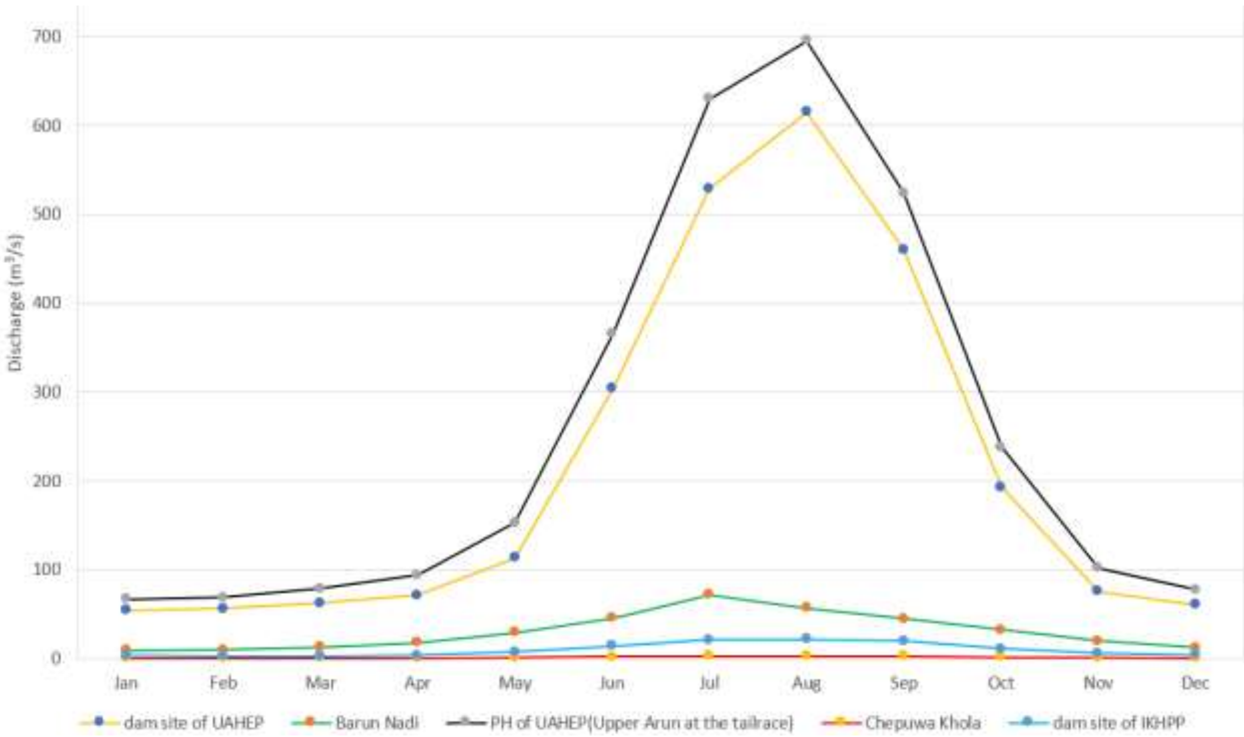
A synthetic long-term flow series was developed for the UAHEP dam site using daily flow records identified in ***Table 6.5***, but primarily relying on the Uwa Gaon gauging station. Based on hydrologic analysis of the available data, the annual average flow at the UAHEP dam site was estimated at 217 m^3/s (CSPDR 2020).

The flow in the Arun River is subject to strong seasonal effect, as evidenced by the average monthly flows (see ***Figure 6.13***):

- December to February – the lowest flows occur during the winter when the little precipitation that occurs is as snow.
- March to early June – still the dry season, but flows slowly begin to increase as warming temperatures slowly start to melt accumulated snow and ice.
- Mid-June to mid-September – the monsoon season with heavy rainfall combined with snow and ice melt.
- Late September to November – gradually decreasing flows as the monsoons end and temperatures begin to cool.

Flow velocities are high along the Arun River, with hand measured flows ranging up to 15 m/s and computed average flows ranging up to nearly 10 m/s.

Figure 6.13: Mean Monthly Arun River Flow Hydrograph at Various Locations

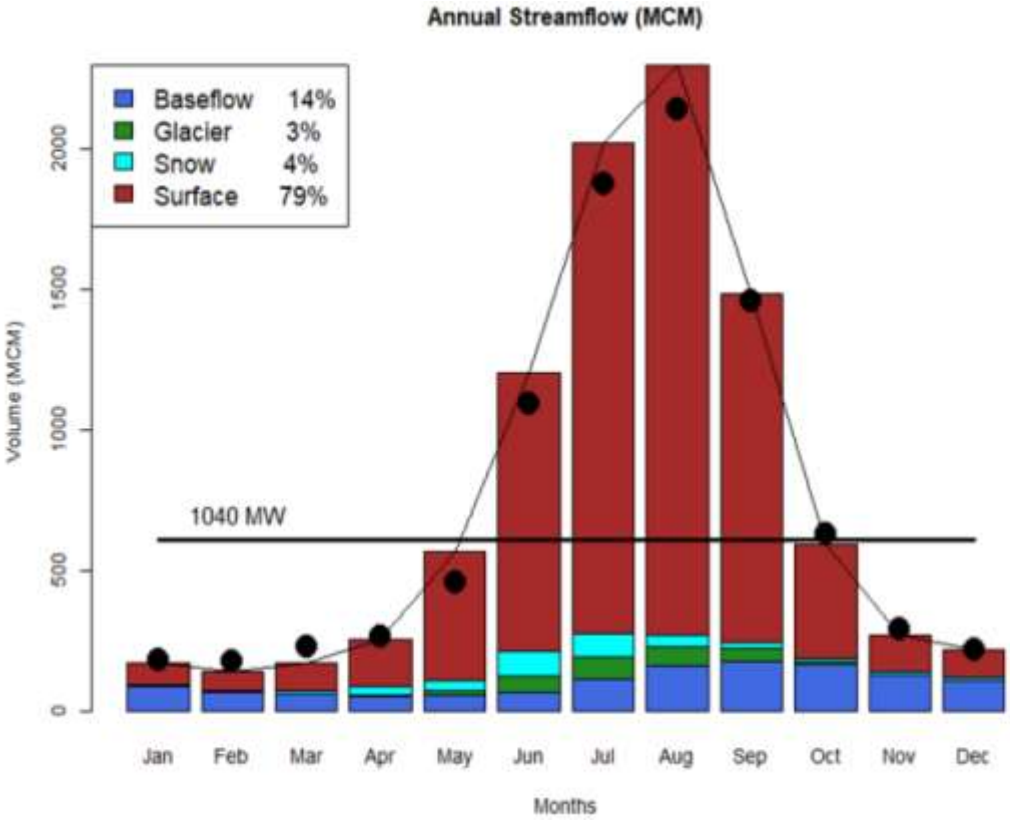


Source: CSPDR 2020

Figure 6.14 presents the modelled sources of flow by month at the dam site by baseflow (groundwater discharge), glacier melt, snow melt, and surface runoff, with surface runoff representing the majority of the flow (79%).

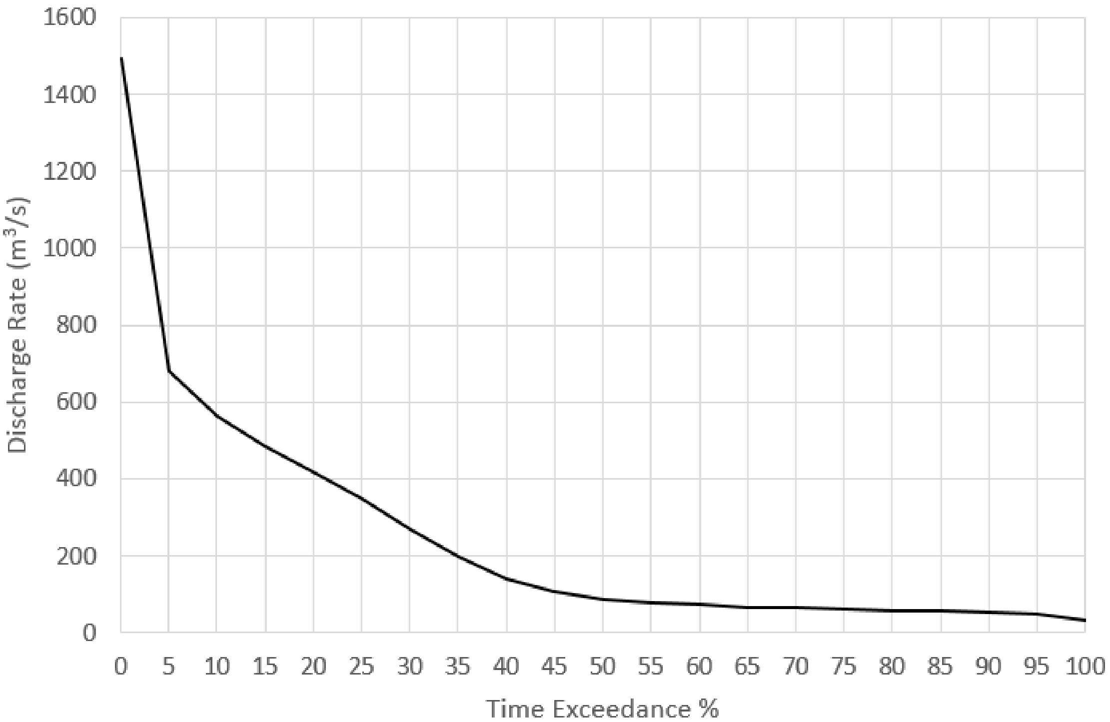
Figure 6.15 presents the flow duration curve for the UAHEP at the dam site, which shows a median flow of 87.4 m^3/s.

Figure 6.14: Sources of UAHEP Hydrology at Dam Site



Source: Wasti and Ray 2021

Figure 6.15: UAHEP Dam Site Flow Duration Curve



Source: CSPDR 2020

Table 6.6 lists the primary tributaries and characteristics to the Arun River in the DIA and IIA (see also and ***Figure 6.16***).

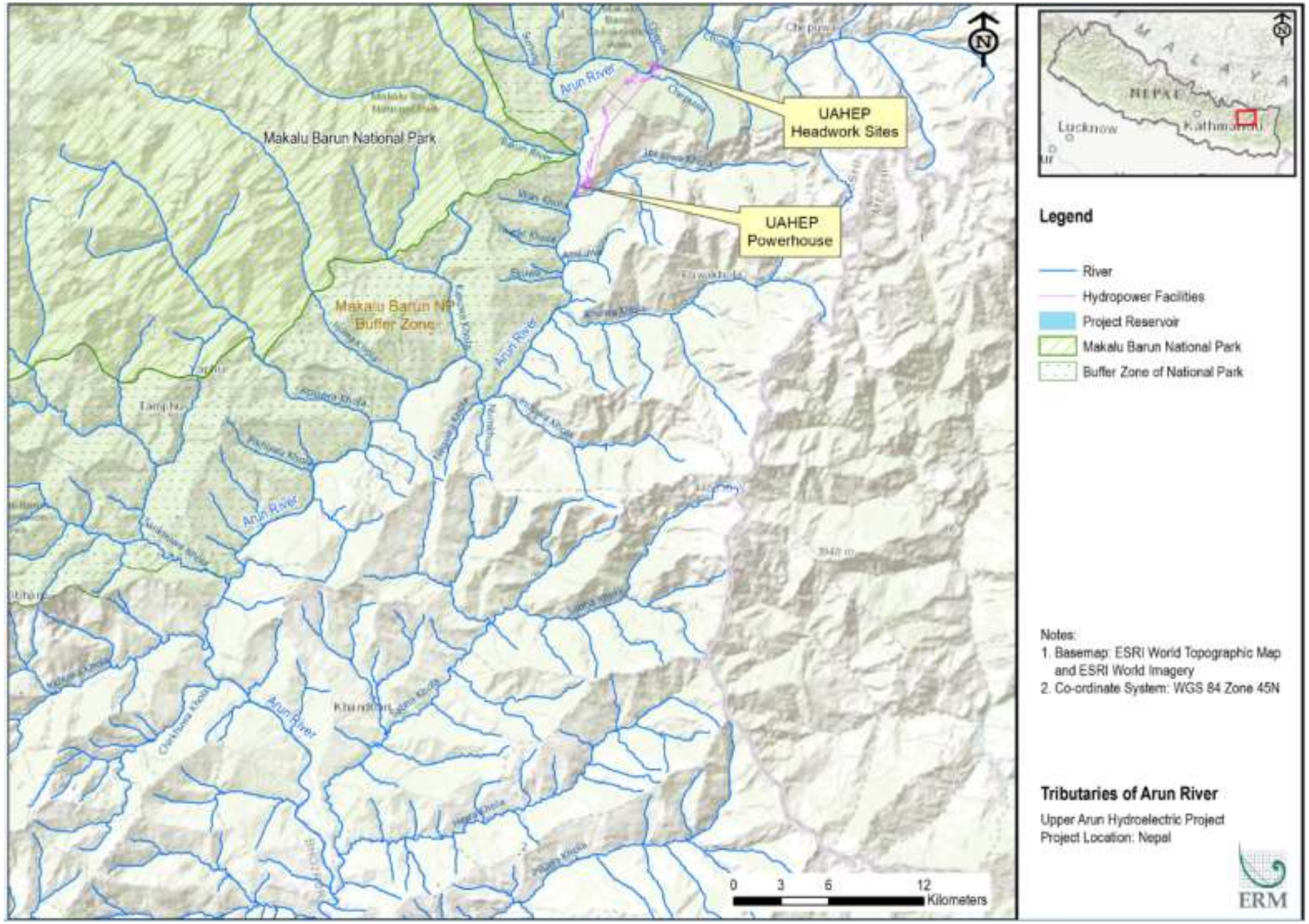
Table 6.6: Main Tributaries of the Arun River in Nepal

Tributary	Left or Right Bank	Glacial-fed or Clear Water	Average Flow[1]	Approx. Drainage Area[2]	Comments
Upstream from the UAHEP Dam					
Chujung Khola	Left bank	Clear water	~12 m^3/s	~257 km^2	
Chepuk Khola	Right bank	Clear water	~0.3 m^3/s	~7 km^2	Chepuwa micro-HEP
Downstream from the UAHEP Dam and Upstream from UAHEP Powerhouse (i.e., Diversion Reach)					
Chepuwa Khola	Left bank	Clear water	0.9 m^3/s	~19 km^2	Enters as waterfall
Sursing Khola	Right bank	Clear water	~0.9 m^3/s	~20 km^2	
Barun River	Right bank	Glacial-fed	30.4 m^3/s	470 km^2	Waterfall ~100 m upstream
Downstream from UAHEP Powerhouse to Arun-3 Dam					
Leksuwa Khola	Left bank	Clear water	7.9 m^3/s	76 km^2	
Wan Khola	Right bank	Clear water	~0.7 m^3/s	~10 km^2	
Thado Khola	Right bank	Clear water	~0.7 m^3/s	~10 km^2	
Amsuwa Khola	Left bank	Clear water	~0.7 m^3/s	~9 km^2	
Ekuwa Khola	Right bank	Clear water	~0.5 m^3/s	~6 km^2	
Ikhuwa Khola	Left bank	Clear water	~12.8 m^3/s	164 km^2	
Induwa Khola	Left bank	Clear water	~6 m^3/s	80 km^2	
Downstream from Arun-3 Dam					
Numkhuwa Khola	Left bank	Clear water	~0.8 m^3/s	~14 km^2	
Neguwa Khola	Left Bank	Clear water	~0.8 m^3/s	~14 km^2	
Kasuwa Khola	Right bank	Glacial-fed	~8 m^3/s	106 km^2	
Apusuwa River	Right bank	Glacial-fed	~16 m^3/s	207 km^2	
Sankhuwa Khola	Right bank	Clear water	~24 m^3/s	302 km^2	
Inkhuwa Khola	Right bank	Glacial-fed	~13 m^3/s	164 km^2	
Chirkhuwa Khola	Right bank	Glacial-fed	~6 m^3/s	71 km^2	
Sabha Khola	Left bank	Clear water	~41 m^3/s	531 km^2	
Piluwa Khola	Left bank	Clear water	~8 m^3/s	99 km^2	

[1] Estimated based on drainage area using the most applicable flow data from other streams

[2] Based on Thakur (2003) for drainage areas above 50 km^2 and measured using Google Earth for smaller drainage areas.

Figure 6.16: Arun River Tributaries



Arun River Flood Characteristics

The Uwa Gaon flow station, which has a 43-year period of record (1973–2013 and 2016–2017), was used to estimate flood characteristics for the Arun River in the project impact area. The probable maximum flood (1 in >10,000 year) values at the dam site and the powerhouse site are estimated to be 4,990 m^3/s and 6,060 m^3/s, respectively.

The geomorphology of the headwaters of the Arun River is characterized by glacial or peri-glacial landforms. There are about 737 glaciers in the Arun Basin with an aerial coverage of 1,357 km^2. Glacial lakes can form behind these glaciers. A glacial lake outburst flood (GLOF) occurs when a glacial lake moraine dam fails due to erosion, water pressure, avalanche, or earthquake, which generates a debris mixed flash flood. Since 1935, 62 GLOFs have been recorded in the Himalayas, including 7 known GLOF events within the Arun River Basin (Ives *et al*. 2010). Washakh *et al.* (2019) identified 49 glacial lakes in the Arun River Basin with surface areas greater than 0.1 km^2, including 4 potentially dangerous lakes for the Upper Arun dam and 3 potentially dangerous lakes for the Upper Arun powerhouse (***Table 6.7***).

Table 6.7: Potentially Dangerous Glacial Lakes for UAHEP

Lake #	Location	Glacial Lake Dam Type	Potential for Lake Impacts	Dam Geometry	Outburst Probability	UAHEP Facility Risk
20	China	Landslide dam	Debris flow	Stable	Medium	Dam
35	China	No dam	Debris flow	Stable	Medium	Dam/Powerhouse
36	China	Moraine dam	Ice avalanche	Unstable	High	Dam/Powerhouse
39	China	Moraine dam	Ice avalanche	Unstable	High	Dam
49	Nepal	Moraine dam	Ice avalanche	Unstable	High	Powerhouse

Source: Washakh *et al.* 2019

Lakes 36 (Qiangzongke Lake in China) and 49 (Lower Barun Lake in Nepal) were selected as posing the greatest GLOF risk, and the potential GLOF for each of these was modelled. The predicted GLOF from Qiangzongke Lake was predicted to be 7,576 m^3/s at the dam site and 6,935 m^3/s at the powerhouse site. The predicted GLOF from Lower Barun Lake was predicted to be 8,478 m^3/s at the powerhouse site (it is located downstream from the dam site, so would not threaten that facility). The magnitude of the these GLOFs is predicted to be larger than a 10,000-year flood event; therefore, the Project has been designed to pass a 7,576 m^3/s flood at the dam site and 8,478 m^3/s flood at the powerhouse.

Springs

There are many springs and small streams found in the project impact area, reflecting the steep topography and shallow depth to bedrock present. As the Project will require extensive tunnelling, which has the potential to affect groundwater, flow in the springs was measured (streams were estimated) during both the dry (April, 2019) and wet (November 2019) seasons in the area where tunnelling will occur (***Figure 6.17*** and ***Table 6.8***). The uses of each spring/stream were noted based on conversations with local residents (also see Section 6.3.8, subsection on Community Use of Forest and Natural Resources). There are also four micro-hydropower plants that provide power to various villages, which are indicated on the ***Figure 6.17*** and ***Table 6.8***.

Figure 6.17: Spring and Community Micro-hydropower Plant Locations

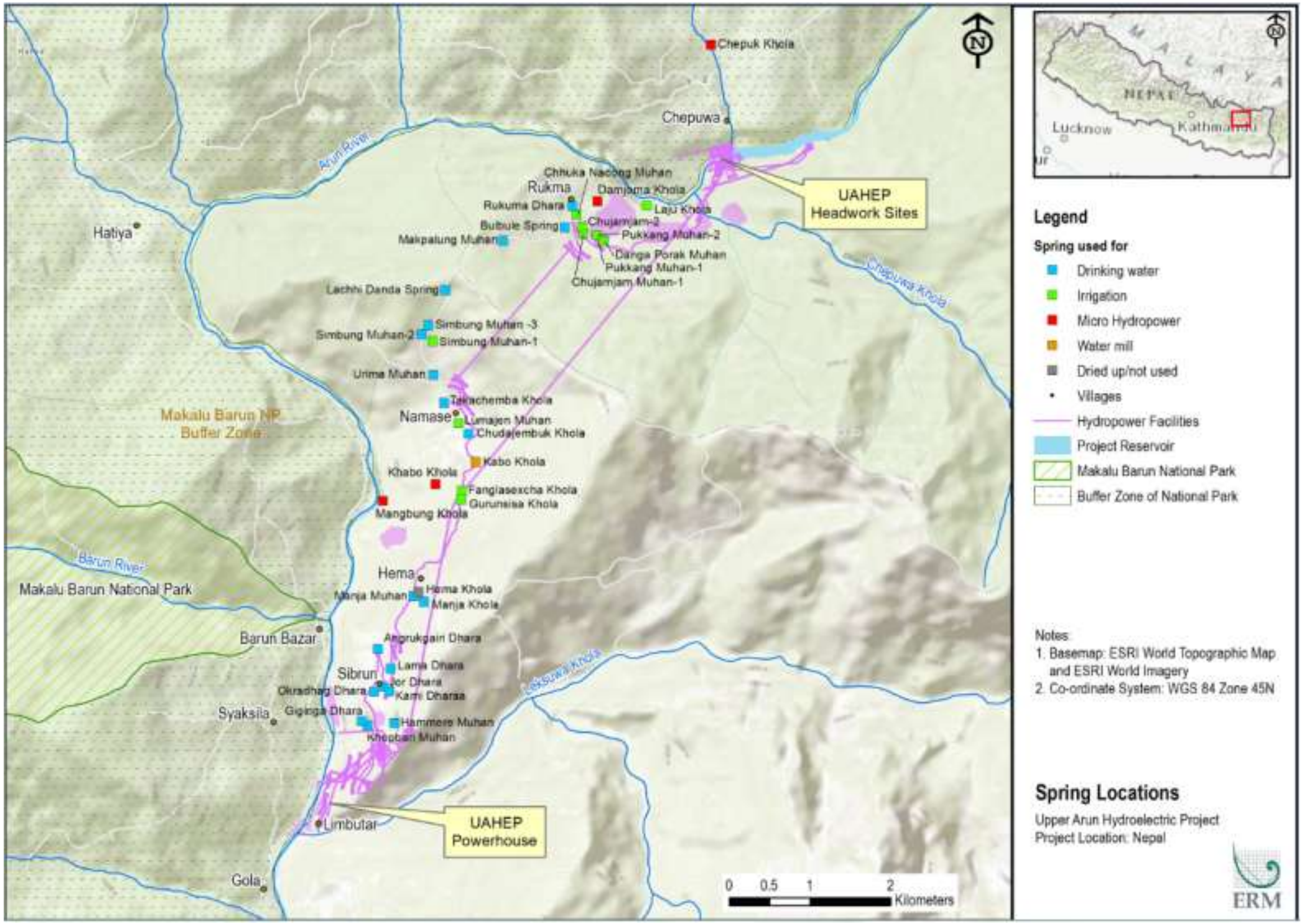


Table 6.8: Direct Impact Area Springs and Community Micro-Hydropower Project

Spring #	Name of Spring	Location	Elevation	Dry Season (Liters/second)	Wet Season (Liters/second)	Open or Piped Spring	Water Use
1	Chepuk Khola	Chepuwa	2,245	NA	NA	Stream	61 kW micro-hydropower used by villages of Chepuwa and Lingam
2	Makpalung Muhan	Rukma	2,433	0.03	0.05	Piped	2 households for drinking water
3	Bulbule	Rukma	1,969	0.21	0.31	Stream	5 households for drinking water
4	Pukkang Muhan-1	Rukma	1,840	0.78	0.94	Stream	Irrigation
5	Pukkang Muhan-2	Rukma	1,843	3.12	3.70	Stream	Irrigation
6	Danga Porak Muhan	Rukma	1,836	0.55	0.64	Open	Irrigation
7	Chujamjam Muhan-1	Rukma	1,881	4.89	5.26	Stream	Irrigation
8	Chujamjam Muhan-2	Rukma	1,883	1.95	2.02	Stream	Irrigation
9	Chhuka Nadong Muhan	Rukma	1,884	0.70	0.81	Open	Irrigation
10	Rukma Dhara	Rukma	1,879	0.15	0.20	Piped	12 households for drinking water
11	Laju Khola	Rukma	1,590	170 (est.)	200 (est.)	Stream	Irrigation
12	Damjoma Khola	Rukma	1,755	NA	NA	Stream	10 kW micro-hydropower used by village of Rukma
13	Lachhi Danda	Above Namase	2,572	0.11	0.15	Piped	Visitors for drinking water
14	Urima Muhan	Namase	1,980	1.00	1.18	Open	1 household for drinking water
15	Simbung Muhan-1	Namase	2,189	0.18	0.49	Open	Irrigation
16	Simbung Muhan-2	Namase	2,246	0.07	0.39	Open	1 household for drinking water
17	Simbung Muhan-3	Namase	2,293	0.01	0.10	Piped	1 household for drinking water
18	Takachemba Khola	Namase	1,874	0.06	1.08	Piped	1 household for drinking water/agriculture
19	Lumajen Muhan	Namase	1,837	0.76	2.21	Piped	Irrigation, bathing, washing
20	Chudajembuk Khola	Namase	1,825	1.92	27 (est.)	Stream	55 households for drinking water

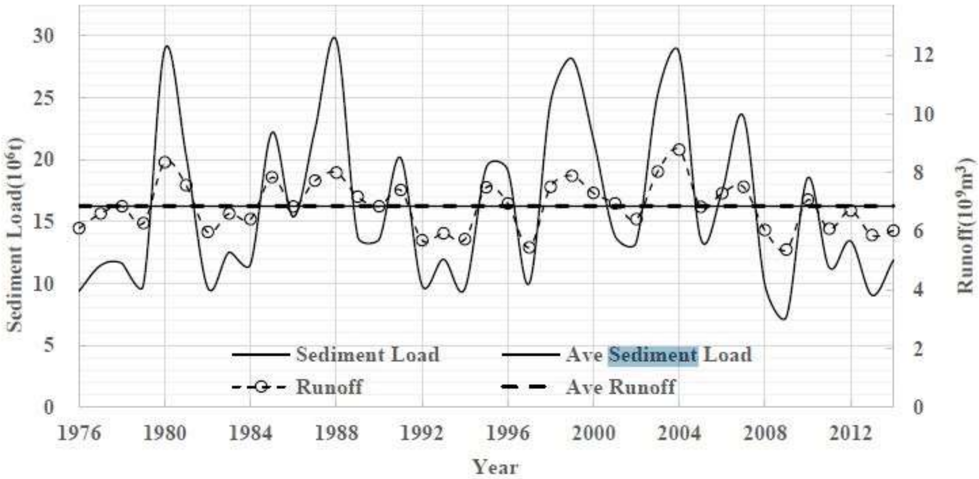
Spring #	Name of Spring	Location	Elevation	Dry Season	Wet Season	Open or Piped Spring	Water Use
				(Liters/second)			
21	Khabo Khola	Namase	1,818	6.8	9 (est.)	Stream	Water mill used by Namase village
22	Fanglasexcha Khola	Namase	1,768	0.21	1.60	Stream	Irrigation
23	Gurunsisa Khola	Namase	1,836	1.92	2.72	Stream	Irrigation
24	Khabo Khola	Namase	1,629	NA	NA	Stream	8 kW micro-hydropower used by village of Namase
25	Manja Khola	Hema	1,726	0.71	0.89	Piped	15 households for drinking water
26	Hema Khola	Hema	1,736	0.16	0.80	Stream	Not used
27	Manja Muhan	Hema	1,789	0.20	0.32	Piped	16 households for drinking water
28	Angrukgaira Dhara	Sibrun	1,524	0.12	0.37	Piped	11 households for drinking water
29	Lama Dhara	Sibrun	1,543	0.08	0.08	Piped	12 households for drinking water
30	Jor Dhara	Sibrun	1,529	0.61	0.96	Piped	10 households/1 school for drinking water
31	Okradhag Dhara	Sibrun	1,524	0.32	0.52	Open	4 households for drinking water
32	Kami Dhara	Sibrun	1,540	0.07	0.24	Piped	9 households for drinking water
33	Hammere Dhara	Sibrun	1,510	0.01	0.05	Piped	5 households for drinking water
34	Mangbung Khola	Sibrun	1,247	NA	NA	Stream	16 kW micro-hydropower used by villages of Sibrun, Hema, Sembung, and Rapsa
35	Khopbari Muhan	Jijinkha	1,386	0.04	Dry	Open	1 household for drinking water
36	Jijinkha Dhara	Jijinkha	1,333	0.53	4.03	Piped	10 households for drinking water

6.1.7 Sediment

The Arun River is one of the most highly sediment laden rivers in Nepal. The sources of this sediment are excessive erosion related to the tectonic dynamism of the terrain, including surface erosion landslides, mass failures, and debris flows, as well as glacial melt. The key erosions are related to the rain splash and runoff waters of the monsoon precipitation forming rills and gullies across the steep topographic landforms/land units formed by the tectonic processes, apart from mass wasting such as debris flows and landslides. In the geologically weak and unstable areas, the snow actions in high altitude areas above 3,000 m also contribute significant sediment to the Arun River. Much of the coarse sediment is arrested on the gentler mountain slopes and toe slopes of the valleys as colluvial and alluvial fans respectively. Of the total eroded sediments, a fraction, thus is available for transportation along the Arun River depending on the intensity of climatic forces (rain/snow and movements of water/ice).

Recent temporal measurements of the sediment discharges on the Arun River reveal a sediment load of 16.24 million tons per year, of which 13.81 million tons is suspended sediment (average suspended sediment load is 2.01 kg/m^3) and 2.43 million tons is coarse bed load (CSPDR 2020). Further, these studies also reveal that high sediment transport (95.5% of sediment load) occurs during the months of May to October. In the dry season (November to April), only a fraction (4.5%) of the sediment load is transported (***Figure 6.18***). In other words, the river discharge or, conversely, monsoon precipitation has a direct relationship with the sediment transport along the Arun River.

Figure 6.18: Upper Arun River Annual Runoff and Sediment Load Variation



Analysis of the particle size distribution of the transported sediment reveals that more than 30% of the transported sediment is larger than 1 mm in diameter, while 70% of the sediment is less than 1 mm in diameter. The transported sediment composition is dominated by the hard/resistant minerals, with quartz silica (hardness 7) representing 57% of the mineral composition, followed by feldspar (hardness 6) at 10%, and other minerals such as mica, garnet, tourmaline, and clay (hardness <5) at 33% (CSPDR 2020).

6.1.8 Water Quality

Water quality sampling was conducted four times covering all seasons from eight sites across the project impact area (Shah Consult International 2018). Another round of water quality sampling was conducted in April 2019 at 11 sites for a more limited range of parameters (NESS 2019). ***Figure 5.8*** shows these sample locations. The results are compared with the World Health Organization (WHO) guidelines and Nepal's National Drinking Water Quality Standards (NDWQS).

Physical Water Quality

Physical water quality parameters include pH, temperature, dissolved oxygen, turbidity, total suspended solids, total dissolved solids, and conductivity, each of which are described below.

pH

The Arun River pH is circum-neutral across all of the sampling locations, ranging from 6.7 to 7.6 with no discernible seasonal or spatial pattern, and was always within the Nepal drinking water quality acceptable range of 6.5–8.5.

Temperature

Table 6.9 presents the results of the water temperature sampling. The water temperatures are consistent with a glacial-fed river with temperatures between 5ºC–8ºC during the winter, warming to 10–14ºC in the spring, peaking at 16ºC–18ºC in the summer, before beginning to drop in the autumn to 15ºC–17ºC. As expected, water temperatures are higher farther downstream at lower elevations. It is worth noting that the water temperatures of the clear water (non-glacial fed) tributaries, such as Leksuwa Khola and Ikhuwa Khola, are warmer than the Arun River by 1ºC to nearly 4ºC, which is important for fish spawning and discussed in more detail in Section 6.2.2.

Table 6.9: Water Temperature (in ºC)

Station #	Station Name	Dec 2017/ Jan 2018	Apr 2018	Jul 2018	Sep/Oct 2018	Apr 2019
Arun River						
N9	Upstream from dam	NA	NA	NA	NA	11.2
S1/N1	Dam area	5	10	16	15	11.4
S2/N2	Upper diversion reach	6	10	17	16	13.2
S3/N3/N11	Diversion reach near Barun confluence	7	12	18	17	12.7/14
S4/N4	Below PH – Leksuwa Khola confluence	7	13	18	17	13.5
S7/N7	Downstream at Ikhuwa Khola confluence	8	15	19	18	13.3
S8	Downstream at Sankhuwa Khola confluence	8	18	21	18	NA
Tributaries						
N10	Barun River	NA	NA	NA	NA	12.5
N12	Leksuwa Khola	NA	NA	NA	NA	16.5
S5/N5	Ikhuwa Khola – above dam	7	14	16	13	15
S6/N6	Ikhuwa Khola – diversion reach	8	16	18	15	17

Data from the continuous temperature logger installed near the headworks site, which operated from December 2019 to mid-May 2020, indicated very cold temperatures ranging from below 7°C from late December to mid-February, and then gradually increasing to a high of 13°C in early May 2020. Data from the other temperature logger retrieved downstream from the Arun-3 dam is still being downloaded at this time.

Dissolved Oxygen

Dissolved oxygen (DO) levels were generally high across all sampling locations and seasons ranging from 6.4 milligrams/liter (mg/L) to 10.7 mg/L. DO concentrations at or above 6.5 mg/L are considered indicative of good water quality and suitable for fish and aquatic life. DO concentration in freshwater is affected by several factors including water temperature, atmospheric pressure, aeration, and biological/chemical oxygen demand. The sampling shows a close inverse relationship between water temperatures and DO levels, with concentrations generally the highest during the winter and lowest during the summer, as oxygen saturation is higher in cold water.

Conductivity and Total Dissolved Solids

The values found for the Arun River during sampling ranged from 48 mg/L–134 mg/L for total dissolved solids (TDS) and 78 microseconds/centimeter (μS/cm)–219 μS/cm for conductivity, all well within applicable WHO and Nepal NDWQS. The only noticeable trend was much lower TDS (range of 14 mg/L–38 mg/L) and conductivity (range of 35 μS/cm–63 μS/cm) for Ikhuwa Khola.

Turbidity and Total Suspended Solids

Turbidity is a measure of the opaqueness of water, representing an indirect measure of suspended matter. Total suspended solids (TSS) are solids present, but not dissolved, in water. For many river systems, especially glacial fed rivers, the primary solids in suspension are sediment particles.

Turbidity levels in the Arun River ranged from 17 nephelometric turbidity units (NTU)–1,702 NTU, with a strong seasonal trend with the lowest levels occurring in winter (range of 17 NTU–39 NTU) and the highest during the summer monsoons (range of 760 NTU–1,702 NTU). Turbidity levels were much lower in Ikhuwa Khola, which is not glacial fed, ranging from <1 NTU– 8NTU. The NDWQS is 10 NTU, so turbidity levels in the Arun River exceed drinking water standards year-round.

The same pattern Is seen in TSS concentrations, although there is a more evident trend of decreasing TSS concentrations in the downstream direction, presumably based on some degree of settling of the suspended particles as water velocities decrease (see ***Table 6.10***).

Table 6.10: Total Suspended Solids

Station #	Station Name	Dec 2017/ Jan 2018	Apr 2018	Jul 2018	Sep/Oct 2018
Arun River					
S1/N9/N1	Upstream from Dam	23	279	10,276	265
S2/N2	Upper diversion reach	24	112	8,948	285
S3/N3/N11	Diversion reach near Barun confluence	13	293	1,309	273
S4/N4	Below PH – Leksuwa Khola confluence	16	74	4,275	191
Tributaries					
S5/N5	Ikhuwa Khola – above dam	<1.0	<1.0	147	<1.0
S6/N6	Ikhuwa Khola – diversion reach	<1.0	<1.0	243	<1.0

Chemical Properties

Arun River water samples were analyzed for a suite of major ions (e.g., hardness, alkalinity, calcium, magnesium, chloride, fluoride, sulphate, sodium, potassium), nutrients (e.g., nitrate, phosphate, ammonia), metals (e.g., iron, manganese, copper, zinc, nickel, chromium, lead, mercury), and metalloids (e.g., arsenic). The analysis indicates that the water quality of the Arun River complies with nearly all standards (see ***Table 6.11***). It does exceed Nepal's NDWQS for iron and manganese, but these parameters are often high in natural waters and there is no indication that the elevated concentrations found in the Arun River are due to anthropogenic sources.

Table 6.11: Arun River Water Quality

Parameter	Units	Maximum Concentration	Station	Nepal Standard or Acceptable Range (mg/L)
Major Ions				
Total Hardness	mg/L as $CaCO_3$	124	1, 2	500
Total Alkalinity	mg/L as $CaCO_3$	118	1, 2	No standard
Calcium	mg/L	38	1	200
Magnesium	mg/L	10	2	No standard
Chloride	mg/L	8	2	250
Fluoride	mg/L	0.7	1	0.5 – 1.5
Sulphate	mg/L	81	3	250
Sodium	mg/L	14	1, 2	No standard
Potassium	mg/L	7	1, 4	No standard
Nutrients				
Nitrate	mg/L as NO_3	1.7	2	50
Phosphate	mg/L	0.34	1	No standard
Ammonia	mg/L	0.28	1, 2	1.5
Metals				
Iron	mg/L	34	4	3.0
Manganese	mg/L	0.8	1, 4	0.2
Copper	mg/L	0.05	1	1.0
Zinc	mg/L	0.9	2, 3	3.0
Nickel	mg/L	0.04	1	No standard
Chromium	mg/L	<0.05	1, 2	0.05
Lead	mg/L	<0.05	1, 2	0.01
Mercury	mg/L	<0.001	1, 2	0.001
Metalloid				
Arsenic	mg/L	<0.05	1, 2	0.05

Note: mg/L = milligrams/liter; CaCO3 = calcium carbonate; NO_3 = nitrate

Microbiological Water Quality

The presence of fecal coliforms, as measured by the number of colonies of the bacterium *E. coli* per 100 mL of water, is an indication of contamination by humans and/or animal waste. Sampling found very low concentrations of *E. coli* in the Arun River, with most samples during the winter, spring, and summer finding no colonies. There was a pattern of slightly higher concentrations in the autumn, which ranged from 3 to 20 colonies/100 mL of water across the various sampling locations, which may be attributed to lower flows providing less dilution of waste flushed during the summer monsoons.

Spring Water Quality

Water quality monitoring was conducted at representative springs in four of the villages in the DIA, with the results presented in ***Table 6.12***. The data indicate that the water quality of the springs generally meets Nepal's NDWQS, with only Rukma Dhara exceeding the turbidity standard and showing elevated ammonia and nitrite concentrations, indicating the potential for low level waste contamination.

Table 6.12: Spring Water Quality (April 2019)

Parameter	Units	Rukma Rukma Dhara	Namase Lumajen Muhan	Sibrun Angrukgairi Dhara	Hema Manja Muhan	Nepal NDWQS
pH	pH units	6.9	7.1	7.3	6.5	6.5–8.5
Conductivity	(µS/cm)	52	147	238	36	1,500
Turbidity	NTU	7	<1	2	2	5
Total hardness	mg/L as CaCO3	32	76	140	26	500
Total alkalinity	mg/L as CaCO3	44	77	177	39	-
Chloride	mg/L	1.0	1.0	1.0	1.0	250
Ammonia	mg/L	1.04	<0.05	<0.05	<0.05	1.5
Nitrate	mg/L	1.9	1.3	2.3	<0.05	50
Nitrite	mg/L	1.0	<0.02	0.02	<0.02	-
Calcium	mg/L	8.0	28.9	36.9	5.6	200
Magnesium	mg/L	2.9	1.0	11.7	2.9	-
Iron	mg/L	0.1	0.1	0.2	0.1	0.3
Manganese	mg/L	<0.02	<0.02	<0.02	<0.02	0.2

Note: NTU = nephelometric turbidity unit; µS = microsecond; mg/L = milligrams/liter; CaCO3 = calcium carbonate

6.1.9 Air Quality

This section describes baseline ambient air quality conditions in the DIA. Air quality in a geographic area is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the area, and the prevailing weather and climate conditions. Pollutant concentrations in the atmosphere are typically expressed in units of parts per million (ppm), parts per billion (ppb) or micrograms per cubic meter (µg/m^3) determined over various periods of time.

Air quality in urban areas of Nepal (e.g., Kathmandu) has deteriorated over time as a result of vehicle emissions, use of diesel generators for backup power, burning of waste materials, and industrial activities, with particulate matter being the main concern. In the rural areas of Nepal, air quality is generally good, although dust from unpaved roads and construction areas, and burning of biofuels and waste for heat and cooking can result in elevated particulate levels in isolated areas. Forest fires, which occur primarily in the late winter and spring months, contribute air pollutants, again primarily particulates, when they occur, creating overall hazy conditions.

The MoFE operates several air quality monitoring stations throughout Nepal, but the nearest one to the UAHEP is in Dhankuta, which is about 160 km south and not representative of air quality conditions in the project impact area (e.g., more developed area in the Mid-hills region of Nepal). Historical ambient air quality measurements for the project impact area do not exist. Therefore, ambient air monitoring was conducted at five locations (see Section 5.3.2, sub-section on Physical Baseline Studies, and ***Figure 5.9***: Air Monitoring Stations).

Table 6.13 presents the sampling results. As expected, ambient air quality at the three monitoring sites near the headworks, project access road, and powerhouse area (monitoring sites A–C) was very good, well below the Nepal Ambient Air Quality Standards (NAAQS). These three sites are located across the Arun River in an area without any roads or vehicular traffic. The two monitoring sites located along the Koshi Highway (monitoring sites D–E) show much higher particulate matter and TSP, although they remain below the NAAQS. These elevated particulate matter concentrations reflect vehicle generated dust from the unpaved Koshi Highway.

Table 6.13: UAHEP Baseline Ambient Air Quality Monitoring Results

Monitoring Station	Parameters (µg/m³)					
	Particulate Matter (PM_{10})	Particulate Matter ($PM_{2.5}$)	Total Suspended Particles (TSP)	Carbon Monoxide (CO)	Nitrogen Dioxide CO_2)	Sulphur Dioxide (SO_2)
A. Headworks area	38	27	65	<322	<1	<1
B. Project access road	32	19	51	<322	<1	<1
C. Powerhouse area	29	17	46	<322	<1	<1
D. Transportation route	120	**88**	208	NA	NA	NA
E. Transportation route	56	32	88	NA	NA	NA
NAAQS limits	120	40	230	10,000	80	70

Source: Ambient Air Quality Monitoring, NESS 2019; NAAQS exceedances in **bold**.

Overall, the lack of industry, fossil fuel power generation, and low vehicular traffic volume along the Koshi Highway results in relatively good air quality in the project impact area. Higher particulate matter concentrations are found along the Koshi Highway as a result of fugitive dust.

6.1.10 Noise

This section describes baseline ambient noise conditions in the DIA. Noise can be defined as unwanted sound. Sound travels in a mechanical wave motion and produces a sound pressure level. The sound pressure level, also referred to as loudness or intensity, is measured in decibels (dB). The decibel scale is logarithmic such that each 10 dB increase represents a tenfold increase in noise intensity. For example, if sound energy is doubled, there is a 3 dB increase in noise because the two sound levels are added logarithmically and not arithmetically (e.g., 70 dB plus 70 dB equals 73 dB, not 140 dB). A sound increase of 3 dB is barely perceptible to the human ear, while a 5 dB increase is clearly noticeable, and a 10 dB increase is heard as twice as loud.

Sound measurement is further refined by using an A-weighted scale that emphasizes the range between 1,000 and 8,000 cycles per second, which is the range of sound frequencies most audible to the human ear. Unless otherwise noted, all dB measurements presented in this ESIA are A-weighted (dBA) on a logarithmic scale. Noise emissions diminish or attenuate with distance from the source such that when distance is doubled, the sound level decreases by 6 dBA. ***Table 6.14*** presents dB levels of common noise sources.

Table 6.14: Decibel Levels of Common Noise Sources

Common Noise Source	dB Level
Jet engine (at 25 meters)	140
Jet aircraft (at 100 meters)	130
Rock concert	120
Pneumatic chipper	110
Jackhammer (at 1 meter)	100
Chainsaw, lawn mower (at 1 meter)	90
Heavy truck traffic	80
Business office, vacuum cleaner	70
Conversational speech, typical TV volume	60
Library	50
Bedroom	40
Secluded woods	30
Whisper	20

Note: dB = decibels

Table 6.15 presents the Government of Nepal and World Bank applicable noise standards.

Table 6.15: Applicable Noise Standards

Area	Daytime Sound Pressure Average dBA	Night-time Sound Pressure Average dBA
Government of Nepal (2012)		
Silent area	50	40
Rural residential area	45	40
Urban residential area	55	50
Mixed residential area	55	45
Business area	65	55
Industrial area	75	70
World Bank (General EHS Guidelines)		
Residential/institutional/educational	55	45
Industrial/commercial	70	70

Note: dBA = A-weighted decibel

There are no permanent noise monitoring stations in Nepal, and no historic noise data available for the project impact area. Therefore, baseline noise monitoring was conducted in 11 locations to document existing ambient noise levels (see Section 5.3.2, sub-section on Physical Baseline Studies and ***Figure 5.10*** Noise Monitoring Stations).

Table 6.16 presents the baseline monitoring results. The data indicate that average daily ambient noise level in most of the project impact area is between 45 and 60 dBA, with daytime averages in the low 60 dBA and night-time averages in the mid 50 dBA, which are fairly typical of rural locations. The few stations with average daily noise levels above 60 dBA include:

- Dam site – where river noise influenced the average daily levels
- Shree Barun Aadharbhoot School in Sibrun – higher daytime noise levels would be expected at a school, resulting in higher average daily levels
- Hema – where the noise monitoring was affected by nearby drilling and blasting associated with construction of a headrace test adit
- Samatar – which is along the Koshi Highway and subject to vehicular noise, which resulted in higher average daily levels

Table 6.16: UAHEP Ambient Noise Monitoring Data

Monitoring Station	Background dB(A)	Leq Average dB(A)	Daytime Average dB(A)	Nighttime Average dB(A)
Dam site	52	60	62	57
Rukma (near Spoil Disposal # 1)	45	58		
Rukma (near Workers' Camp # 1)	41	61		
Namase (near tunnel portal)	26	45		
Hema (near project access road)	32	68	70	66
Sibrun (Shree Barun Aadharbhoot School)	38	61		
Sibrun (near Workers' Camp # 3)	27	54		
Limbutar (near powerhouse area)	51	59	60	57
Gola (along transportation route)	43	53		
Samatar (along transportation route)	55	64		

Note: db = decibel; dBA = A-weighted decibel

6.1.11 Land Cover

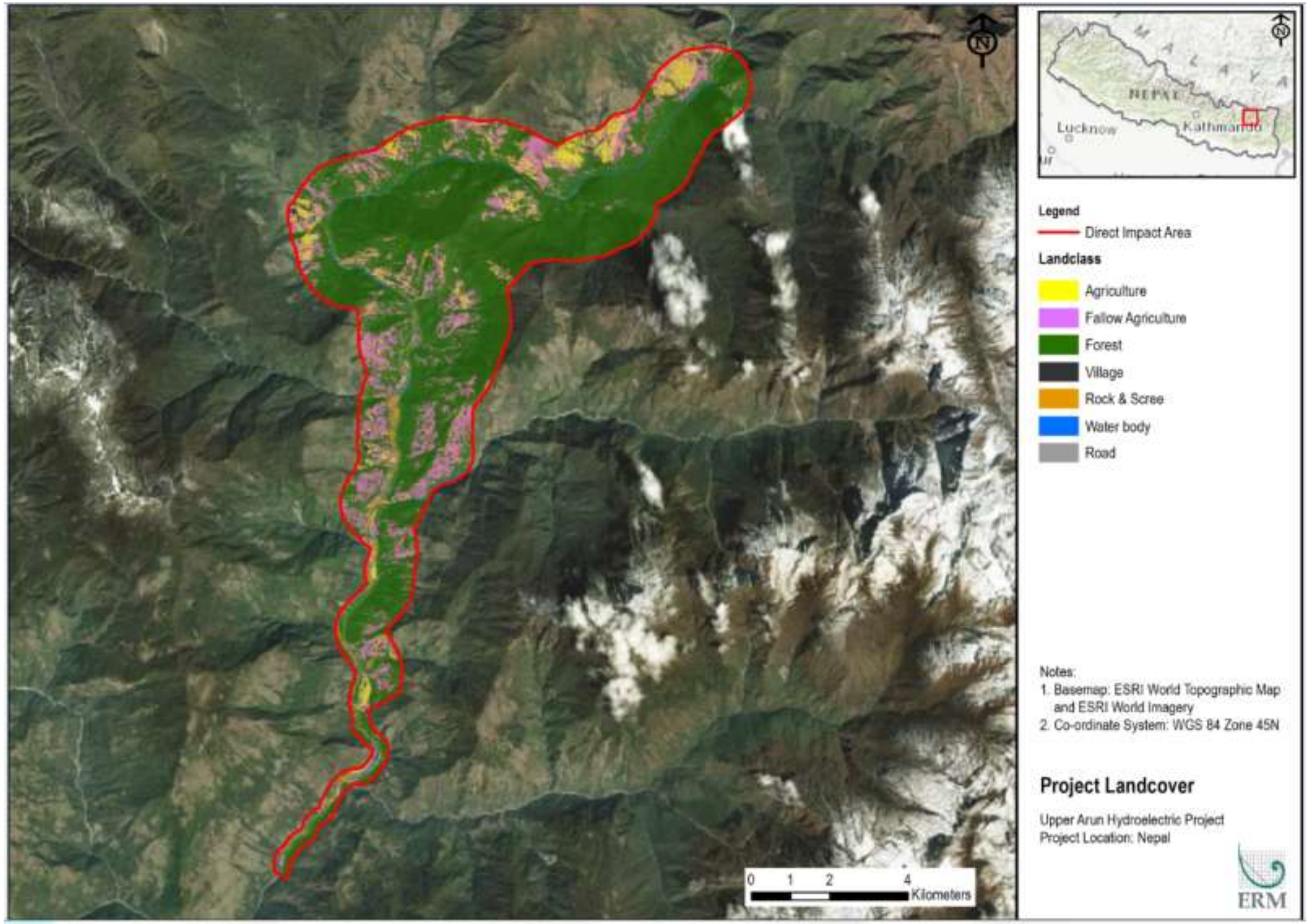
The Project is located in a relatively remote portion of northeast Nepal. It was only with the initiation of construction of the Arun-3 HEP in 2018 and the construction of the Num–Kimathanka portion of the Koshi Highway in 2019 that vehicular access was available along the west side of the Arun River, currently as far as the Barun River. There is still no vehicle access to the east side (left bank) upstream from Arun-3 HEP.

Table 6.17 and ***Figure 6.19*** show the existing land cover for the UAHEP DIA. As this table indicates, forest is by far the dominant land cover (67%), with agriculture (primarily cardamom, millet, and small plots of crops grown for local consumption) representing most of the remaining land (26%). There are over 20 small villages present within the DIA, ranging from about 135 households in Hatiya, which is the headquarters for Bhotkhola Rural Municipality, to small settlements like Jijinkha and Limbutar, with about 6 households each.

Table 6.17: UAHEP Land Cover Summary

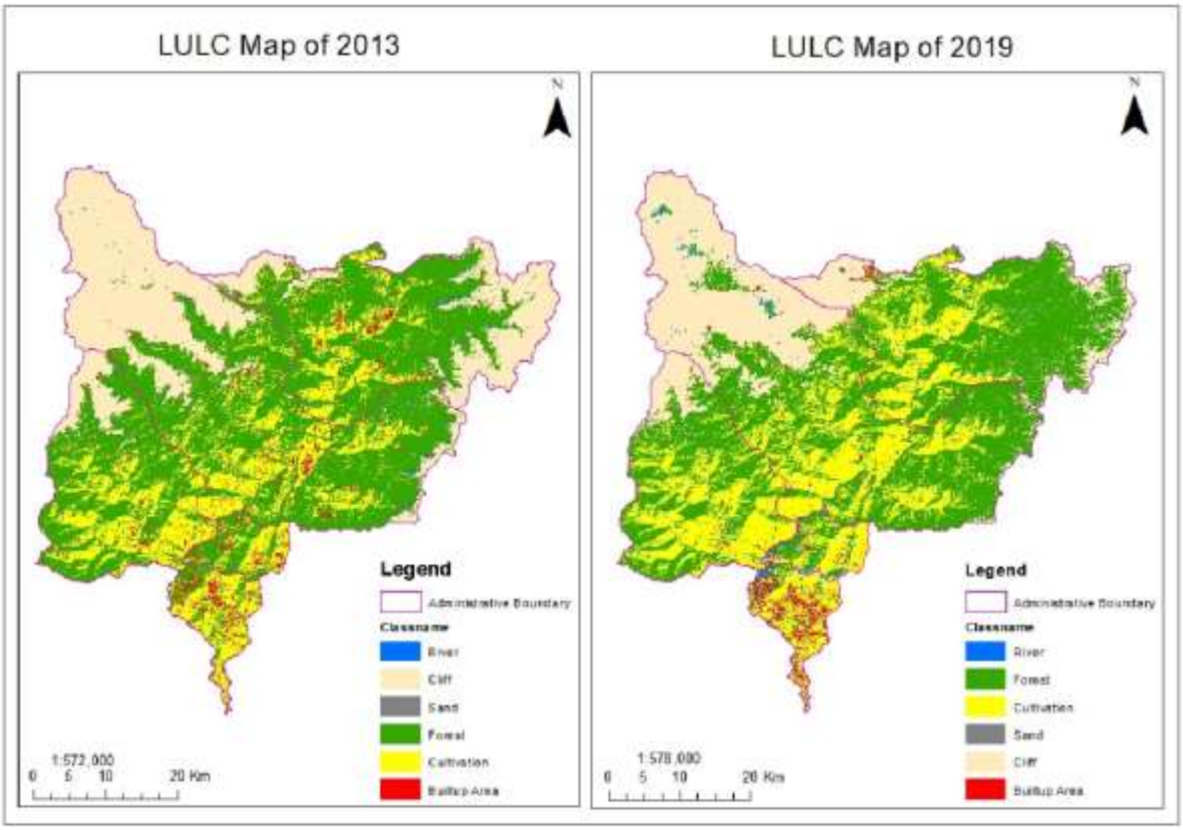
Land Cover Classes	Area within Direct Impact Area (ha)	Area within Direct Impact Area (%)
Agriculture	1,747.6	26.0%
Barren (rock and scree)	172.3	2.6%
Forest	4,476.4	66.6%
Grassland	189.1	2.8%
Water (rivers, streams, lakes)	110.5	1.6%
Developed (villages/roads/trails)	30.5	0.4%
Total	6,726.2	100%

Figure 6.19: UAHEP Existing Land Cover



Even before construction began on the Arun-3 HEP and the Koshi Highway in 2018/2019, changes in land uses and land covers were already being detected. The Makalu Barun National Park and Its Buffer Zone Management Plan (DNPWC 2020) noted a dramatic decline in rangeland/grasslands (-95%) and forest (-13%) and an increase in cultivated land (+69%) between 1995 and 2013 within the national park boundary. An updated analysis of land cover over the larger Arun River Basin in Nepal (NESS 2020) found similar trends, with a 19% increase in cultivated land and a 12% decrease in forest land between 2013 and 2019 (***Figure 6.20***). Improvements in access to the project impact area will likely accelerate these trends.

Figure 6.20: Upper Arun Basin in Nepal Land Cover Trends



6.1.12 Landscape Values and Visual Amenity

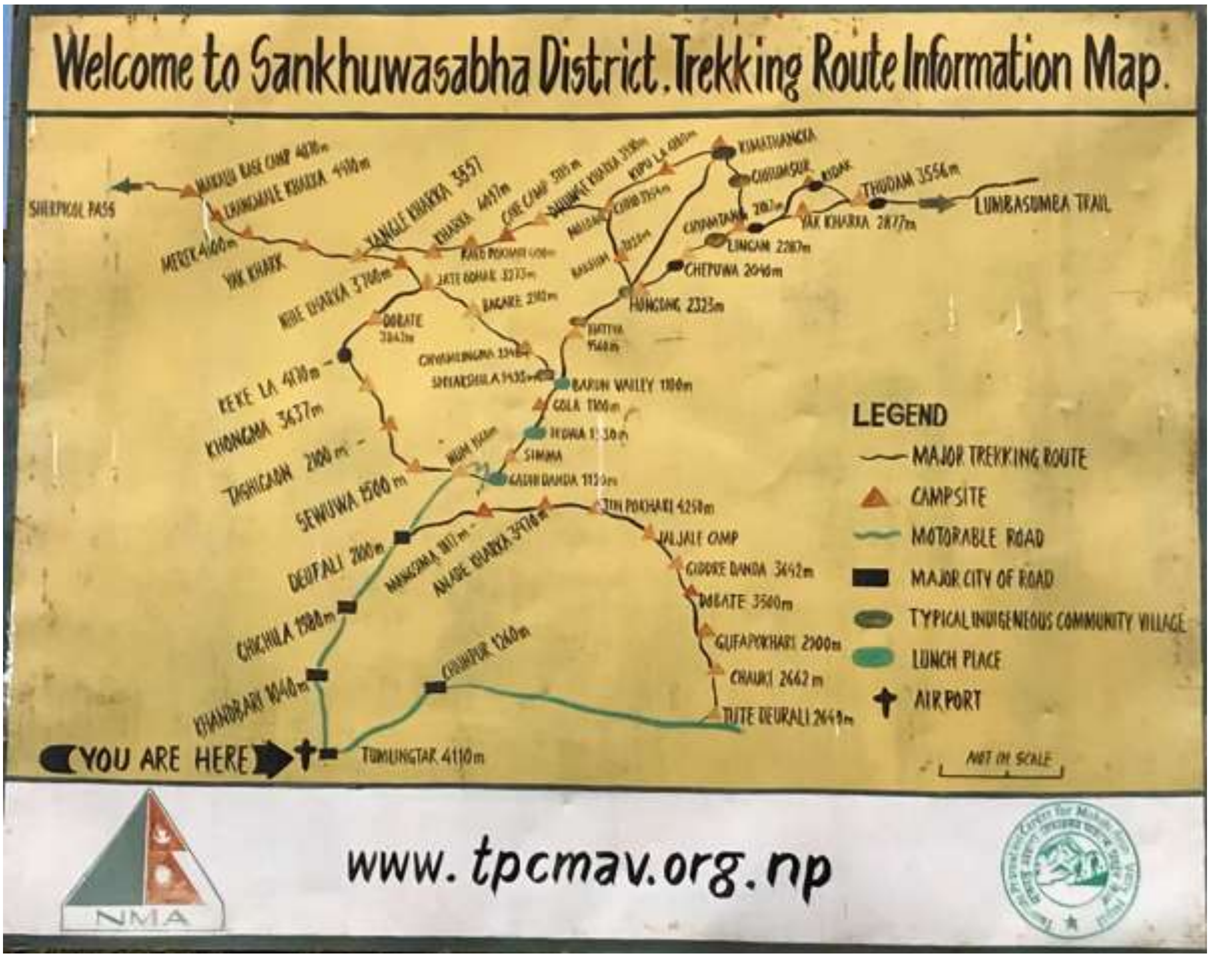
The project impact area is rich in natural beauty, cultural heritage, and ethnic diversity, including the MBNP and Barun Bazar, which is the site of the annual Barun Mela (see Section 6.3.14, sub-section on Natural Heritage). Waterfalls are common throughout the project impact area, with Chepuwa Khola falls, which is located on Chepuwa Khola whose confluence with the Arun River is about 350 m downstream from the UAHEP dam, being one of the largest and most visible. There is also a large waterfall on the Barun River approximately 100 m upstream from its confluence with the Arun River, which is visible from the Arun Valley from locations near Sibrun and Hema. The Arun River gorge cuts through steep forested slopes and fields of cardamom and millet. The area is of high scenic value (***Figure 6.21***). See Section 6.3.14 for additional details on the cultural heritage of the project impact area and its value and relationship to resident’s spiritual beliefs.

Figure 6.21: Photographs of the Arun River Valley

The project impact area is not one of the primary trekking areas in Nepal, and its number of visitors is far less than the more popular treks to Everest Base Camp and the Annapurna Circuit, but there is an extensive network of trails present in the area, which are used by both locals and trekkers (***Figure 6.22***). MBNP is the main trekking destination in the project impact area, with most trails eventually leading toward the Makalu Base Camp. The primary trekking route to Makalu Base Camp heads northwest from Num, but an alternative route does go up the Arun River Valley to the Barun River before climbing to the northwest to Makalu Base Camp. The completion of the Koshi Highway to China will make this area much more accessible and may affect the preferred trekking routes.

Other trails exist that extend farther up the Arun Valley to Hatiya, Chepuwa, and on to Kimathanka, although these are primarily used by local residents and, more recently, Contractors for the Upper Arun and Kimathanka hydropower projects.

Figure 6.22: Sankhuwasabha District Trekking Route Map

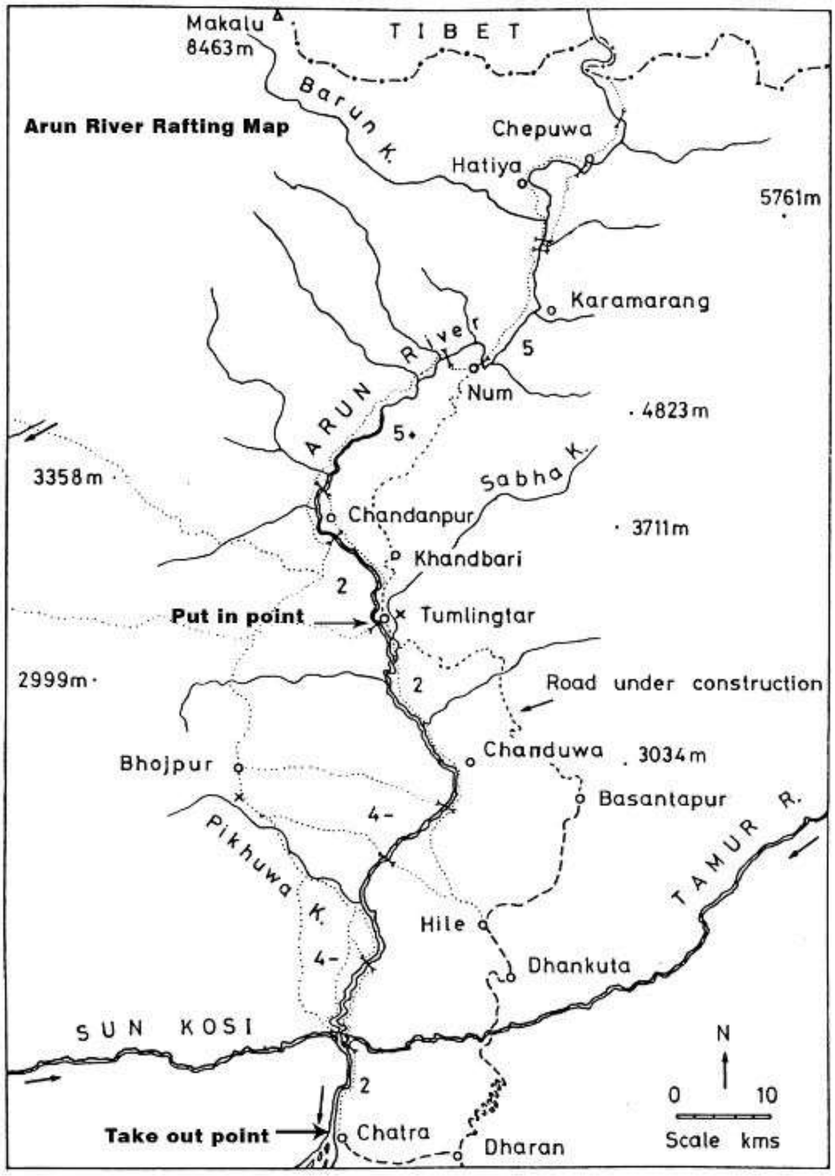


The Lumbasumba Trail was established as an official trekking route by the Trekking Association of Nepal in 2012 and connects the Kanchenjunga Conservation Area to the east with MBNP via the Lumbasumba Pass (elevation 5,177 m). This trail, coming from the east, crosses the Arun River about 6 km upstream from the UAHEP dam, and climbs up to the village of Chyamtan, and on through Lingam and Chepuwa, with options to go west through Hongon to Makalu Base Camp or south through Hatiya, Barun Bazar, and Gola to Num.

There are plans to establish the Great Himalaya Trail, which would cross the length of Nepal through the Himalayas (https://en.wikipedia.org/wiki/Great_Himalaya_Trail). The proposed eastern portion of the route would follow the Lumbasumba Trail, as described above, which would follow the route immediately to the north and west of the project DIA.

Rafting does occur on the Arun River, but only far downstream from the project impact area, with most outfitters putting in to the river near Tumlingtar (about 50 river kilometers downstream from the UAHEP), and taking out near the confluence with the Sun Koshi River (***Figure 6.23***).

Figure 6.23: Arun River Rafting Map



The Arun River in the project impact area would be unsafe for commercial rafting because of its steep gradient, relative high flows, and lack of takeout/rescue areas. It would be considered at least a Class V river segment, as defined below (***Figure 6.24***):

- Class V: Expert Level – Extremely long, obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes, congested chutes with complex, demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end of the scale, several of these factors may be combined. Scouting is recommended, but may be difficult. Swims are dangerous, and rescue is often difficult even for experts. Proper equipment, extensive experience, and practiced rescue skills are essential (American Whitewater Association, 2005).

There are no commercial rafting outfitters in Nepal advertising trips on the Upper Arun River.

Figure 6.24: Photograph of the Upper Arun River Gorge

In summary, the project impact area offers high scenic quality. Key scenic viewspots within the project impact area include:

- Views of Chepuwa Khola waterfalls
- Views of the Arun River Gorge, especially between Rukma/Chepuwa and the Barun River
- Views of various religious shrines, commonly found on bluffs overlooking the Arun River
- Views of the Barun River and its waterfall
- Views from the crest of the trail between Namase and Rukma

6.2 Terrestrial and Aquatic Biodiversity

The following sections outline the baseline assessment of biodiversity values undertaken for the UAHEP. The objectives of the baseline assessment are to document conformance with the requirements of WB ESF ESS 6, IFC Performance Standard (PS) 6, and EIB Standard 3 (Biodiversity and Ecosystems), including specifically the following:

- Delineate the areas of natural and modified habitat according to the definition contained within WB ESF ESS 6.
- Determine presence or likely presence of aquatic and terrestrial biodiversity values that may trigger critical habitat (as defined under WB ESF ESS 6).
- Determine the existing ecological health/condition of aquatic and terrestrial biodiversity values and threats, including invasive alien species.

The biodiversity baseline assessment considered three different spatial scales for different aspects of the analysis:

- Protected and Key Biodiversity Areas – A 50 km area around the Project has been applied to identify the presence of legally protected areas, Key Biodiversity Areas (KBAs), and other sensitive biological receptors with which the Project could have potential interactions. This 50 km area is used in the Integrated Biodiversity Assessment Tool (IBAT) as a general buffer zone. Based on the interaction with biological receptors, this area was considered appropriate given the terrain and distribution of endemic species within this part of Sankhuwasabha District and the adjoining portion of China. The use of the IBAT biodiversity tool provided a first indication of the presence of critical habitat species in the wider project area.
- Ecologically Appropriate Area of Analysis (EAAA) – The EAAA is a spatial area that delineates the extent to which a proposed project may affect the surrounding biodiversity, especially in terms of assessing potential effects on species that could trigger critical habitat. This EAAA is established for each critically endangered and endangered species group (see analysis below in this chapter) and then overlaid by the Direct Impact Area and the Indirect Impact Area of the project. Based on this analysis it can be determined if the wider project area contains critical habitat and for which species.
- Direct Impact Area (DIA) – The DIA was the focal area for the field studies (see Section 5.2)

6.2.1 Terrestrial Biodiversity

The Project is located in an area with a low human population density and no major residential areas. Consequently, terrestrial biodiversity conditions are generally of moderate to good quality, especially along the Arun River valley, its tributary valleys, and along inaccessible hill ridges, as they are relatively undisturbed due to the remoteness and inaccessibility of these areas. The forest and shrub habitats close to the settlements in the project impact area are degraded by human influence, such that only species that are accustomed to human influence are expected to be present. The Arun River may be used as a migratory pathway for birds from the Himalayas to their breeding grounds around Koshi Tappu, including the bar-headed goose, ruddy shelduck, red-crested pochard, northern shoveler, gadwal, mallard, Eurasian wigeon, common teal, common coot, and northern pintail. The Koshi Tappu, as well as the project area, is part of the EAAA for these bird species. The river valleys are also used by soaring raptors and vultures, which forage along the lower hill slopes and river banks.

Protected and Key Biodiversity Areas

The background assessment considered the following protected and key biodiversity areas, which are described in more detail below (***Table 6.18***):

- Legally Protected Areas
- World Wildlife Fund (WWF) Ecoregion data
- Key Biodiversity Areas (KBA)

UNESCO World Heritage Sites

Ramsar Wetlands of International Importance (Ramsar Wetland)

National Protected Areas

National protected areas within the EAAA include national parks, conservation reserves, and wildlife reserves (***Figure 6.25*** and ***Table 6.18***). National protected areas within 50 km of the Project include the Makalu Barun and Sagarmatha National Parks, and the Kanchenjunga Conservation Area within Nepal and the Qomolangma National Nature Reserve, which is a protected area in China. The Koshi Tappu Wildlife Reserve is approximately 100 km away, but is referenced here because the Arun River is a tributary of the Koshi River, which flows through this wildlife reserve. With the exception of the Koshi Tappu Wildlife Reserve, these sites have multiple designations (KBAs and/or Important Bird Areas [IBAs]) in addition to their national protected area status. **Figure 6.26** distinguishes the MBNP Core Area and Buffer Zone.

Table 6.18: Protected and Key Biodiversity Areas within the EAAA

S/N	Name	World Heritage Site	Ramsar Wetland	Nationally Protected Areas	KBA	Distance to Project	Description
1.	Sagarmatha National Park	X		X	X	~50 km northwest	Sagarmatha National Park was gazetted as a National Park in 1976 and inscribed on the World Heritage List in 1979. It covers an area of 124,400 ha and includes the highest mountain on Earth, Mt Sagarmatha (Mt Everest) at 8,848 m, as well as another seven peaks over 7,000 m. The park has also been designated an IBA, with a total of 194 bird species recorded in the park (Basnet 2004). The park has large temperate forest and alpine zone areas. These support significant populations of characteristic bird species of the Sino-Himalayan Temperate Forest and Eurasian High Montane biomes, respectively, including the globally threatened wood snipe, which may breed in alpine meadows. The area is also home to several rare species such as the snow leopard and red panda. The area represents a major stage of the Earth's evolutionary history and is one of the most geologically interesting regions in the world, with high, geologically young mountains and glaciers. This park contains the world's highest ecologically characteristic flora and fauna, intricately blended with the rich Sherpa culture[10].
2.	Makalu Barun National Park			X	X	Within MBNP Buffer Zone	The Makalu Barun National Park (MBNP) Core Area (IUCN management category II) and its Buffer Zone (IUCN management category IV) is a biodiversity hotspot of international importance. The MBNP was established in 1992 as an eastern extension of the Sagarmatha National Park (under the National Parks and Wildlife Conservation Act, 1973) AD. It is the world's only protected area with an elevation gain of more than 8,000 m enclosing tropical forest as well as snow-capped peaks. It covers an area of 1,500 km^2 in Solukhumbu and Sankhuwasabha Districts, and is surrounded by a buffer zone to the south and southeast with an area of 830 km^2. With a total area of 2,330 km^2, MBNP is managed by park staff, adopting a people-oriented approach as per the Himalayan National Park Regulation 2036 BS (1979 AD). According to this

[10] Extracted from https://whc.unesco.org/en/list/120

S/N	Name	World Heritage Site	Ramsar Wetland	Nationally Protected Areas	KBA	Distance to Project	Description
							regulation, legal access to the resources of the park and its buffer zone for subsistence harvesting is granted to local people living within the park and its buffer zone boundary. More than 3000 species of flowering plants are found in the MBNP, among which 56 species are rare and endangered. Almost two hundred (199) species of flowering plants have been recorded in the park (TMI and IUCN 1955). Seven species of endemic flowering plants have been recorded in the MBNP, which include *Desideria nepalensis, Pedicularis pseudoregeliana, Carex himalaica, Kobresia gandakiensis, Kobresia, fissiglumis, Ranunculus himalaicus* and *Ranunculus makaulensis*. Panchaunle (*Dactylorhiza hatagirea*) and kutki (*Neopicrorhiza scrophulariiflolia*) are plant species protected by the Government of Nepal, found in the MBNP. The MBNP Core Area and Buffer Zone have also been designated an IBA. A total of 348 bird species has been recorded from the park and Buffer Zone. The park is especially important for the globally threatened wood snipe, which breeds in the wider project area, and the near-threatened satyr tragopan and yellow-rumped honeyguide, which are resident and probably breed in the wider project area. It is also of special importance to the high number of seven restricted-range species from the Central and Eastern Himalayas Endemic Bird Areas (EBAs), which are probably resident: yellow-vented warbler, broad-billed warbler, Nepal wren babbler, rufous-throated wren babbler, spiny babbler, hoary-throated barwing and white-naped yuhina. Birdlife has identified 158 trigger species for IBA designation, including one IUCN VU species, three IUCN NT, 153 IUCN LC, and 1 IUCN not recognized (NR) species (Birdlife International 2019a).

S/N	Name	World Heritage Site	Ramsar Wetland	Nationally Protected Areas	KBA	Distance to Project	Description
3.	Kanchenjunga Conservation Area			X	X	~30 km east	Kanchenjunga Conservation Area was established in 1997, and measures 203,500 ha. Ranging in altitude from 1,200 to 8,586 m, it covers a range of bioclimatic zones, like other conservation areas of the region, with a concomitant rich biodiversity. The Conservation Area has also been designated an IBA. As many as 279 bird species have been recorded in the Conservation Area, but many more are likely to occur. The status of bird species in the IBA is uncertain. Considering the IBA's location and the high quality of extensive remaining forests, it is likely to be important for many east Himalayan species, including several species from the East Himalayan EBA. Birdlife International has identified 114 trigger species for the IBA designation, including the wood snipe (*Gallinago nemoricola*, IUCN VU), satyr tragopan (*Tragopan satyra*, IUCN NT), Himalayan griffon (*Fyps himalayensis*, IUCN NT), and 111 other IUCN LC species (Birdlife International 2019a).
4.	Koshi Tappu		X	X	X	~120 km south	The Koshi Tappu Wildlife Reserve was designated as a Ramsar Wetland in 1987. The Reserve comprises extensive mudflats, reed beds, and freshwater marshes in the floodplain of the Sapta Koshi River[11]. The Koshi Tappu has also been designated an IBA. A large number (486) of bird species has been recorded in the Koshi Tappu and Barrage area. Koshi is by far the most important wetland staging post for migrating waders and waterfowl in Nepal and was considered one of the most important in Asia. Koshi Tappu also has the largest heronry in Nepal, where as many as 25,730 nests belonging to 12 species of medium to large waders were reported in 1996. As many as 20 globally threatened bird species have been recorded in the Koshi Tappu and Koshi Barrage area and 11 of these occur regularly. This IBA is especially important for some wetland and grassland species, notably swamp francolin, Baer's pochard (*Aythya baeri*), Pallas's fish eagle, greater spotted eagle, imperial eagle, lesser adjutant, spot-billed pelican, and bristled grassbird. It holds the largest population of the globally threatened swamp francolin in Nepal,

[11] Extracted from https://www.ramsar.org/wetland/nepal

S/N	Name	World Heritage Site	Ramsar Wetland	Nationally Protected Areas	KBA	Distance to Project	Description
							and also supports a good population of bristled grassbirds. The site is also important for Nepal's near-threatened birds: 13 of the country's total of 23 occur there and 8 of these are wetland birds. Only two restricted-range species have been recorded and both are rare visitors. A marked decline in wintering and passage migrant waterbird has been noted since 1990 and has been highlighted in the Annual Waterfowl Counts. In February 2003 a total of nearly 9,800 birds were counted at the site in one day, a very low number compared to 20 years ago when more than 50,000 birds were estimated (Birdlife International 2019a).
5.	Qomolangma National Nature Reserve and Biosphere Reserve in China	X		X		~10 km north	The Qomolangma National Nature Reserve, which is also a UNESCO Man and the Biosphere Reserve, is the highest altitude biosphere reserve in the world, protecting approximately 3.4 million ha of central Himalaya in Tibet Autonomous Region. It contains or abuts several of the world's highest peaks, including Qomolangma (Chinese: Zhulangmafeng) or Mt. Everest 8,848 m). There are about 10 nationally protected plant species, such as *Alcimandra cathcartii*, Himalayan yew (*Taxus wallichiana*), and Himalayan spruce (*Picea smithiana*), and 33 nationally protected animal species such as the endemic snow leopard (*Panthera uncia*), Himalayan tahr (*Hemitragus jemlahicus*), and Hanuman (or common, gray) langur (*Presbytis entellus*).
6.	Tamur Valley and Watershed IBA				X	~15 km east	The Tamur Valley and Watershed KBA and IBA, encompassing 20,000 ha, has extensive forests of oaks *(Quercus spp.)* and chinquapin *(Castanopsis spp.)*, with rich patches of *Rhododendron* spp. A total of 260 bird species have been recorded in this site, including 215 possible breeding species, and several restricted range species. These include the restricted-range species rufous-throated wren babbler, spiny babbler, and hoary-throated barwing, and near-threatened yellow-rumped honeyguide, which are probably resident (Birdlife International 2019a). Non-bird fauna include a range of mammals and herpetofauna, including several large cats, monkeys, wolves, marten, and deer (Birdlife International 2019b).

S/N	Name	World Heritage Site	Ramsar Wetland	Nationally Protected Areas	KBA	Distance to Project	Description
7.	Khandbari-Num Forests IBA				X	~10 km south	This IBA is located on the east side (left bank) of the Arun River, across from the MBNP and its buffer zones. It encompasses 45,000 ha, containing grasslands, shrublands, temperate forest, and broadleaved subtropical forest that is dominated by *Castanopsis* spp. and *Quercus* spp. A total of 289 bird species have been recorded in this IBA, including several restricted range species and threatened species, including the Critically Endangered white-rumped vulture (*Gyps benghalensis*) and the red-headed vulture (*Sarcogyps calvus*).
8.	Eastern Himalayas EBA				X	Within	The Eastern Himalayas EBA follows the Himalayan range east from the Arun-Kosi valley of eastern Nepal, through Bhutan, northeast India (Sikkim, northern West Bengal, and Arunachal Pradesh), southeast Tibet Autonomous Region (China), and northeast Myanmar to southwest China (northwest Yunnan province). It also includes the mountain ranges to the south of the Brahmaputra River, which extend through northeast India (Nagaland, Manipur, southern Assam, Meghalaya, and Mizoram) to the Chin Hills in western Myanmar, and the Chittagong hills in southeast Bangladesh (Birdlife International 2019c). The Himalayan Mountains in the northern part of the EBA have an avifauna distinctly different from the mountain ranges in the south: eight or nine of the restricted-range species are only known from the north and four are known only from the south. These two regions are combined into a single EBA because of the 9–10 range-restricted bird species common to both. This EBA contains the Kanchenjunga National Park, Makalu Barun National Park, and Tamur Valley and Watershed IBAs.

S/N	Name	World Heritage Site	Ramsar Wetland	Nationally Protected Areas	KBA	Distance to Project	Description
9.	Central Himalayas EBA				X	Within	The Central Himalayas EBA extends through the Himalayas from the extreme east of Nepal to the extreme west, and possibly into adjacent regions of India. It partly overlaps with the Eastern Himalayas EBA in the east of Nepal. Two of the three restricted-range bird species for which this EBA is designated, *Pnoepyga immaculata* and *Actinodura nipalensis*, breed in Himalayan moist temperate forest between about 1,800 and 3,300 m elevation, and *Turdoides nipalensis* occupies dense scrub and secondary growth at slightly lower altitudes (Birdlife International 2019d). This EBA contains the Kanchenjunga Conservation Area, Makalu Barun National Park, and Tamur Valley and Watershed IBAs.

Figure 6.25: Nationally Protected Areas within 50 km of the Project

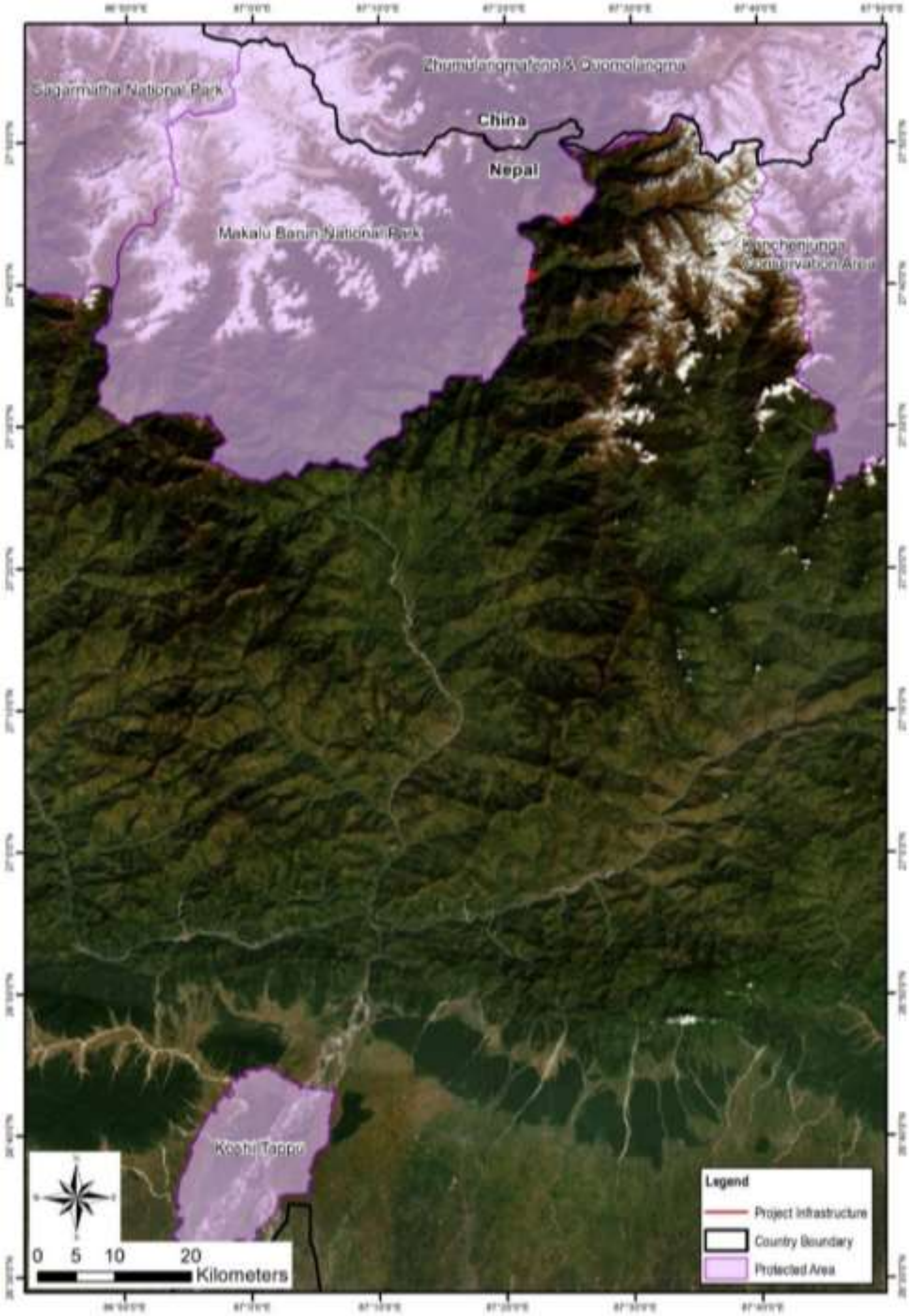
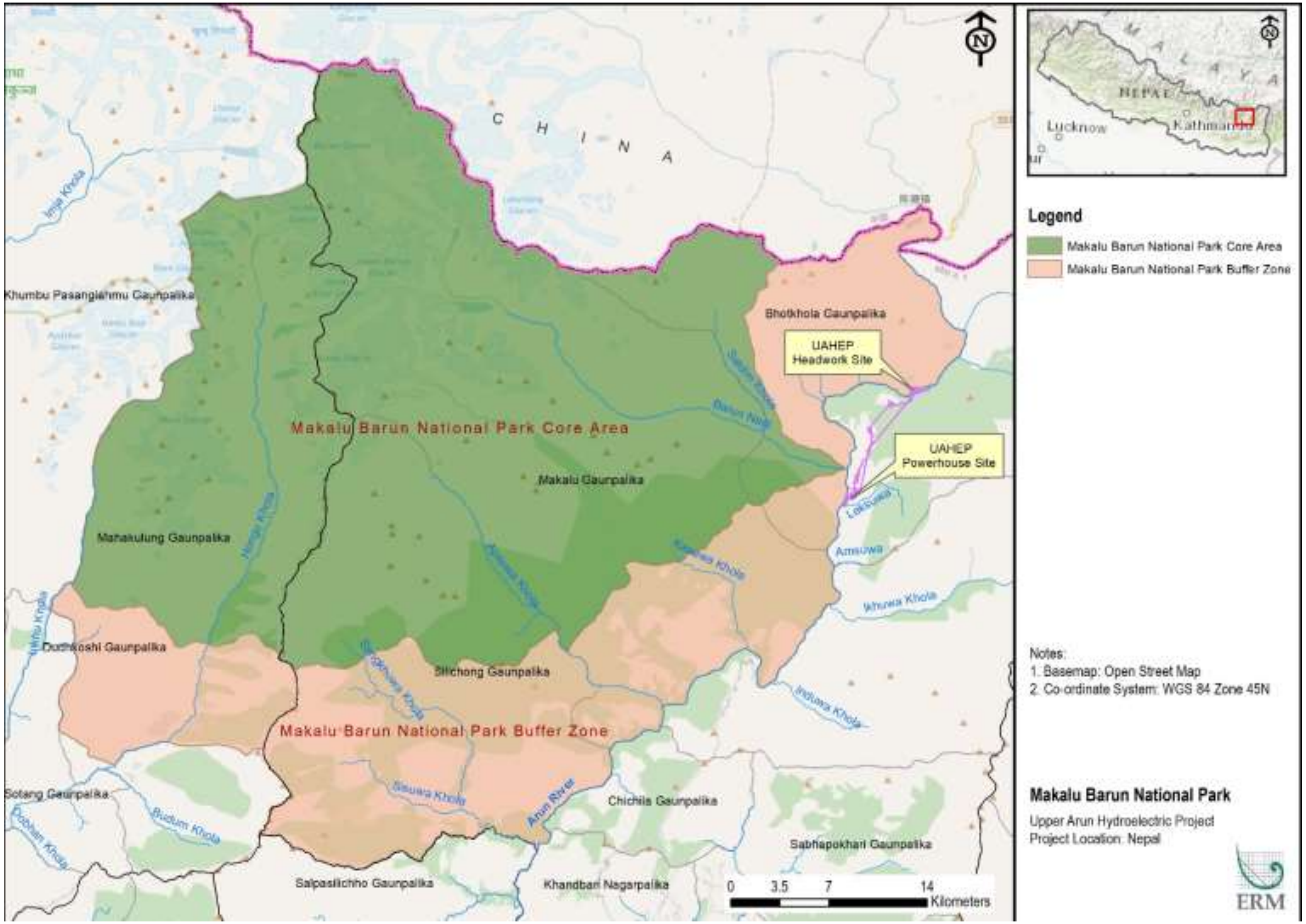


Figure 6.26: Makalu Barun National Park Core and Buffer Zone



WWF Ecoregion Data

An ecoregion is a large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions.[12] The boundaries of an ecoregion are not fixed and sharp, but rather encompass an area within which important ecological and evolutionary processes most strongly interact. WWF created an inventory of key ecoregions around the world, including several that occur in Nepal. The DIA of the Project occurs within the Eastern Himalayan Broadleaf Forests ecoregion. The Eastern Himalayan Broadleaf Forests ecoregion represents the band of temperate broadleaf forest between 2,000 and 3,000 m elevation, stretching from the deep Kali Gandaki River gorge in central Nepal, eastward through Bhutan, into India's eastern states of Arunachal Pradesh and Nagaland. This ecoregion is one of the few Indo-Pacific ecoregions that is globally outstanding for both species richness and levels of endemism. The eastern Himalayas are a crossroads of the Indo-Malayan, Indo-Chinese, Sino-Himalayan, and East Asiatic floras, as well as several ancient Gondwana relicts that have taken refuge here. This ecoregion is a biodiversity hotspot for rhododendrons and oaks. It provides habitat to 125 species of mammals, including four endemic and near-endemic species such as the Namdapha flying squirrel *(Biswamoyopterus biswasi)* and golden langur *(Trachypithecus geei)*, and several rare species, including the endangered tiger *(Panthera tigris)*, among others. There are almost 500 bird species in this ecoregion, which is among the highest across the bioregion, including 12 species that are endemic to the ecoregion.

Key Biodiversity Areas

A Key Biodiversity Area (KBA) is defined as a site that contributes significantly to the global persistence of biodiversity, applicable to terrestrial, freshwater, and marine ecosystems (Birdlife International 2018a). Sites qualify as global KBAs if they meet one or more of 11 criteria, grouped into the following 5 categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes, and irreplaceability. KBAs include Important Bird Areas (IBAs) and Key Biodiversity Areas, Important Plant Areas (IPAs), and Alliance for Zero Extinction (AZE) sites.

Only IBAs have been identified within 50 km of the Project, as no IPA or AZE sites are present in this part of the EAAA. Five currently listed IBAs occur within 50 km of the Project, including the Sagarmatha National Park, the Makalu Barun National Park, the Kanchenjunga Conservation Area, the Tamur Valley and Watershed and the Khandbari-Num Forests IBA. The IBAs are listed with further details on trigger species in and are shown in ***Figure 6.27***.

Endemic Bird Areas

An EBA is an area where the distribution of two or more restricted-range bird species (i.e., bird species with breeding range of no more than 50,000 km^2) overlap (Birdlife International 2018b). The Project lies within two EBAs: the Eastern Himalayas EBA and the Central Himalayas EBA, as described in ***Table 6.18*** and displayed in ***Figure 6.28****.* None of the trigger species for the EBAs were identified during Project field surveys, although these surveys were only conducted for a fixed period of time and likely did not observe all species present.

[12] Extracted from https://www.worldwildlife.org/biomes

Figure 6.27: IBAs within 50 km of the Project

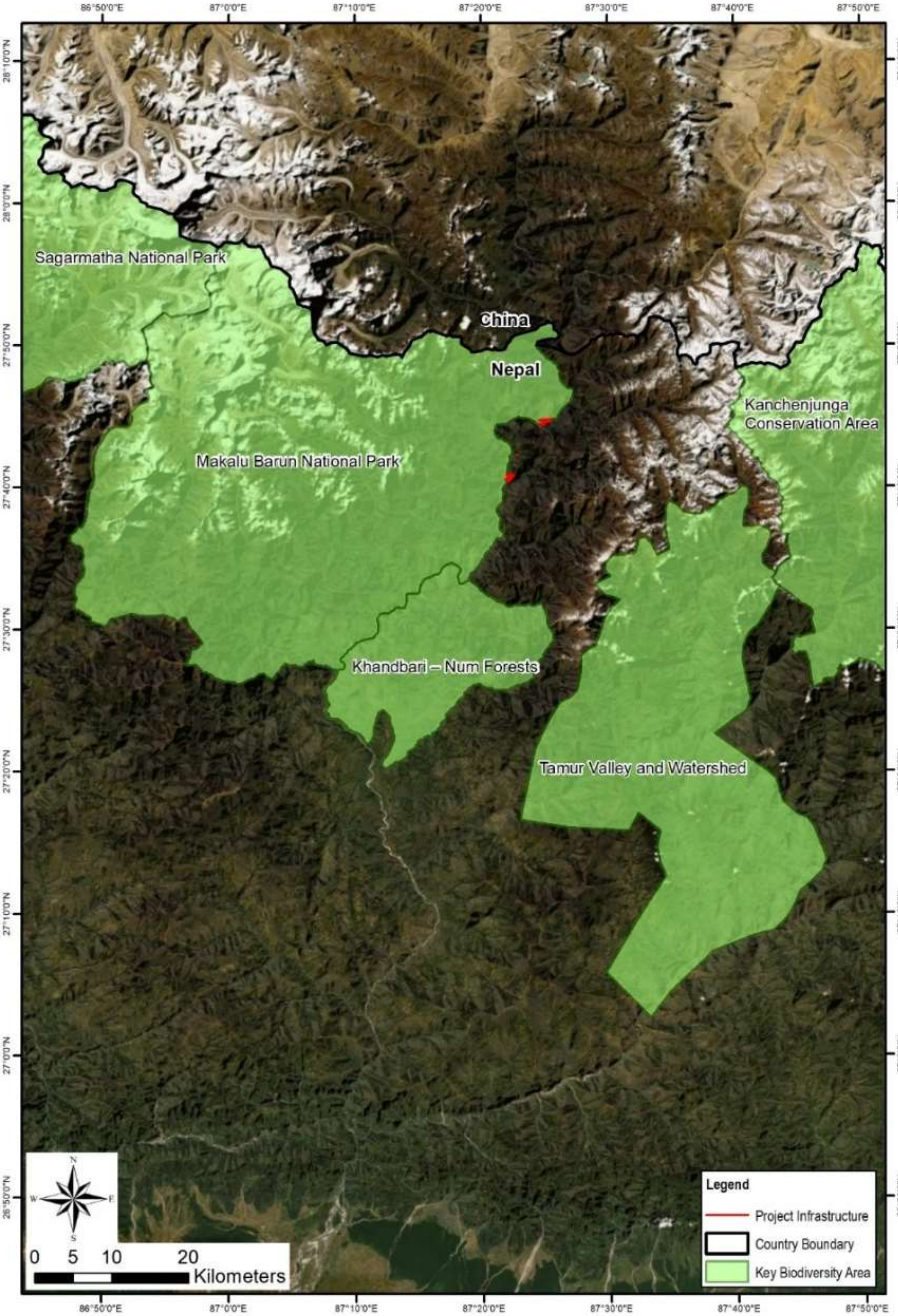
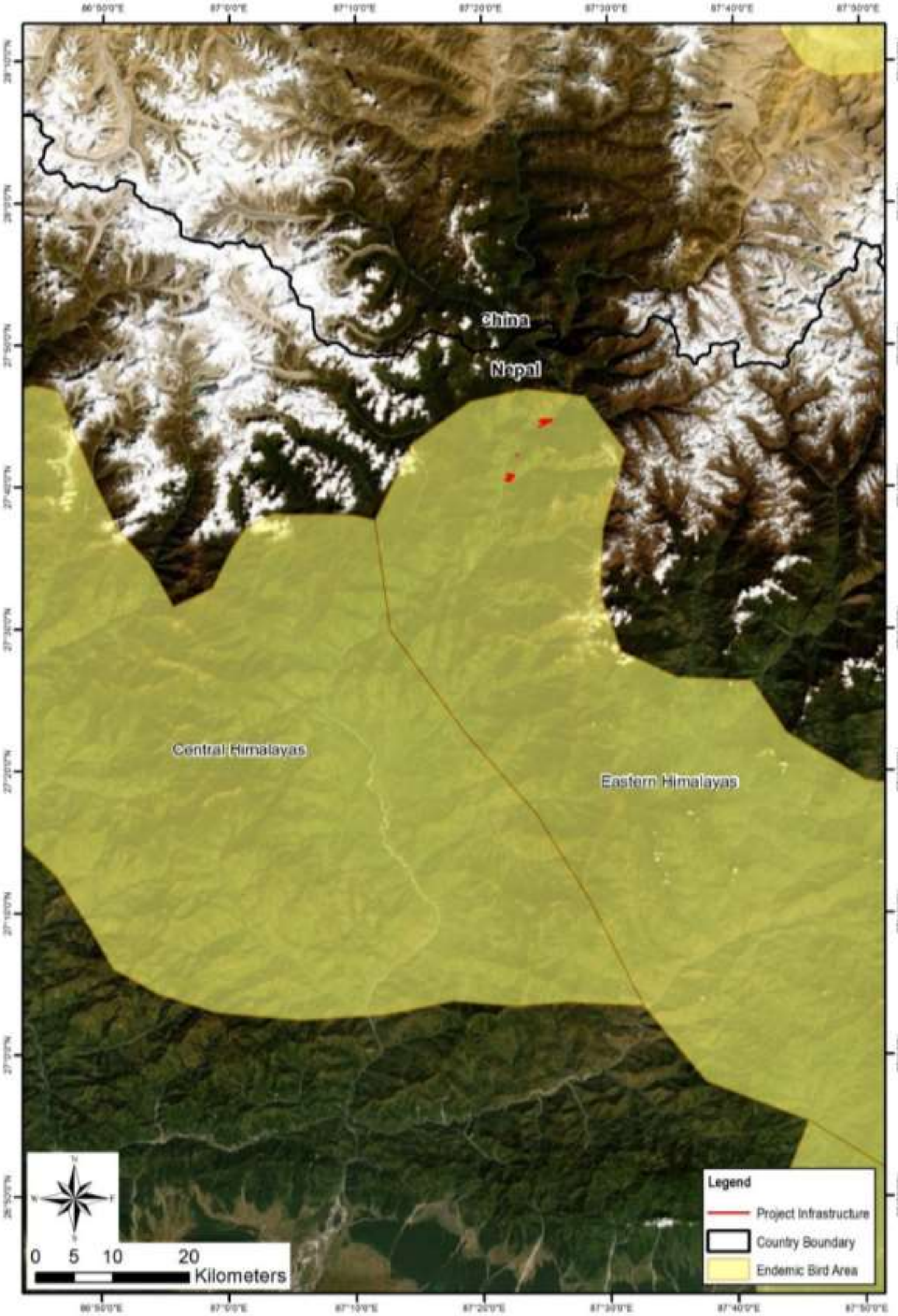


Figure 6.28: EBAs within 50 km of the Project



World Heritage Sites

World Heritage Sites are sites that are selected by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as having cultural, historic, scientific or other form of significance. These areas are legally protected by international treaties and demarcated by UNESCO as protected zones. This allows for practical conservation of areas that would otherwise be subjected to threats such as uncontrolled and unrestricted access, and associated activities such as poaching and illegal logging. The nearest World Heritage Site to the Project is the Sagarmatha National Park, about 45 km west of the Project (***Figure 6.27****)*. The Qomolangma National Nature Reserve, which lies approximately 10 km north of the UAHEP site and encompasses much of the drainage area to the Upper Arun River, is a UNESCO Man and the Biosphere Reserve (***Figure 6.27***).

Ramsar Wetlands

The International Convention of Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for the conservation and use of wetlands and their resources (Ramsar 2014). Nepal has 10 Ramsar wetlands, however, none are within 50 km of the project impact area. The Koshi Tappu Ramsar wetland (located 120 km downstream from the Arun River along the Sapta Koshi River, at an elevation between 75 and 81 m) is the only Ramsar wetland with a hydrological connection to the Project. Although water from the Upper Arun will flow through the Koshi Tappu Ramsar wetland, the Project will have no effect on the hydrology or water quality at this site (see Section 7.1 – Impacts on Physical Environment).

Natura 2000 and Emerald Network Sites

The EIB Standard 3 on Biodiversity and Ecosystems includes Natura 2000 network sites and potential Natura 2000 sites and the Emerald Network of Areas of Conservation Interest as internationally recognized areas for biodiversity conservation. There are no officially adopted or potential/nominated Natura 2000 or Emerald Network sites in Nepal, so the Project will have no effect on any of these sites.

Terrestrial Ecologically Appropriate Area of Analysis

This section defines the Ecologically Appropriate Area of Analysis (EAAA), scoping assessment for species values subject to further analysis, outlines the results of the land class assessment as well as the natural habitat and modified habitat assessment. It also provides information on the terrestrial baseline survey results for flora and fauna values.

Key factors that assist in delineating a Terrestrial EAAA include presence of natural barriers (e.g., mountain ranges), presence of conservation significant species, and anthropogenic influences. For wide-ranging species (such as vultures and migrating birds), areas of aggregation or known migration corridors can be used to assist in defining the EAAA. For this assessment, the species considered when developing the Terrestrial EAAA were defined into major species groups, including: terrestrial mammals, herpetofauna, and resident/migratory birds. A review of the available desktop data did not identify any terrestrial endemic/restricted range species that would influence the delineation of the EAAA. Several endemic plants are found within the Makalu Barun National Park, which is included within the EAAA.

For terrestrial mammals, herpetofauna, and resident birds, the species likely present within the project impact area are associated with a mix of natural and modified habitats below 4,000 m elevation. Generally, these species are associated with steep tree lined slopes, scree, and areas modified for farming. This elevation level was chosen for the assessment, as it is indicative of the treeline elevation that varies between 3,500 and 4,200 m within eastern Nepal. The ecotone of the treeline represents the upper limit of habitat available to forest dwelling species in the project impact area.

For migratory birds, definition of the EAAA included consideration of important habitats associated with breeding and foraging, as well as known migratory pathways along the Arun River Valley. The 4,000 m elevation boundary was also used to define the EAAA for migratory birds that generally roost below the treeline. Birds of prey (eagles) and scavengers (vultures/griffons) are known to occur at elevations of up to 4,500 m in eastern Nepal; however, most individuals of these species forage at lower levels. Flight behavior, including foraging and transit during migratory periods, does occur within the airspace, which is likely to coincide with valley floors and slopes below 4,000 m elevation. ***Figure 6.29*** shows the Terrestrial EAAA for the Project.

Terrestrial Species of Conservation Significance

The Integrated Biodiversity Assessment Tool (IBAT)[13] was used to determine the potential presence of species of conservation significance that may occur in EAAA and the surrounding area. For the purposes of this assessment, species of conservation significance refers to critical habitat candidate species and species associated with natural habitat values. These species can be defined as:

- Critically Endangered, Endangered and Vulnerable species listed on the global IUCN Red List of Species
- Critically Endangered and Endangered species listed on Nepal's National Red List for birds (released in 2016), and mammals (released in 2012)
- Species considered to be endemic/restricted range (as defined by World Bank ESS 6 and IFC PS6)
- Species considered to be migratory and/or congregatory (as defined by World Bank ESS 6 and IFC PS6).

Table 6.19 lists terrestrial species of conservation significance that are potentially present within the EAAA based on the IBAT search results. They include five Critically Endangered, eight Endangered, 18 Vulnerable, and two Restricted Range species as designated on the IUCN Red List of Threatened Species (IUCN 2019). Twelve migratory species have been identified from literature reviews.

The IBAT list does not include the seven endemic plants referenced above as found in MBNP. These seven plant species are included in the Critical Habitat Assessment (see Section 6.2.3).

Figure 6.29: Terrestrial EAAA for the Project

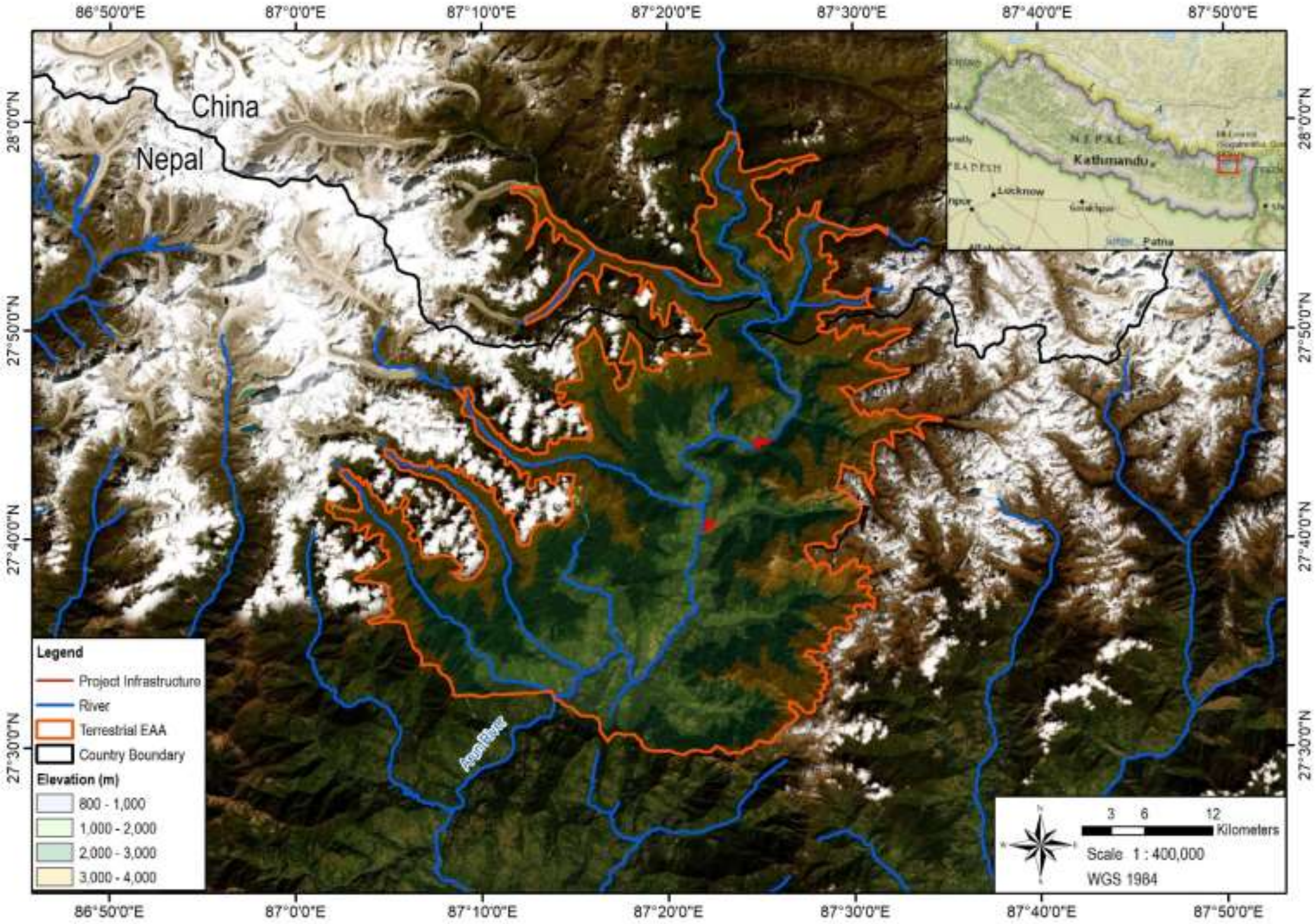


Table 6.19: Terrestrial Species of Conservation Significance (IBAT Screening Results)

S/N	Class	Scientific Name	Common Name	Migratory	Endemic/Restricted Range	IUCN Red List Status	National Red List Status[1]	CITES[2]
10.	Birds	*Aythya baeri*	Baer's pochard	Yes	No	CR	CR	-
11.	Birds	*Gyps bengalensis*	White-rumped vulture	No	No	CR	CR	II
12.	Birds	*Gyps tenuirostris*	Slender-billed vulture	No	No	CR	CR	II
13.	Birds	*Sarcogyps calvus*	Red-headed vulture	No	No	CR	EN	II
14.	Birds	*Aquila nipalensis*	Steppe eagle	Yes	No	EN	VU	II
15.	Birds	*Falco cherrug*	Saker falcon	Yes	No	EN	EN	II
16.	Birds	*Haliaeetus leucoryphus*	Pallas's fish-eagle	Yes	No	EN	CR	II
17.	Birds	*Acanthoptila nipalensis*	Spiny babbler	No	No	LC	LC	-
18.	Birds	*Geokichla wardii*	Pied thrush	Yes	Yes	LC	LC	-
19.	Birds	*Antigone antigone*	Sarus crane	Yes	No	VU	VU	II
20.	Birds	*Aquila heliaca*	Eastern imperial eagle	Yes	No	VU	CR	I
21.	Birds	*Aythya ferina*	Common pochard	Yes	No	VU	NT	-
22.	Birds	*Gallinago nemoricola*	Wood snipe	Yes	No	VU	VU	-
23.	Birds	*Grus nigricollis*	Black-necked crane	Yes	No	VU	DD	I
24.	Birds	*Leptoptilos javanicus*	Lesser adjutant	Yes	No	VU	VU	-
25.	Birds	*Mulleripicus pulverulentus*	Great slaty woodpecker	No	No	VU	EN	-
26.	Mammals	*Manis pentadactyla*	Chinese pangolin	No	No	CR	EN	I
27.	Mammals	*Ailurus fulgens*	Himalayan red panda	No	No	EN	EN	I
28.	Mammals	*Cuon alpinus*	Dhole	No	No	EN	EN	II

S/N	Class	Scientific Name	Common Name	Migratory	Endemic/Restricted Range	IUCN Red List Status	National Red List Status[1]	CITES[2]
29.	Mammals	*Moschus chrysogaster*	Alpine musk deer	No	No	EN	EN	I/II/NC
30.	Mammals	*Moschus fuscus*	Black musk deer	No	No	EN	DD	I/II
31.	Mammals	*Moschus leucogaster*	Himalayan musk deer	No	No	EN	DD	I
32.	Mammals	*Aonyx cinereus*	Asian small-clawed otter	No	No	VU	DD	II
33.	Mammals	*Arctictis binturong*	Binturong	No	No	VU	DD	III
34.	Mammals	*Myotis sicarius*	Mandelli's mouse-eared myotis	No	No	VU	VU	-
35.	Mammals	*Neofelis nebulosa*	Clouded leopard	No	No	VU	EN	I
36.	Mammals	*Panthera pardus*	Leopard	No	No	VU	VU	I
37.	Mammals	*Panthera uncia*	Snow leopard	Yes	No	VU	EN	-
38.	Mammals	*Rusa unicolor*	Sambar	No	Yes	VU	VU	-
39.	Mammals	*Ursus thibetanus*	Himalayan black bear	No	No	VU	EN	I
40.	Reptiles	*Crocodylus palustris*	Mugger	No	No	VU	-	I
41.	Reptiles	*Python bivittatus*	Burmese python	No	No	VU	-	II
42.	Flowering Plants	*Anacyclus pyrethrum*	Atlas daisy	No	No	VU	-	-

Notes: LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered; DD = Data Deficient; NT = Not listed; P = Protected

[1] The status of Nepal's Birds: The national red list series (2016); The Status of Nepal's Mammals: The National Red List Series Nepal Red List (2012)

[2] Convention on International Trade in Endangered Species of Wild Fauna and Flora:

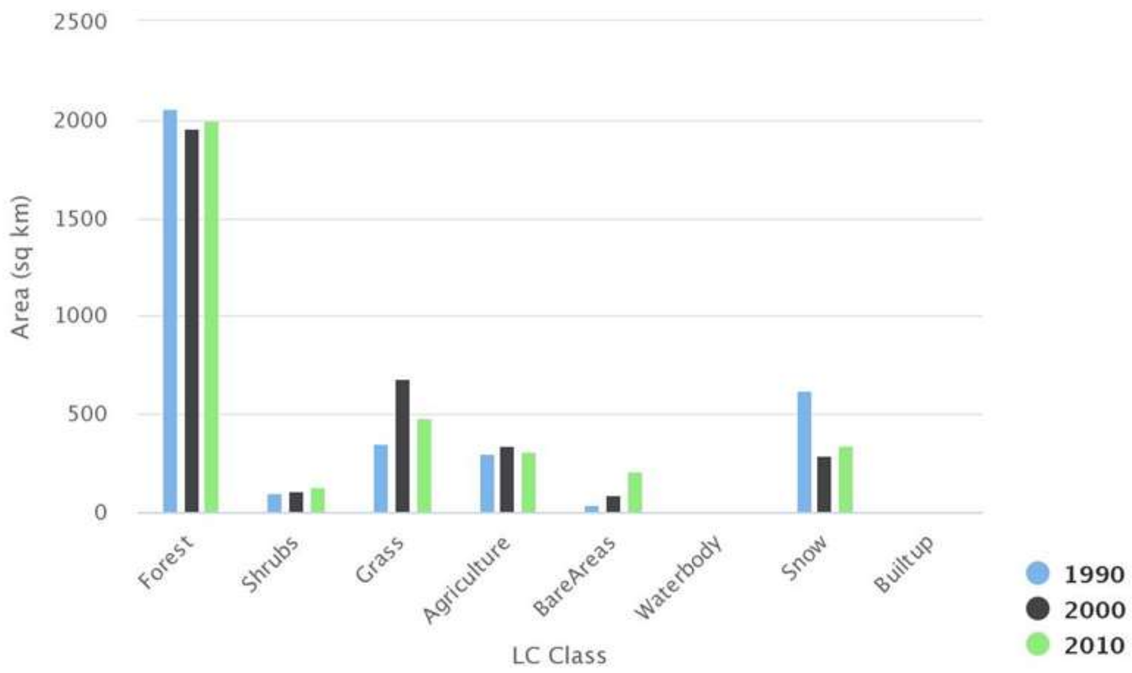
- CITES Appendix I includes species threatened with extinction; trade in specimens of these species is permitted only in exceptional circumstances.
- CITES Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled to avoid utilization incompatible with their survival.
- CITES Appendix III contains species that are protected in at least one country, which has asked other CITES parties for assistance in controlling the trade.

Land Use/Cover Assessment

Several land use/cover classifications have been developed in Nepal. Among the most recent classifications, the 2015 Land Use Policy (Ministry of Land Reform and Management 2015) classified all of Nepal into 11 land use zones, while a recent analysis by the Ministry of Forests and Environment (MoFE 2019) employed seven classes. No regional level analyses are available from these studies.

One source of district-level statistics is the *Land Cover Dynamics in Nepal* (ICIMOD n.d.). It contains data for eight land use classes in three consecutive decades (1990, 2000, and 2010). Data retrieved for the Sankhuwasabha District where the Project site is located is shown in ***Figure 6.30***. The majority of the district consists of forests, with grasslands and agricultural areas also covering sizeable areas. The relative proportions of most land use classes has, for the most part, not changed significantly over the period from 1990 through 2010, although the area under snow has halved and the area of bare ground has correspondingly increased. The area of grassland declined between 2000 and 2010, which likely reflects enforcement of the prohibition on grazing within MBNP and a concomitant increase in shrub and forest land.

Figure 6.30: Land Cover Distribution for Sankhuwasabha



Land Cover Classes

Remote sensing techniques and field investigations were used to identify, describe, and map land cover classes within the Terrestrial EAAA. Land classes included agriculture, forest, water, barren ground, developed land, and grassland. Land classes are described in ***Table 6.20*** showing the distribution of land classes within the EAAA and the DIA. The land classes are illustrated in ***Figure 6.31*** and ***Figure 6.312***. Please note that there is no snow/glacier land cover within the DIA as shown on ***Figure 6.32***.

Table 6.20: Land Class Descriptions and Areas

S/N	Land Class	Description	EAAA Land Cover (ha)	Direct Impact Area Land Cover (ha)
1.	Agriculture	Agriculture areas are typically dominated by cultivated species; however, non-cultivated species also may be present including small trees, herbaceous plants, shrubs, and grasses. These areas are often subject to light grazing and agricultural management. Terrace cropping is common. Agriculture areas are common throughout the EAAA.	8,210	1,486
2.	Bare (rock/scree)	Rock/scree consists of exposed rock and areas that are subject to landslide or intensive agriculture where no vegetation is present. Steep ravines and escarpments prevent vegetation from growing and result in the exposure of rock. Scree includes mounds and masses of small loose stones that cover a slope on a mountain. Bare rock and scree areas are scattered throughout the EAAA.	36,941	150
3.	Forest	Forests are dense areas with a high diversity of tree species. Herbaceous, shrubs and grasses also exist in the forests. This land class is the most common throughout the EAAA. Forests exists at lowland and highland areas up to elevations of between 3,500 and 4,200 asl	73,455	4,908
4.	Grassland	Grassland areas include forested areas cleared of tree cover and alpine treeless meadows below the snowline.	8,300	61
5.	Waterbody (rivers, streams, and lakes)	The Arun River runs throughout the EAAA. Several smaller tributaries feed into the Arun River. The Arun River is fast flowing and runs for several hundred kilometers.	2,525	92
6.	Snow/glacier	Glacial areas, snow and ice are located in the higher elevations of the EAAA.	1077	0
7.	Built-up (villages, roads, and trails)	Small-scale human settlements exist throughout the EAAA. These settlements have low human population density and are scattered throughout the EAAA. The presence of the settlements impacts the surrounding native biodiversity through hunting, vegetation clearing, and the introduction of predators (e.g., dogs).	308	19
	Total		130,816	6,723

Figure 6.31: Land Classes within the Terrestrial EAAA

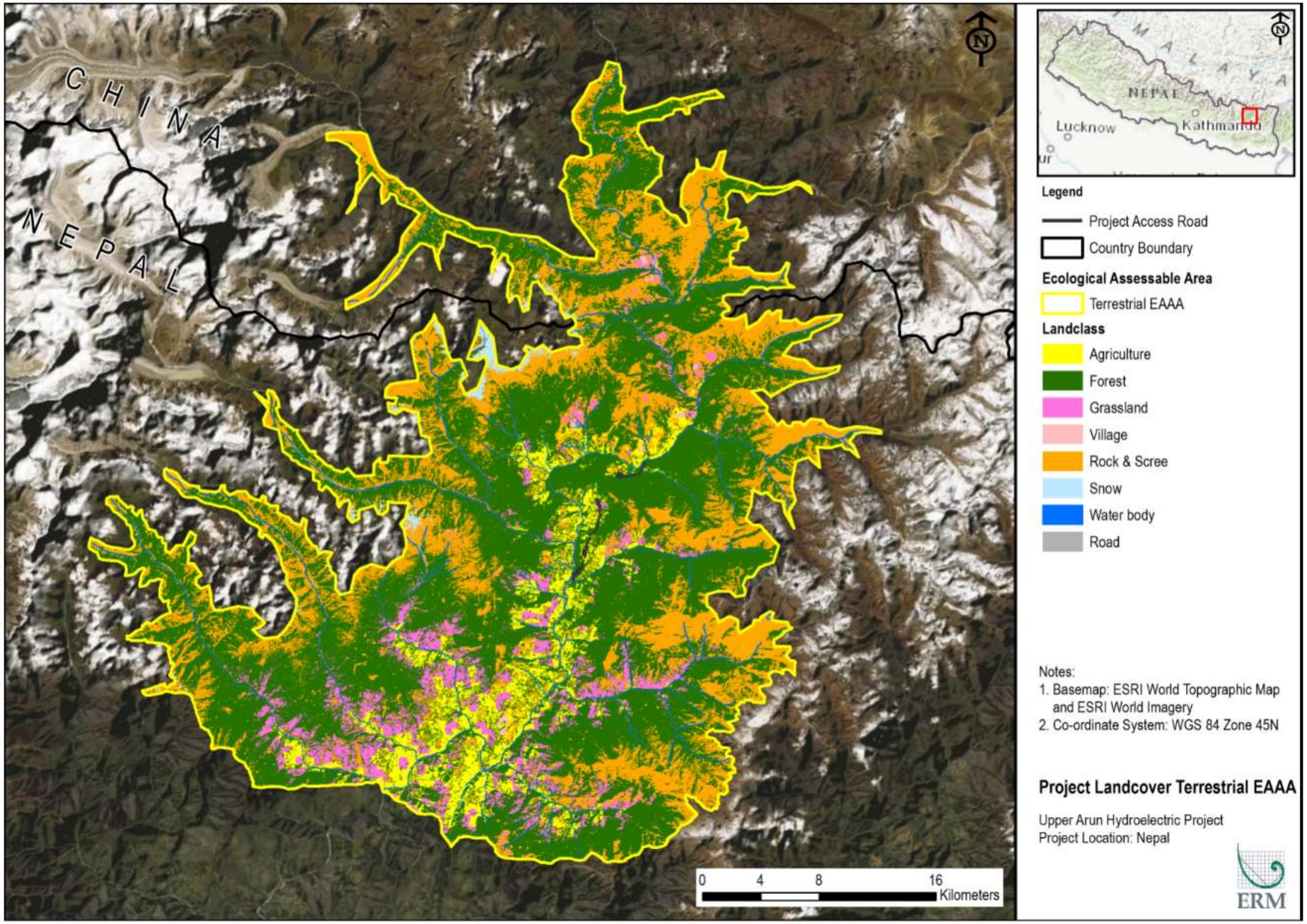
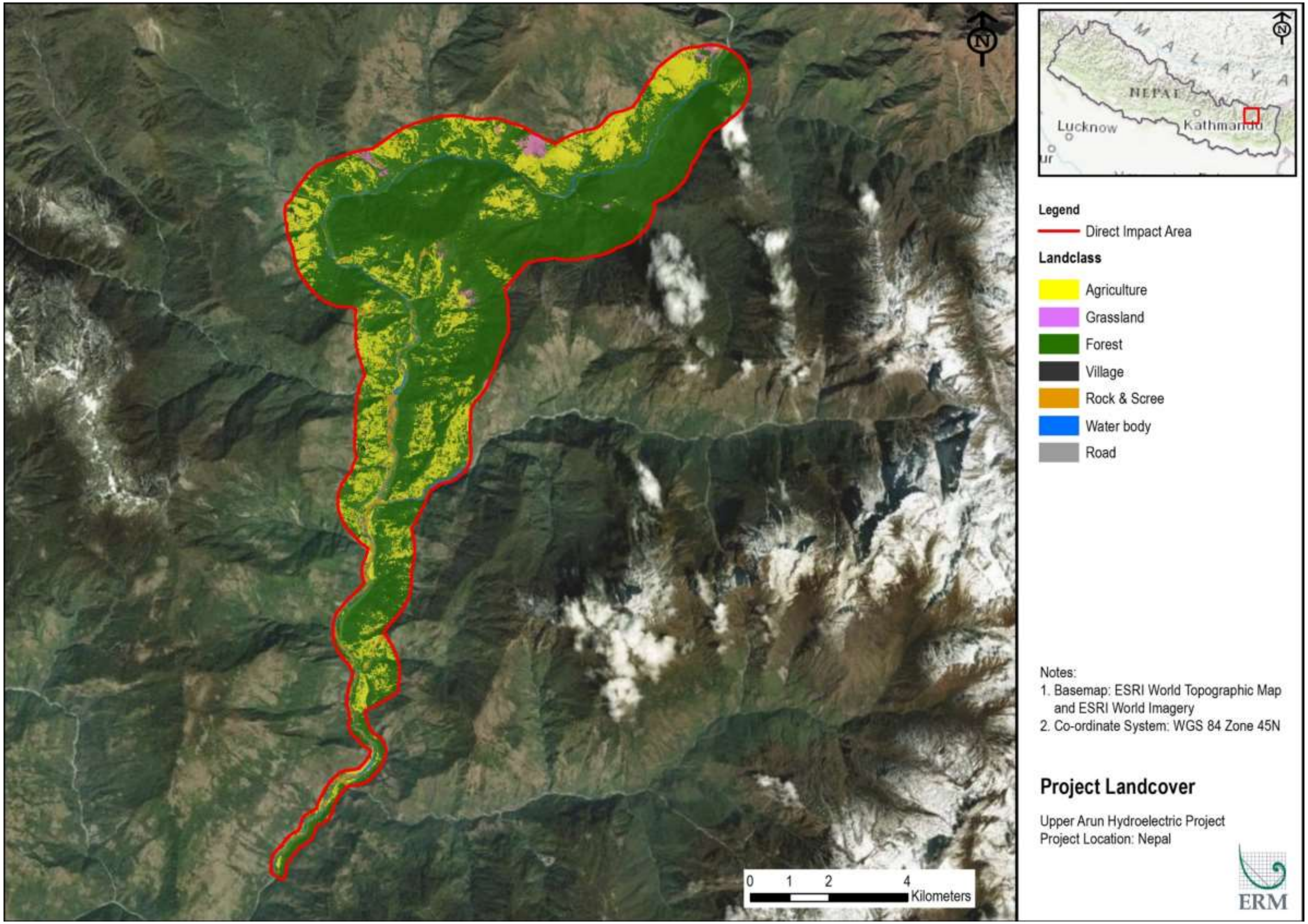


Figure 6.32: Land Class Areas within the Direct Impact Area



Terrestrial Natural and Modified Habitat Assessment

World Bank ESF ESS 6 and IFC PS 6 guidance requires the assessment of the distribution of Natural Habitat and Modified Habitat to identify risks and mitigations to biodiversity values during the impact assessment phase of an action or development. There is currently no methodology within IFC PS6 and the associated Guidance Note on the approach to assess the distribution of these habitat types.

Habitats have been classified based on the understanding of the land classes in the EAAA and the associated species assemblages within each. Each land class has been assigned a habitat classification according to the definitions of WB ESF ESS 6. The justification for the classification is shown in ***Table 6.21***. The areas of natural habitat and modified habitat within the EAAA are summarized in ***Table 6.22*** and depicted in ***Figure 6.33*** for the Terrestrial EAAA and ***Figure 6.34*** for the Project DIA.

Table 6.21: Land Class-IFC PS6 Habitat Assessment

Land Class	WB ESF ESS 6 Habitat Classification	Justification
Agriculture	Modified	Agriculture areas are considered to be modified habitat. Human use has substantially modified the condition of the habitat.
Forest	Natural	The forests in the EAAA are naturally occurring and have been subject to minimal human impacts. Therefore, the forests are considered natural habitat.
Grassland	Mix Natural/Modified	Grasslands are a mix of natural and modified habitats. These areas have been modified by humans at lower elevations where the tree canopy has been removed. At higher elevations, these areas consist of alpine meadows which is considered natural habitat.
Waterbodies	Natural	The rivers and waterbodies are considered natural. These areas have formed naturally and have been subject to minimal human impacts.
Bare (rock/scree)	Natural/Modified	Rock/scree areas are considered to be natural habitat. Although there is a lack of vegetation, these areas are naturally occurring and caused by natural geological processes. However, cleared areas are considered to be modified habitat and consist of the majority of barren areas identified.
Built-up (villages, roads, and trails)	Modified	Settlement areas are considered modified habitat. Human use has substantially modified the condition of the settlement areas.
Snow/glacier	Natural	Snow/glacier is considered to be natural habitat. This area consists of glaciers and snow-covered mountains. The habitat is considered not to have been modified by humans.

Table 6.22: Areas of Natural and Modified Habitat

Habitat Type	EAAA (ha)	Direct Impact Area (ha)
Natural habitat	8,518	5,000
Modified habitat	122,298	1,723
Total	**130,816**	**6,723**

The right bank of the Arun River in the EAAA has good coverage of dense forest, while along the left bank of the river, particularly around the proposed power house and project access road, the dense forest cover is replaced by shrub vegetation, agricultural land, and settlements. The conservation value of the right bank of the Arun River, which is part of the MBNP, is greater than the left bank at the project site. However, encroachment into the dense forest areas upslope and downslope of the settlements has occurred on both sides of the Arun River, diminishing the biodiversity value of the forest. Specifically, dense forest cover has been reduced at lower elevations on the right bank near the villages of Chyamtan, Lingam, Chepuwa, Gimbar, Hongon, Thanthumbuk, Hatiya, Sembung, Barun Bazar, Syaksila, and Gola, and on the left bank around the villages of Rukma, Namase, and Sibrun.

Figure 6.33: Distribution of Modified and Natural Habitat with the Terrestrial EAAA

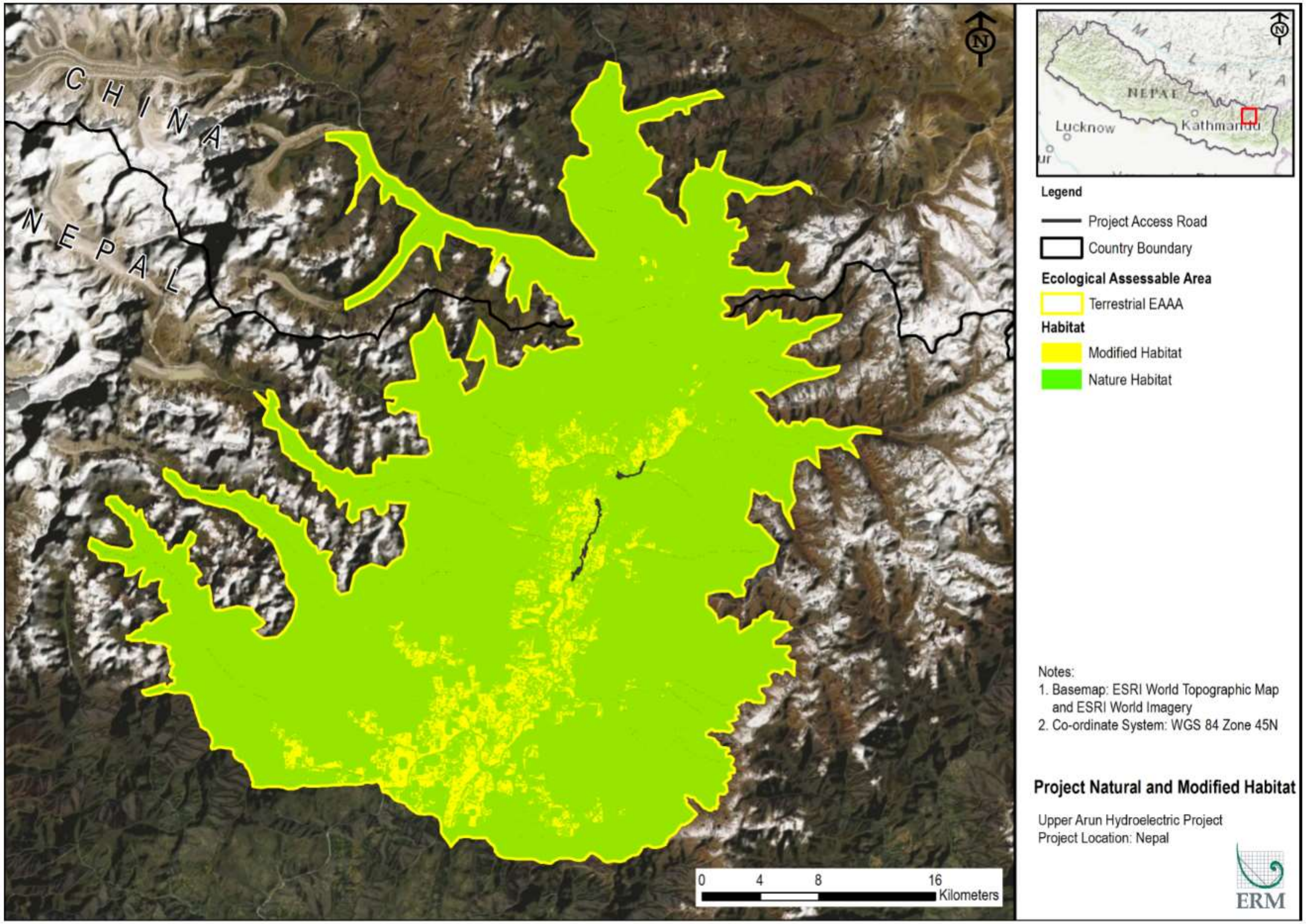
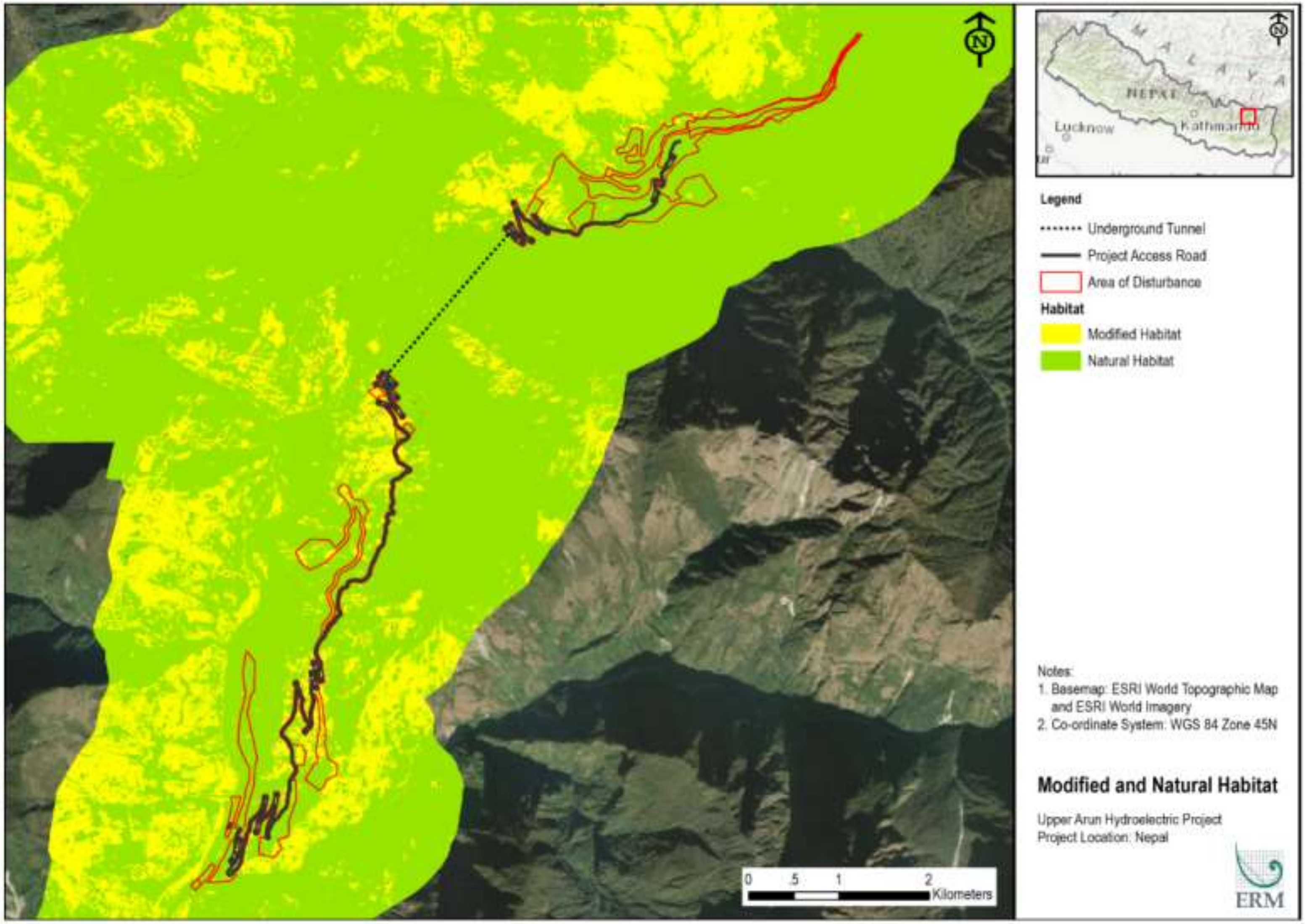


Figure 6.34: Distribution of Modified and Natural Habitat within the Direct Impact Area



Direct Impact Area – Flora

This section describes the forest communities and ownership, agricultural habitats, flora species of conservation significance, flora species of ethnological importance, and invasive species found in the DIA.

Forest Habitats

The forest of eastern Nepal is categorized into eight broad types (Stainton 1972). ***Table 6.23*** describes these forest types. The DIA encompasses areas with elevations between 1,000 and 3,000 m.

Table 6.23: Forest Types within Eastern Nepal

Forest Type	Elevation	Flora Species and Distribution
Tropical forest	<1,000 m	*Shorea robusta (Sal), Terminalia* spp., *Adina cordifolia, Lagerstroemia parviflora, Bombax ceiba and Albizzia* spp., are the main tree species in these forests. *Acacia catechu, Dalbergia sissoo*, and *Bombax ceiba* are common in riverine forests.
Sub-tropical broadleaved forest	1,000–2,000 m	*Schima wallichii/Castanopsis indica* forests are found in central and eastern Nepal. *Pinus roxburghii* forests occur particularly on the south-facing slopes.
Sub-tropical pine forest	1,000–2,200 m	This forest type is predominantly composed of *Shorea robusta* in the southern parts of Nepal. *Acacia catechu/Dalbergia sissoo* forests replace *Shorea robusta* forests along streams and rivers.
Upper temperate broadleaved forest	2,200–3,000 m	*Quercus semecarpifolia* forests are widespread in central and eastern Nepal on south-facing slopes.
Upper temperate mixed broadleaved forest	2,500–3,500 m	This forest type occurs in central and eastern Nepal, mainly on north and west-facing slopes. Acer and Rhododendron are prominent species.
Temperate coniferous forest	2,000–3,000 m	*Pinus wallichiana, Cedrus deodara, Cupressus torulosa, Tsuga dumosa* and *Abies pindrow* forests characterize the temperate conifer forest type.
Sub-alpine forest	3,000–4,100 m	*Abies spectabilis, Betula utilis*, and *Rhododendron* forests occur in subalpine zones, the latter in very wet sites.
Alpine scrub	above 4,100 m	Juniper-Rhododendron associations include *Juniperus recurva, J. indica, J. communis, Rhododendron anthopogon*, and *R. lepidotum* associated with *Ephedra gerardiana*, and *Hippophae tibetana* in inner valleys.

Source: Stainton, J. 1972. *Forests of Nepal*. London: John Murray.

The field surveys identified four distinct forest communities in the DIA (***Table 6.24***). Note that Stainton (1972) classifications are in brackets:

- *Alnus-schima* mixed forest (sub-tropical broadleaved forest)
- *Lyonia-rhododendron* forest (upper temperate mixed broadleaved forest),
- *Alnus-pinus* forest (temperate coniferous forest)
- *Alnus-castonopsis-lyonia* mixed forest (sub-alpine forest)

Table 6.24: Forest Communities in the Direct Impact Area

Name of Forest	Dominant tree species	Associated tree species	Associated shrubs/herbs
Alnus-schima mixed forest	*Alnus nepalensis, Schima walichii, Macaranga indica, Erythrina stricta*	*Rhus javanica, Sapium baccutum, Ficus hipsida, Bahunia varrigeta, Engelhardia spicata, Pinus roxburghii, Albizia procera, Querus glauca, Choerospondias axillaris, Toona cilata, Terminalia myriocarpa, Sapium insigne, Lindera nessiana, Cinamomum tamala, Cassia fistula, Syzgium cumuni, Ficus nerifolia, Prunus ceracoides, Ficus semicordata, Bombax ceiba*	*Artemesia indica, Rubus ellipticus, Bidens pilosa, Sida acuta, Dioscorea sp., Oxalis latifolia, Ageratina adenophora, Lantana camara, Nephrolepis cordifolia, Amomum sublatum, Zanthoxylum armatum, Desmodium trifolium, Maesa chisia, Datura sp., Urtica diocia, Peranema cyatheoides, Sonchus arvensis, Thysanolaena maxima Aconogonum molle, Persicaria capitalata, Inula cappa Rumex nepalensis, Elephantopus scaber, Conyza sp., Diplanzium esculentum, Elsholtzia sp., Euphorbia sp., Cyperus roduntus, Rubus nepalensis,Curculigo sp., Cynodon dactylon, Arundinaria falcata, Lycopodium clavatum, Phyllanthus urinaria, Dryopteris intermedia, Rosa sp.*
Lyonia-rhododendron forest	*Lyonia ovalivolia, Rhododendron arboretum, Engelhardia spicata, Pinus roxburghii*	*Callicarpa arboreum, Eurrya accuminata, Zizyphus spinosa, Myrisine capitilleta, Leucosceptrum canum, Alnus nepalensis, Ficus nerifolia, Rhus javanica, Debregeasia salcifolia, Michelia champaca, Betula alnoides, Prunus ceracoides, Rhododendron barbatum*	*Artemesia indica, Aconogonum molle, Sida acuta, Datura sp., Urtica diocia, Maesa chisia, Curculigo sp., Cyperus roduntus Rubus ellipticus, Rubus nepalensis, Arundinaria sp., Dryopteris sp. Aster sp., Hypericum uralum, Dendrobium densiflorium, Fragaria nubicola, Boehmeria rugulosa, Desmodium trifolium, Eleagnus latifolia, Anaphalis sp., Swrtia spp.*
Alnus-pinus forest	*Alnus nepalensis, Pinus wallichiana, Rhododendron sp., Betula alnoides*	*Rhus javanica, Prunus ceracoides, Debregesis salicifolia, Rhus wallichii, Myrisine capitellata, Michelia sp., Eriobtrya elliptica, Eurrya acuminate, Ficus sp., Sarauria nepalensis, Quercus lamellosa, Zizyphussp., Lindera, nessiana, Leucosceptrum canum, Betula alnoides, Rhus javanica, Lyonia ovalifolia*	*Vibrunum spp., Osbekia stellata, Berberis aristata, Maesa chisia Arundinaria spp., Eleagnus latifolia, Rubus ellipticus, Rubus nepalensis Melostomia sp., Urtica diocia, Artimesia indica, Dryopteris sp., Dioscorea sp. Cyperus sp., Viscus album, Astible rivularis, Boehmeria platyphylla, Aconogonum molle, Persicaria sp., Evodia fraxinifolia, Prunella vulgaris, Trifolium ripens, Hadera nepalensis, Oxyspora paniculata, Paris polyphylla*
Alnus-castonopsis-lyonia mixed forest	*Alnus nepalensis, Castonopsis tribuloides, Lyonia ovalifolia, Rhododendrum spp*.	*Eurrya accuminata, Prunus ceracoides, Rhus javanica, Rhus wallichii, Debregeasia salicifolia, Toona ciliata, Sarauria nepalensis, Myrisine spp., Albizia sp., Eriobtrya elliptica, Eurrya accuminata, Leucosceptrum canum, Qurcus glauca, Quercus lamellosa, Quercus lanata, Ficus spp., Daphinophyllum himalayanse, Macaranga indica, Pinus spp., Michelia spp., Rhododendron spp., Persica dutheii, Evodia fraxinifolia, Sapium insigne*	*Hypericum uralum, Vibrunum spp., Elaeagnus latifolia, Oxyspora paniculata, Arundinaria sp., Rubus ellipticus, Artemesis indica, Rubus nepalensis, Melostamia sp, Osbekia stellata, Solanum xanthocarpum, Boehmeria spp., Cyperus rodontus, Desmodium trfolium, Trifolium repens, Oxalis corniculata, Swertia spp, Astible rivularis, Paris polyphylla Zanthoxylum armatum, Curciligo sp., Mimosa rubicaulis, Heracleum sp.*

Forest Ownership

There are several types of forest ownership in Nepal including public forest, which include government, community, leasehold, and religious forests; and private forests. No leasehold, religious, or private forests were identified within the DIA. Government and Community Forests are described below.

Government Forests

Government Forests are owned and managed by the Department of Forests within the Ministry of Forests and Environment. The main objectives of Government Forests are to enhance biodiversity and to increase the development of forest related enterprises to counter poverty in rural areas of Nepal. In the DIA, all public forest that is not community forest is considered government forest.

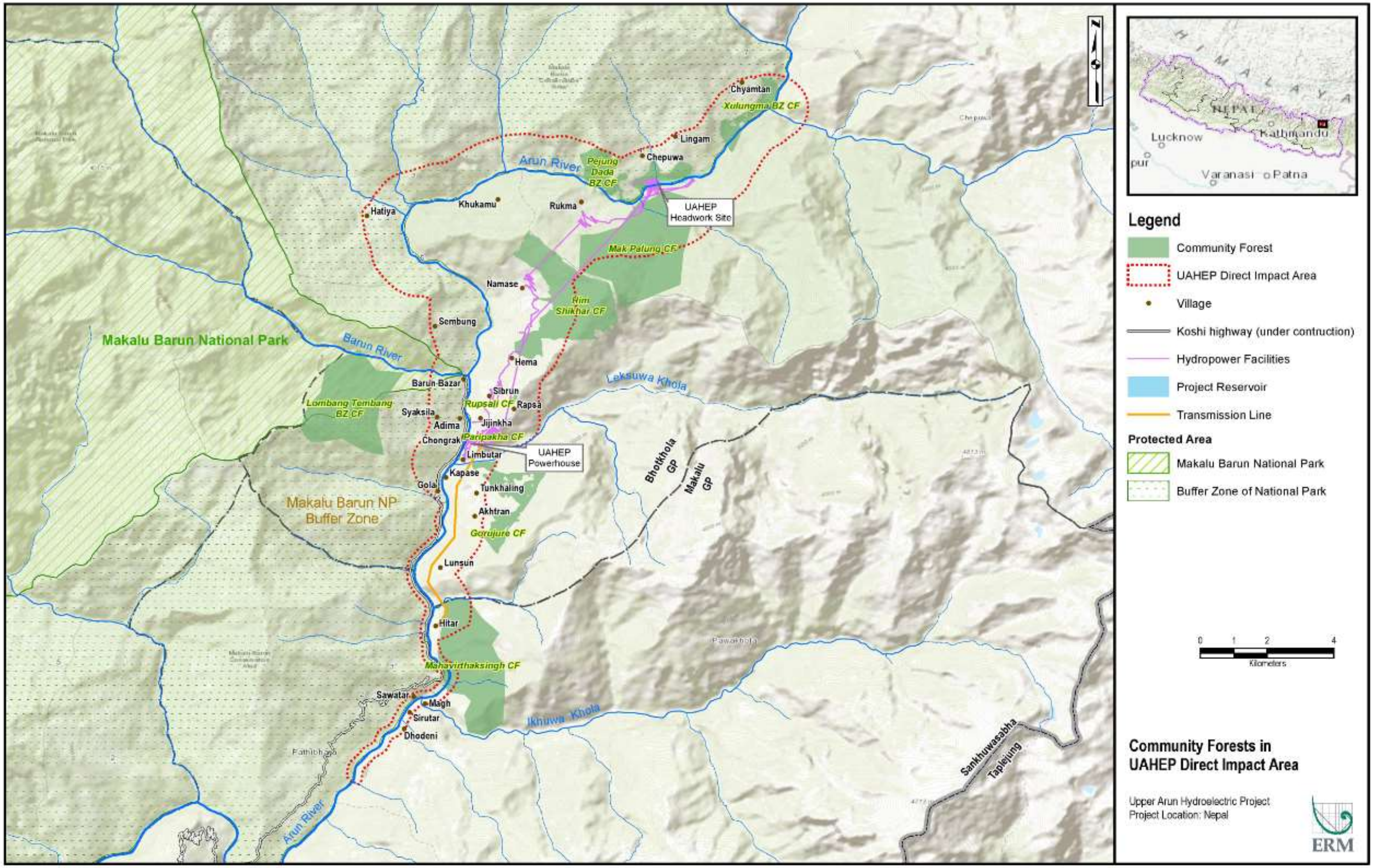
Community Forests

Community Forests are designated through a community participatory forest management system, which was developed in Nepal in the 1970s. Community Forests aim to provide social benefits to local residences, while providing biodiversity benefits to the management area. Local residents are able to utilize resources from the forest, which can provide important economic and social benefits to local communities. The field surveys identified eight Community Forests within the DIA (***Table 6.24*** and ***Figure 6.35***).

Table 6.25 Community Forests in the Direct Impact Area

Community Forest	Year Established	Area (ha)	Forest Uses	NTFP Species
Xulungma	1999	90	Fodder, timber, fuelwood, wild vegetables, forage, medicine	*Swerita sp., Paris sp., Astible sp., Urtica sp., Arundinaria sp.*
Pejung Danda	2002	495	Fodder, timber, fuelwood, wild vegetables, medicinal plants	*Cinamomum sp., Amomum sp., Urtica sp., Dryopteris sp., Acorus sp., Aconogonum sp., Arundinaria sp., Swerita sp.*
Mak Palung	1997	731	Fodder, timber, fuelwood, wild vegetables, forage, medicine	*Swerita* sp., *Paris* sp., *Astible* sp., *Urtica* sp., *Arundinaria* sp.
Him Shikhar	1996	481	Timber, fodder, fuelwood, NTFPs, medicinal plants, forage, grass	*Daphne sp., Arundinaria sp., Swerita sp.*
Rapsali	1995	3.5	Fodder, fuelwood, NTFPs, forage	*Arundinaria sp., Swerita sp.*
Pari Pakha	2015	3.9	Fodder, timber, fuelwood, wild vegetables, forage, medicine	*Swerita* sp., *Paris* sp., *Astible* sp., *Urtica* sp., *Arundinaria* sp.
Gorujure	1996	312	Timber, fodder, fuelwood, NTFPs, forage,	*Daphne sp., Arundinaria sp., Swerita sp.*
Mahavir Thaksingh Thapla	1996	500	Timber, fodder, fuelwood, forage, grass, agriculture equipment, NTFPs and medicinal plants	*Daphne sp., Arundinaria sp., Swerita sp., Taxus baccata*

Figure 6.35: Community Forests within the Project's Direct Impact Area



Agricultural Flora

The field surveys included an analysis of agricultural lands within the EAAA. Agricultural lands primarily occur around village (***Table 6.26***). A total of 34 agricultural species were documented on agricultural lands within the EAAA.

Table 6.26: Agricultural Plant Species within the EAAA

S/N	Agricultural Species		Village					
	Scientific Name	Common Name	Gola	Hatiya	Lingam	Chyamtan	Chepuwa	Rukma
8.	*Allium cepa*	Onion			X			
9.	*Allium sativum*	Garlic					X	
10.	*Amomum cardamomum*	Cardamom	X					
11.	*Amomum subulatum*	Hill cardamom	X					
12.	*Brassica juneca*	Mustard						X
13.	*Brassica rapa*	Turnip				X	X	
14.	*Castonopsis indica*	Chestnut			X			
15.	*Choerospondias axillaris*	Nepali hog plum				X		
16.	*Citrus aurantium*	Mandarin					X	
17.	*Dolichos sp.*	Hyacinth bean	X	X				
18.	*Elaeocarpus sphaericus*	Bead tree						X
19.	*Eleusine coracana*	Finger millet				X		
20.	*Fagopyrum esculentum*	Buck wheat		X				
21.	*Ficus nerifolia*	Willow leaf fig		X				
22.	*Ficus semicordata*	Drooping fig		X	X			
23.	*Hordeum vulgare)*	Barley	X					
24.	*Juniperus communis*	Juniper		X		X		
25.	*Lens esculenta*	Lentil				X		
26.	*Mangifera indica*	Mango				X		
27.	*Momordica charantia*	Bitter gourd		X				
28.	*Musa paradisiaca*	Banana	X					
29.	*Oryza satva*	Rice						X
30.	*Phaseolus vulgaris*	Common bean		X				
31.	*Prunus persica*	Plum	X					
32.	*Psidium guava*	Guava			X			
33.	*Psium sativum*	Pea					X	
34.	*Pyrus communis*	Pear					X	
35.	*Raphanus sativus*	Radish					X	X

S/N	Agricultural Species		Village					
	Scientific Name	Common Name	Gola	Hatiya	Lingam	Chyamtan	Chepuwa	Rukma
36.	*Saurauia napaulensis*	Bitter-sweet			X			
37.	*Solanum tuberosom*	Potato					X	
38.	*Thysanolaena maxim*	Tiger grass						X
39.	*Triticum aestivum*	Wheat						X
40.	*Vigna unguiculata*	Cow pea	X	X				
41.	*Zea mays*	Maize				X		

Floral Species of Conservation Significance

Of all the flora species identified during field surveys, 15 species are considered conservation significant species because they are (1) protected under Nepali law (8 species), (2) have an IUCN status of vulnerable or higher (1 species), and/or (3) have CITES conservation status (9 species) (***Table 6.27**, **Figure 6.36***). Fourteen of these conservation significant species were considered scarce or rare within the DIA based on field transect surveys, with *Curculigo capitulate* being the only exception, which was considered common.

Three transects (i.e., Lomba Tembang, Tutin, and Paripakha) contained six conservation significant species, which was the greatest of all transects. The Damdama transect contained no conservation significant species. *Swerita chiryta* was identified at the most transects, while four species (*Coelogyne cristata, Taxus wallichiana, Vanda cristata,* and *Pleione praecox)* were only identified along one transect each.

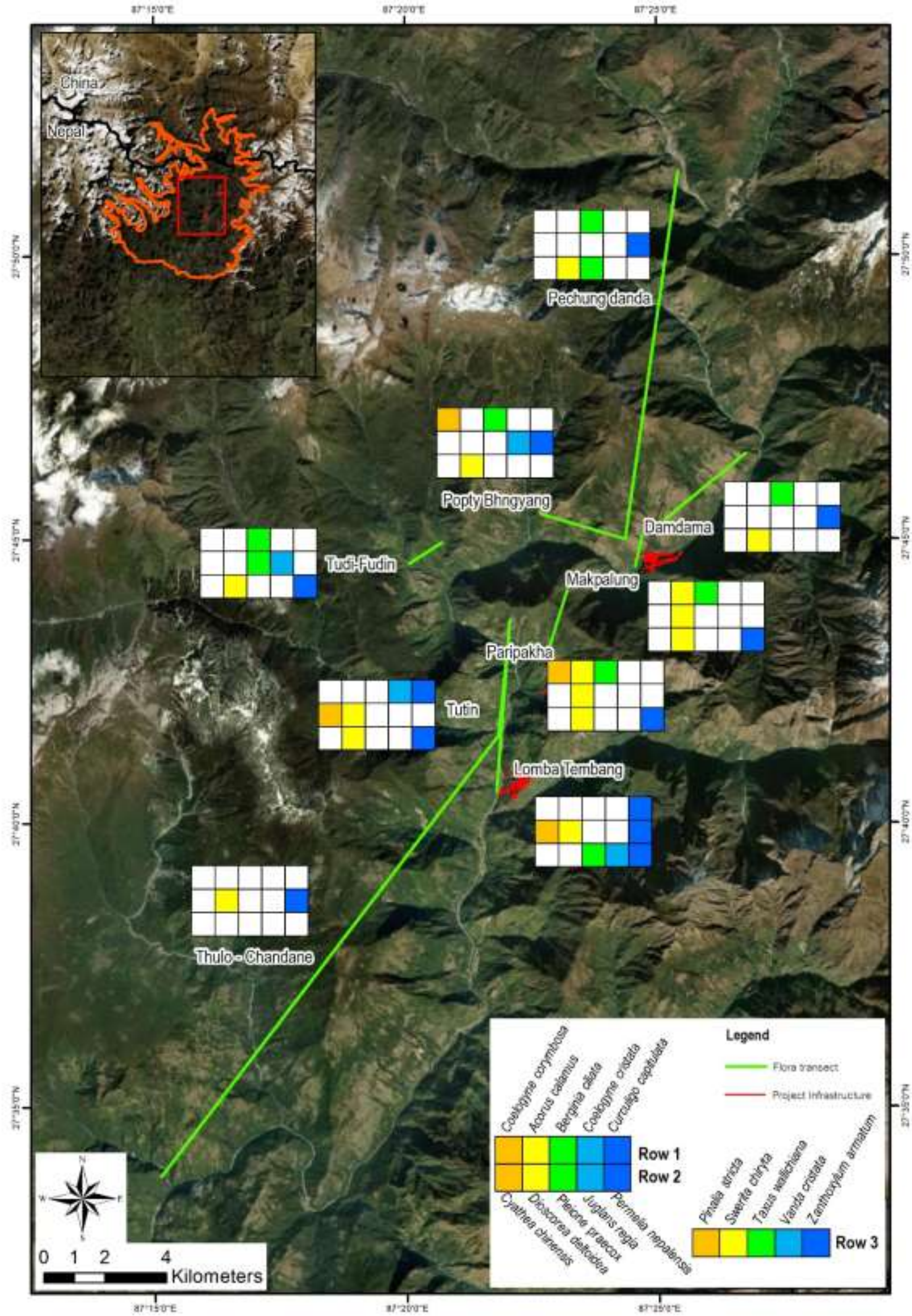
Table 6.27: Flora Species of Conservation Significance Documented During Field Surveys

Scientific Name	Local Name	Transect	Occurrence Frequency[1]	Nepalese Protection Status	IUCN[2]	CITES Status
Coelogyne corymbosa	Orchid	1. Poptybhangyang 2. Paripakha	1. Rare 2. Rare	Not listed	Not listed	CITES II
Acorus calamus	Bojo	1. Makpalung 2. Paripakha	1. Rare 2. Rare	Research and development	LC	Not listed
Berginia ciliata	Pakhanbed	1. Tudi-futin 2. Poptybhangyang 3. Pejungdanda 4. Dangdangma 5. Makpalung 3. Paripakha	1. Rare 2. Rare 3. Rare 4. Rare 5. Rare 3. Rare	Research and development	Not listed	Not listed
Coelogyne cristata	Sunakhari orchid	1. Tutin	1. Rare	Not listed	Not listed	CITES II
Curculigo capitulata	Syalfusre	1. Lomba tembang 2. Tutin	1. Common 2. Common	Not listed	Not listed	CITES II
Cyathea chinensis	Rukh uniyu	1. Lomba tembang 2. Tutin	1. Rare 2. Rare	Not listed	Not listed	CITES II
Dioscorea deltoidea	Tarul	1. Thulo chandane 2. Lomba tembang 3. Tutin 4. Makpalung 5. Paripakha	1. Rare 2. Rare 3. Rare 4. Rare 5. Rare	Research and development	Not listed	CITES II
Pleione praecox	Sunakhari	1. Tudi-futin	1. Rare	Not listed	Not listed	CITES II
Juglans regia	Okhar	1. Tudi-futin 2. Poptybhangyang	1. Rare 2. Rare	Bark of the species is banned for transport	LC	Not listed
Permelia nepalensis	Jhyau	1. Thulo chandane 2. Lomba tembang	1. Rare 2. Rare	Banned for collection/transport	Not listed	Not listed

Scientific Name	Local Name	Transect	Occurrence Frequency[1]	Nepalese Protection Status	IUCN[2]	CITES Status
		3. Poptybhangyang 4. Pejungdanda 3. Dangdangma	3. Rare 4. Scarce 3. Rare			
Pinalia stricta	Sunakhari	42. Makpalung	Not confirmed	Not listed	Not listed	CITES II
Swertia chirata	Chiraito	1. Tutin 2. Tudi-futin 3. Poptybhangyang 4. Pejungdanda 5. Dangdangma 6. Makpalung 7. Paripakha	1. Rare 2. Rare 3. Rare 4. Rare 5. Rare 6. Rare 7. Rare	Prioritized for agro-tech, research and development	Not listed	Not listed
Taxus wallichiana	Lauth salla	1. Pejungdanda	1. Scarce	Prioritized for agro-tech, research and development	EN	CITES II
Vanda cristata	Sunakhari	1. Lomba tembang	1. Rare	Not listed	Not listed	CITES II
Zanthoxylum armatum	Timur	1. Lomba tembang 2. Tutin 3. Tudi-futin 4. Makpalung 2. Paripakha	1. Scarce 2. Scarce 3. Rare 4. Rare 2. Scarce	Prioritized for agro-tech, research and development	Not listed	Not listed

[1] Occurrence frequency: Rare – was not encountered regularly during surveys; Scarce – was encountered at less than 10 locations; Common – was encountered in the majority of samples
[2] LC = Least Concern; VU = Vulnerable; EN = Endangered

Figure 6.36: Presence/Absence of Conservation Significant Flora Species along Transects in Direct Impact Area



Floral Species of Ethnological Importance

The field surveys identified 43 flora species with ethnological importance to residents within and near the EAAA. The ethnologically important flora species identified have many different uses for the residents, including medicinal properties, nutrition, livestock fodder, ornamental, fuelwood, and timber. Ethnologically important flora species identified during field surveys and stakeholder consultation are listed in ***Table 6.28***.

Table 6.28: Ethnologically Significant Flora Species

S.N	Scientific Name	Common Name	Use
43.	*Rhus javanica*	Chinese galls	Edible
44.	*Choerospondias axillaris*	Nepali hog plum	Edible
45.	*Bauhinia variegate*	Orchid tree	Edible
46.	*Astible rivularis*	Astilbe	Medicine
47.	*Berberis aristate*	Tree turmeric	Edible
48.	*Daphne bholua*	Nepalese paper plant	Fiber
49.	*Rubus ellipticus*	Golden raspberry	Edible
50.	*Thysanolaena maxima*	Tiger grass	Fodder
51.	*Urtica diocia*	Stinging nettle	Fiber
52.	*Paris polyphylla*	Loveapple	Medicine
53.	*Berginia ciliata*	Bergenia	Medicine
54.	*Viscum album*	Mistletoe	Medicine
55.	*Swerita chiryta*	Chiraita	Medicine
56.	*Girardinia diversifolia*	Himalayan Nettle	Fiber
57.	*Lindera nessiana*	Lindera	Medicine
58.	*Cinamomum tamala*	Cinnamon	Edible
59.	*Ficus nerifolia*	Willow leaf fig	Fodder
60.	*Castonopsis indica*	Chestnut	Forage
61.	*Castonopsis tribuloides*	Chinkapin	Forage
62.	*Juglans regia*	Walnut	Edible
63.	*Dioscorea sp.*	Yam	Edible
64.	*Arundinaria maling*	Maling	Edible
65.	*Amomum subulatum*	Hill Cardamom	Edible
66.	*Zanthoxylum armatum*	Prickly ash	Edible
67.	*Acorus calamus*	Sweet flag	Medicine
68.	*Diplanzium esculentum*	Vegetable fern	Edible
69.	*Alnus nepalensis*	Alder	Timber

S.N	Scientific Name	Common Name	Use
70.	*Schima wallichii*	Needlewood	Timber
71.	*Ficus semicordata*	Drooping fig	Fodder
72.	*Pinus roxburghii*	Chir pine	Timber
73.	*Rhododendrum arboreum*	Nilgiri rhododendron	Fuelwood
74.	*Pinus wallichina*	Blue pine	Timber
75.	*Juniperus sp.*	Juniper	Ornamental
76.	*Sarauria nepalensis*	Bitter-sweet	Fodder
77.	*Cannabis sativa*	Cannabis	Medicine
78.	*Aetremesia vulgaris*	Mugwort	Medicine
79.	*Aconogonum molle*	Thrumbula	Edible
80.	*Agaricus sp.*	Button mushroom	Edible
81.	*Eleocarpus spahericus*	Bead tree	Ornamental
82.	*Quercus glauca*	Ring-cupped oak	Fuelwood
83.	*Elaegnus latifolia*	Oleaster	Edible
84.	*Heracleum nepalens*	Cowparsnip	Medicine
85.	*Evodia fraxinofolia*	Evodia	Edible

Invasive Flora Species

The forest weed *Eupatorium adenophorum* (locally known as banmara or forest killer) is reported in the Ikhuwa Khola Hydropower Project IEE as being found in the surrounding areas. The species was identified during field surveys. Banmara has a remarkable range of altitudinal distribution (800 m to 2,000 m), which overlaps with human settlements and is, thus, commonly associated with farmland, pasture, and forest management. Abandoned slopes after slash and burn cultivation are invaded by banmara, which provides a vegetative cover to exposed slopes. Similarly, fresh landslides or areas with deep gully cuttings and open grasslands are also encroached upon by this species. It does not invade dense forests, where light becomes a limiting factor, although heavily disturbed forests with adequate sunlight allow favorable condition for its growth. Invasion by Banmara over marginal and grazing land has become a significant problem for farmers in Nepal.

Direct Impact Area – Terrestrial Fauna

Overall, the biodiversity field surveys recorded 266 terrestrial species, including 239 birds, 20 mammals, and 7 herpetofauna (reptiles and amphibians). Appendix F, Annex FB-2 contains the Nepal Environmental and Social Services (NESS) Biodiversity Reports, which provide additional details about fauna survey methodology and comprehensive survey results.

Birds

Spring and Fall Survey Results

The spring (April 2019) and autumn (October/November 2019) field bird surveys detected a total of 239 avian species. Of all bird species identified during both survey efforts, 54 are considered to be of conservation significance because they met one or more of the following criteria (***Table 6.29***):

- IUCN Red Book listing – classified as Near Threatened or higher level of threat
- Nepal Red Book listing – classified as Near Threatened or higher level of threat
- Endemic or restricted range species
- Migratory species
- CITES listing

Four bird species identified in the DIA are classified by the IUCN as Near Threatened or higher:

- Steppe eagle (*Aqila nipalensis*) – IUCN Endangered; Nationally Vulnerable)
- Asian woollyneck (*Ciconia episcopus*) – IUCN Vulnerable; Nationally Near Threatened
- Bearded vulture (*Gypaetus barbatus)* – IUCN Near Threatened; Nationally Vulnerable
- Himalayan griffon (*Gyps himalayensis*) – IUCN Near Threatened; Nationally Vulnerable

This study identified the steppe eagle (*Aqila nipalensis)*, as present in both spring and autumn surveys. The bearded vulture (*Gypaetus barbatus*) is considered a fairly common resident of the nearby Makalu Barun National Park. A recent study of the distribution of this species recorded six individuals nearby and within the EAAA (Karki *et al*. 2019). The Himalayan griffon (*Gyps himalayensis)* was identified during the spring survey at the Hatiya site; however, it was not observed during the autumn survey. This species is considered a fairly common resident within the Sankhuwasabha District. The Asian woollyneck (*Ciconia episcopus*) was found during the autumn survey and is a found in MBNP.

No restricted range species were observed during the surveys; however, according to IBAT, one range restricted species, the Nepal wren babbler (*Pnoepyga immaculate*), had an estimated extent of occurrence that extends into the EAAA. The surveys identified 23 bird species that are protected under Nepalese Law and 38 species that are considered migratory.

Comparison of Spring and Fall Survey Results

During the spring surveys, 19 of the species were detected (***Figure 6.37***). The Rukma site had the greatest detection frequency of bird species with a total of 15 species, with 12 bird species detected at the Hatiya site. The surveys found the fewest bird species, just two species, at the Hema and Barun sites.

During the autumn surveys, 49 species were detected (***Figure 6.38***). The location with the greatest detection frequency was Line Transect 4 with 15 conservation significant species being identified. This was followed by Line Transect 3 and Line Transect 7, each with ten (10) conservation significant species identified. Line Transect 9, Vantage Point 2 and Vantage Point 4 had the fewest conservation significant species identify with just two (2) species.

Table 6.29: Birds Species Identified during Seasonal Surveys in the EAAA

S/N	Common name	Scientific Name	Survey Site Observed	IUCN Global Red List Status	Nepalese Red List Status	Endemic or Restricted Range	Migratory	CITES Status	Season Observed
1	Steppe eagle	*Aquila nipalensis*	Hatiya LT3 VP1 VP5 VP6	EN	VU	–	X	II	Both
2	Asian woollyneck	*Ciconia episcopus*	VP3 LT10 LT13	VU	NT	–	X	-	Autumn
3	Bearded vulture	*Gypaetus barbatus*	Hatiya	NT	VU	–	–	II	Spring
4	Himalayan griffon	*Gyps himalayensis*	Hatiya	NT	VU	–	–	II	Spring
5	White-browed piculet	*Sasia ochracea*	LT10	LC	CR	–	–	–	Autumn
6	White-naped yuhina	*Yuhina bakeri*	Magpalung Rukma Jimber Barun VP3 LT10 LT13	LC	CR	–	–	–	Both
7	Golden babbler	*Stachyris chrysaea*	Magpalung Rukma LT1	LC	EN	–	–	–	Both
8	Broad-billed warbler	*Tickellia hodgsoni*	LT2 LT7	LC	EN	–		–	Autumn
9	Golden-naped finch	*Pyrrhoplectes epauletta*	Magpalung Rukma	LC	VU	–	–	–	Spring

S/N	Common name	Scientific Name	Survey Site Observed	IUCN Global Red List Status	Nepalese Red List Status	Endemic or Restricted Range	Migratory	CITES Status	Season Observed
			Chemtang						
10	Hen harrier	*Circus cyaneus*	VP5	LC	VU	–	X	II	Autumn
11	Black-chinned yuhina	*Yuhina nigrimenta*	LT1	LC	VU	–		–	Autumn
12	Grey-cheeked warbler	*Seicercus poliogenys*	Magpalung Rukma Chemtang Jimber LT5 LT8 LT10	LC	NT	–	–	–	Both
13	Spot-winged grosbeak	*Mycerobas melanozanthos*	Hema Magpalung Rukma	LC	NT	–	–	–	Spring
14	Plain martin	*Riparia paludicola*	Rukma Chemtang Hatiya	LC	NT	–	–	–	Spring
15	Ferruginous flycatcher	*Muscicapa ferruginea*	Magpalung Rukma Chemtang Jimber Hatiya LT1	LC	NT	–	–	–	Both
16	Blue-winged laughingthrush	*Trochalopteron squamatum*	LT2 LT4	LC	NT	-	-	-	Autumn
17	Large niltava	*Niltava grandis*	LT11 LT12	LC	NT	–		–	Autumn

S/N	Common name	Scientific Name	Survey Site Observed	IUCN Global Red List Status	Nepalese Red List Status	Endemic or Restricted Range	Migratory	CITES Status	Season Observed
18	Rufous-chinned laughingthrush	*Garrulax rufogularis*	LT3	LC	NT	–		–	Autumn
19	Grey wagtail	*Motacilla cinerea*	Hema Rukma Chemtang Jimber Hatiya Barun Chongrang LT1 LT8 LT9 LT10 VP5 VP6	LC	Not Listed	–	X	–	Both
20	Oriental honey-buzzard	*Pernis ptilorhyncus*	Rukma Chemtang Hatiya	LC	Not Listed	–	X	–	Spring
21	Red-rumped swallow	*Hirundo daurica*	Sibrun Namase Rukma Chemtang Hatiya	LC	Not Listed	–	X	–	Spring
22	Tickell’s leaf-warbler	*Phylloscopus affinis*	Rukma Chemtang Jimber Hatiya LT4 LT7	LC	Not Listed	–	X	–	Both

S/N	Common name	Scientific Name	Survey Site Observed	IUCN Global Red List Status	Nepalese Red List Status	Endemic or Restricted Range	Migratory	CITES Status	Season Observed
23	Buff-barred warbler	*Phylloscopus pulcher*	Rukma Chemtang Hatiya	LC	Not Listed	–	X	–	Spring
24	Yellow-breasted greenfinch	*Carduelis spinoides*	Rukma Jimber Hatiya Barun LT3 LT4 LT6 LT7 LT8 VP3	LC	Not Listed	–	X	–	Both
25	White-tailed robin	*Cinclidium leucurum*	Rukma	LC	Not Listed	–	X	–	Spring
26	Booted eagle	*Hieraaetus pennatus*	Rukma Jimber Hatiya Barun LT4 LT5 VP1 VP5	LC	Not Listed	–	X	II	Both
27	Eurasian coot	*Fulica atra*	Chongrang	LC	Not Listed	–	X	–	Spring
28	Himalayan buzzard	*Buteo (buteo) burmanicus*	VP4	LC	Not Listed	–	X	–	Autumn
29	Ultramarine flycatcher	*Ficedula superciliaris*	LT7	LC	Not Listed	–	X	–	Autumn

S/N	Common name	Scientific Name	Survey Site Observed	IUCN Global Red List Status	Nepalese Red List Status	Endemic or Restricted Range	Migratory	CITES Status	Season Observed
30	Blue-capped rock thrush	*Monticola cinclorhyncha*	LT3	LC	Not Listed	–	X	–	Autumn
31	Rusty-tailed flycatcher	*Muscicapa ruficauda*	LT2 LT3	LC	Not Listed	–	X	–	Autumn
32	Dark-sided flycatcher	*Muscicapa sibirica*	LT7 LT8	LC	Not Listed	–	X	–	Autumn
33	Verditer flycatcher	*Eumyias thalassinus*	LT2 LT4 LT5 LT6 LT7	LC	Not Listed	–	X	–	Autumn
34	Black redstart	*Phoenicurus ochruros*	LT4	LC	Not Listed	–	X	–	Autumn
35	Red-throated thrush	*Turdus ruficollis*	LT7	LC	Not Listed	–	X	–	Autumn
36	Lesser whitethroat	*Sylvia curruca*	LT8	LC	Not Listed	–	X	–	Autumn
37	Dusky warbler	*Phylloscopus fuscatus*	LT4	LC	Not Listed	–	X	–	Autumn
38	Greenish warbler	*Phylloscopus trochiloides*	LT3 LT4 LT6 LT7 LT13 VP1	LC	Not Listed	–	X	–	Autumn
39	Eurasian siskin	*Carduelis spinus*	LT5	LC	Not Listed	–	X	–	Autumn
40	Alpine swift	*Tachymarptis melba*	VP1	LC	Not Listed	–	X	–	Autumn

S/N	Common name	Scientific Name	Survey Site Observed	IUCN Global Red List Status	Nepalese Red List Status	Endemic or Restricted Range	Migratory	CITES Status	Season Observed
41	Common stonechat	*Saxicola torquatus*	LT1 LT2 LT8 LT9 LT10 LT13 VP6	LC	Not Listed	–	X	–	Autumn
42	Upland buzzard	*Buteo hemilasius*	LT3 LT4 VP1 VP6	LC	Not Listed	–	X	II	Autumn
43	Black eagle	*Ictinaetus malayensis*	LT7 LT11 VP5	LC	Not Listed	–	X	II	Autumn
44	Common kestrel	*Falco tinnunculus*	LT1 LT2 LT3 LT4 LT7 LT8 LT10 LT11 LT13 VP1 VP2 VP3 VP4 VP5 VP6	LC	Not Listed	–	X	II	Autumn
45	Gűldenstädt’s redstart	*Phoenicurus erythrogaster*	LT4 LT7 LT10	LC	Not Listed	–	X	–	Autumn

S/N	Common name	Scientific Name	Survey Site Observed	IUCN Global Red List Status	Nepalese Red List Status	Endemic or Restricted Range	Migratory	CITES Status	Season Observed
			LT12 VP5						
46	Eurasian sparrowhawk	*Accipiter nisus*	VP1 VP6	LC	Not Listed	–	X	II	Autumn
47	Besra	*Accipiter virgatus*	VP6	LC	Not Listed	–	X	II	Autumn
48	Bonelli's eagle	*Hieraaetus fasciatus*	VP2 VP6	LC	Not Listed	–	–	II	Autumn
49	Black kite	*Milvus migrans*	LT3 VP3	LC	Not Listed	–	X	II	Autumn
50	Mountain hawk eagle	*Nisaetus nipalensis*	VP6	LC	Not Listed	–	X	–	Autumn
51	Rufous-bellied niltava	*Niltava sundara*	LT2 VP3	LC	Not Listed	–	X	–	Autumn
52	Smoky warbler	*Phylloscopus fuligiventer*	LT4	LC	Not Listed	–	X	–	Autumn
53	Blyth's leaf warbler	*Phylloscopus reguloides*	LT12	LC	Not Listed	–	X	–	Autumn
54	Fire-tailed sunbird	*Aethopyga ignicauda*	VP5	LC	Not Listed	–	X	–	Autumn
Notes: LC = Least Concern; VU = Vulnerable; EN = Endangered; ; CR = Critically Endangered NT = Near Threatened; – = No; X = Yes									

Figure 6.37: Birds Species Identified along Specific Transect during Spring Surveys

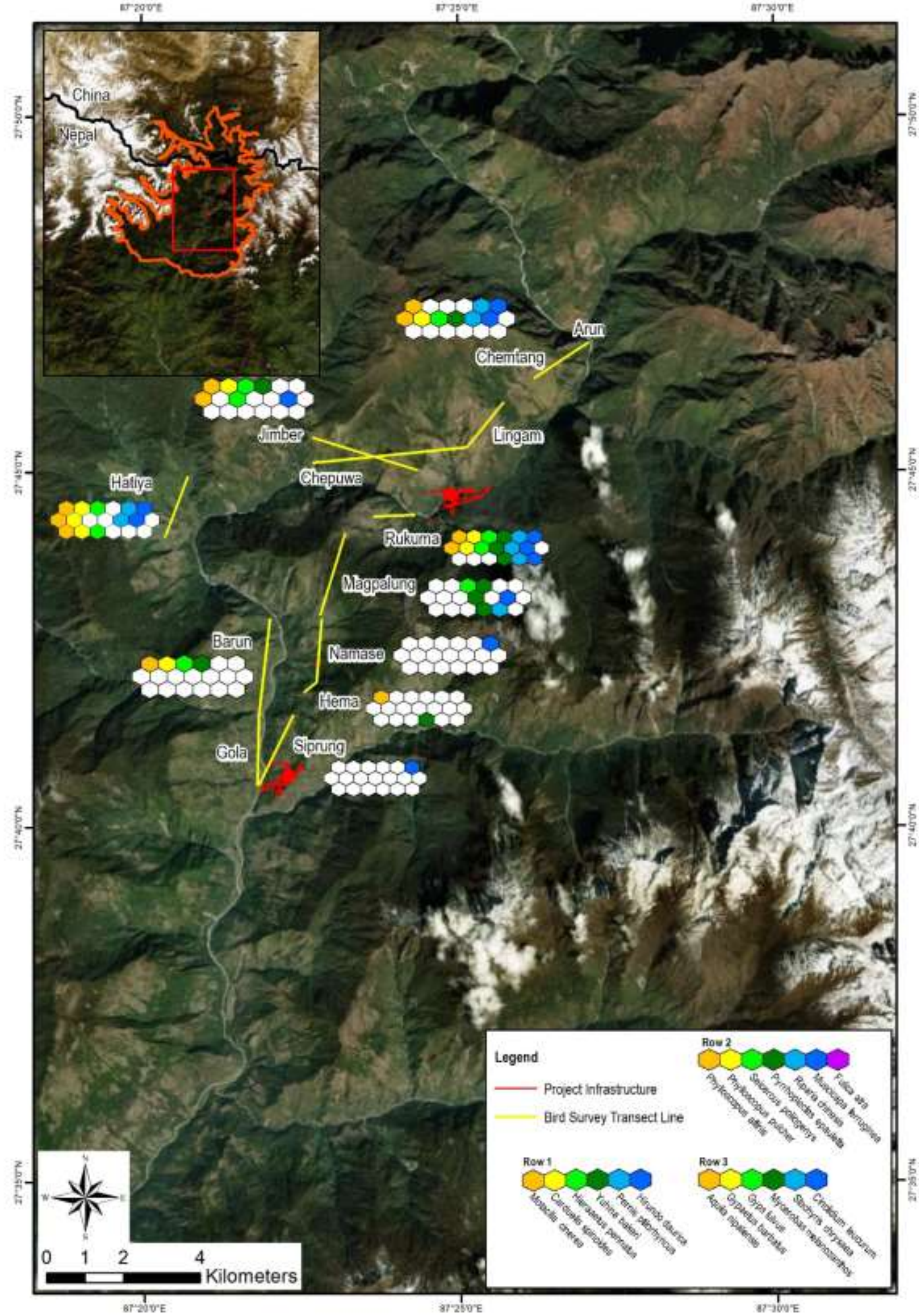
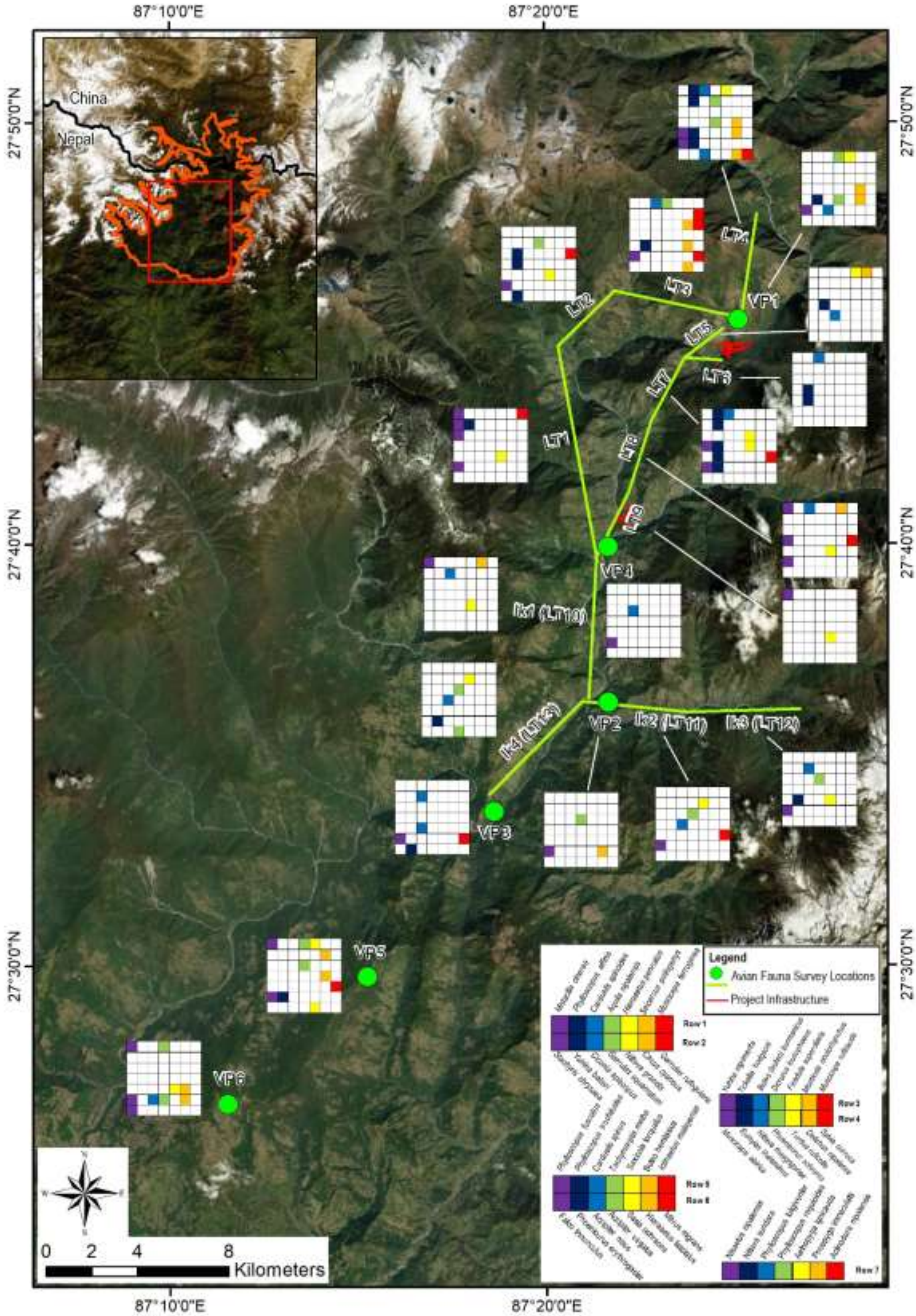


Figure 6.38: Bird Species Identified along Specific Transects and from Vantage Point Surveys during Autumn Survey



Mammals

Twenty species of mammals were recorded during the surveys from field observations and interviews. Of these species, seven species are considered to be of conservation significance because of their IUCN status of Near Threatened or higher (***Table 6.30***, ***Figure 6.39***). Nine species are listed under Nepalese Law. There were no endemic or migratory species recorded.

All seven species were recorded in mixed forest habitat and six (6) of the species were recorded in farmland habitat. Conservation significant mammal records were fairly even across transects, although the Barun Transect had a slightly higher number of conservation significant species compared with the other transects (recorded four conservation significant species) (***Figure 6.39***).

The frequency of mammal occurrence at each transect varied. The species considered rare within the DIA based on encounters during the transects included Assamese monkey, Himalayan black bear, Common leopard, Eurasian otter and Red panda.

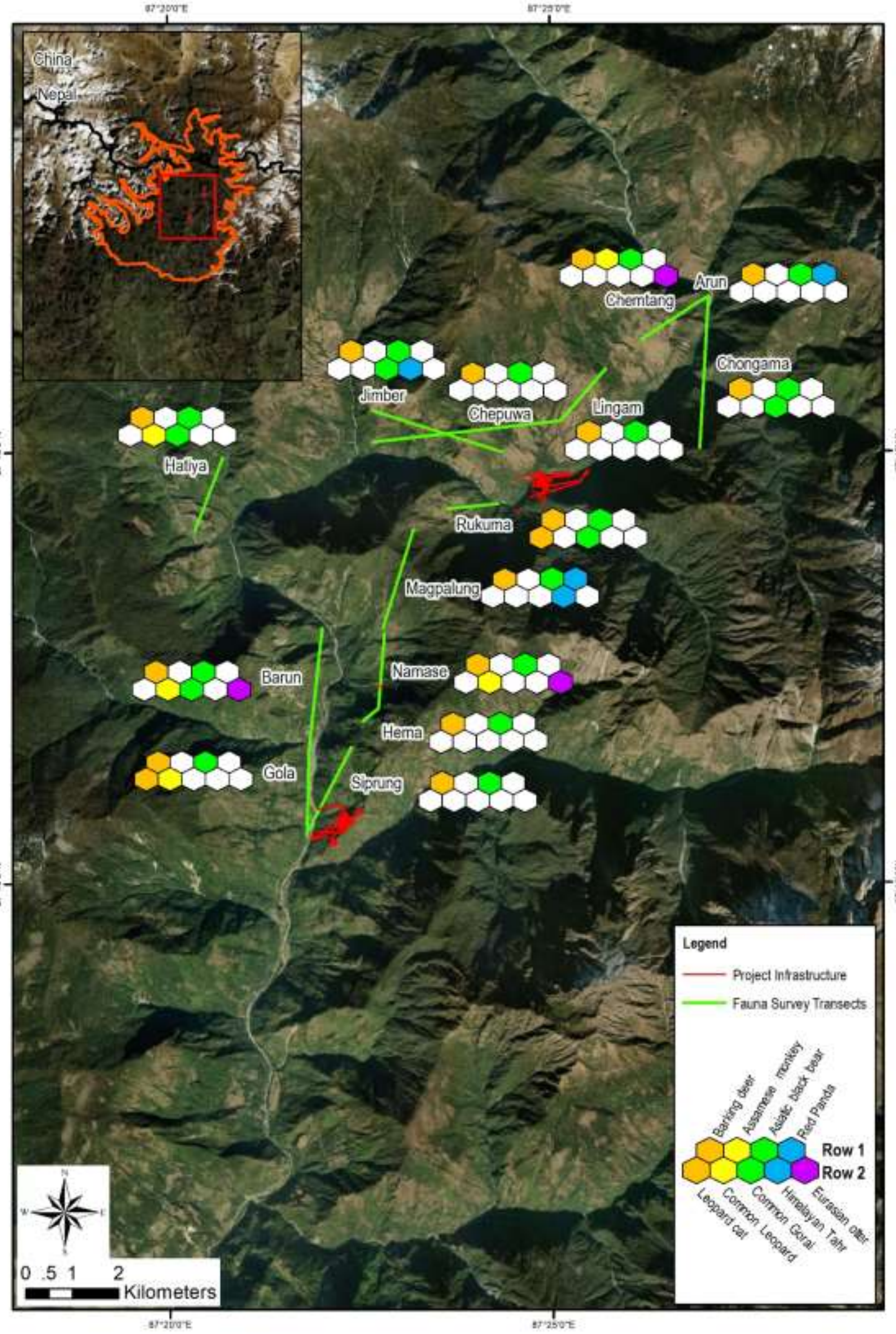
Table 6.30: Mammal Species Documented during Surveys

Common name	Scientific Name	Transect	IUCN Red List Status	National Red List Status	Endemic/ Restricted Range	Observed or Reported
Red panda	*Ailurus fulgens*	Arun, Magpalung	EN	EN	No	Reported
Himalayan black bear	*Ursus thibetanus*	Gola, Barun, Hatiya, Jimber, Chepuwa, Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung	VU	EN	No	Reported
Common leopard	*Panthera pardus*	Gola, Barun, Hatiya, Namase	VU	VU	No	Reported
Assamese monkey	*Macaca assamensis*	Chemtang	NT	VU	No	Reported
Eurasian otter	*Lutra lutra*	Barun, Chemtang, Namase	NT	NT	No	Reported
Common goral	*Naemorhedus goral*	Barun, Hatiya, Jimber, Chongama, Rukuma	NT	NT	No	Observed
Himalayan tahr	*Hemitragus jemlahicus*	Jimber, Magpalung	NT	NT	No	Observed
Leopard cat	*Felis bengalensis*	Gola, Rukuma	LC	VU	No	Reported
Barking deer	*Muntiacus vaginalis*	Gola, Barun, Hatiya, Jimber, Chepuwa, Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung	LC	VU	No	Observed
Orange bellied Himalayan squirrel	*Dremomys lokriah*	Hatiya, Jimber	LC	LC	No	Observed
Nepal grey langur	*Semnopithecus schistaceus*	Gola, Barun, Hatiya, Jimber, Chepuwa,	LC	LC	No	Observed

Common name	Scientific Name	Transect	IUCN Red List Status	National Red List Status	Endemic/ Restricted Range	Observed or Reported
		Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung				
Rhesus monkey	*Macaca mulatta*	Gola, Barun, Hatiya, Jimber, Chepuwa, Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung	LC	LC	No	Reported
Yellow throated marten	*Martes flavigula*	Gola, Barun, Hatiya, Jimber, Chepuwa, Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung	LC	LC	No	Reported
Small Indian mongoose	*Herpestes auropunctatus*	Gola, Barun, Hatiya, Jimber, Chepuwa, Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung	LC	LC	No	Reported
Jungle cat	*Felis chaus*	Gola, Barun, Hatiya, Jimber, Chepuwa, Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung	LC	LC	No	Reported
Wild boar	*Sus scrofa*	Magpalung, Namase	LC	LC	No	Reported
Small Indian civet	*Viverricula indica*	Jimber, Arun, Namase	LC	LC	No	Reported
Particolored flying squirrel	*Hylopetes alboniger*	Chemtang, Arun, Magpalung	LC	LC	No	Reported
Red fox	*Vulpes vulpes*	Gola, Barun, Hatiya, Jimber, Chepuwa, Lingam, Chemtang, Arun, Chongama, Rukuma, Magpalung, Namase, Hema, Siprung	LC	DD	No	Reported
Malayan porcupine	*Hystrix brachyura*	Barun, Hatiya	LC	DD	No	Reported

Notes: LC = Least Concern; VU = Vulnerable; EN = Endangered; CR = Critically Endangered; DD = Data Deficient; NT = Near Threatened

Figure 6.39: Key Mammal Species Observed or Reported in the EAAA



Herpetofauna

Surveys recorded seven species of herpetofauna, including two amphibians and 5 reptiles. None of the seven species meet the criteria to be of conservation significance (***Table 6.31***).

Table 6.31: Herpetofauna Species Recorded

S/N	Common Name	Scientific Name	IUCN	Nepalese Listing	Migratory	Restricted Range/ Endemic to Nepal
1	Spiny armed frog	*Nanorana liebigii*	LC	LC	No	No
2	Indian rat snake	*Ptyas mucosa*	LC	Not listed	No	No
3	Green pit viper	*Trimeresurus sp.*	LC	Not listed	No	No
4	Mountain pit viper	*Ovophis sp.*	LC	Not listed	No	No
5	Mountain cascade frog	*Amolops monticola*	Not listed	Not listed	No	No
6	Hodgson racer	*Orthriophis hodgsoni*	Not listed	Not listed	No	No
7	Oriental garden lizard	*Calotes versicolor*	Not listed	Not listed	No	No

Notes: LC = Least Concern

6.2.2 Aquatic Biodiversity

This section provides a description of the aquatic EAAA, results of screening and scoping of aquatic biodiversity values, and a summary of the biodiversity survey results. See Appendix F, Annex FB-3 for aquatic biodiversity survey data.

Aquatic Ecologically Appropriate Area of Analysis

The areas of fish spawning, aggregation, and recruitment for wide ranging species as well as habitats for resident critical habitat candidate species have been used to determine the aquatic EAAA.[14] In this regard, a number of both mid- and long range migratory species are likely present within the EAAA, including the long-range migrant golden mahseer or *Tor putitora* (IUCN EN) and mid-range migrant common snow trout or *Schizothorax richardsoni* (IUCN VU). The long range migratory species are generally found within the watershed below 1,200 m elevation, with long distance migrants traveling down to sea level. The distance travelled by mid-range migrants varies from a few kilometers to over 100 km. The elevational range of the common snow trout is reported as 784 m to 3,323 m (Shrestha 1981), although water temperature rather than elevation is likely the real limit to their range, which is around 8 degrees Celsius.

The aquatic EAAA has been refined during the assessment based on survey results and consultation with experts, as defined in the IFC PS6 guidance note. In this regard, the EAAA has been defined based on the ecological requirements of the golden mahseer, as this species was identified as being the

[14] IFC PS6 GN Paragraphs 59–60 (June 27, 2019) https://www.ifc.org/wps/wcm/connect/5e0f3c0c-0aa4-4290-a0f8-4490b61de245/GN6_English_June-27-2019.pdf?MOD=AJPERES&CVID=mRQjZva

species most likely to trigger critical habitat. Other species predicted to occur and detected during survey (including resident and mid-range migrating species) generally inhabit the EAAA as defined for the *T. putitora*.

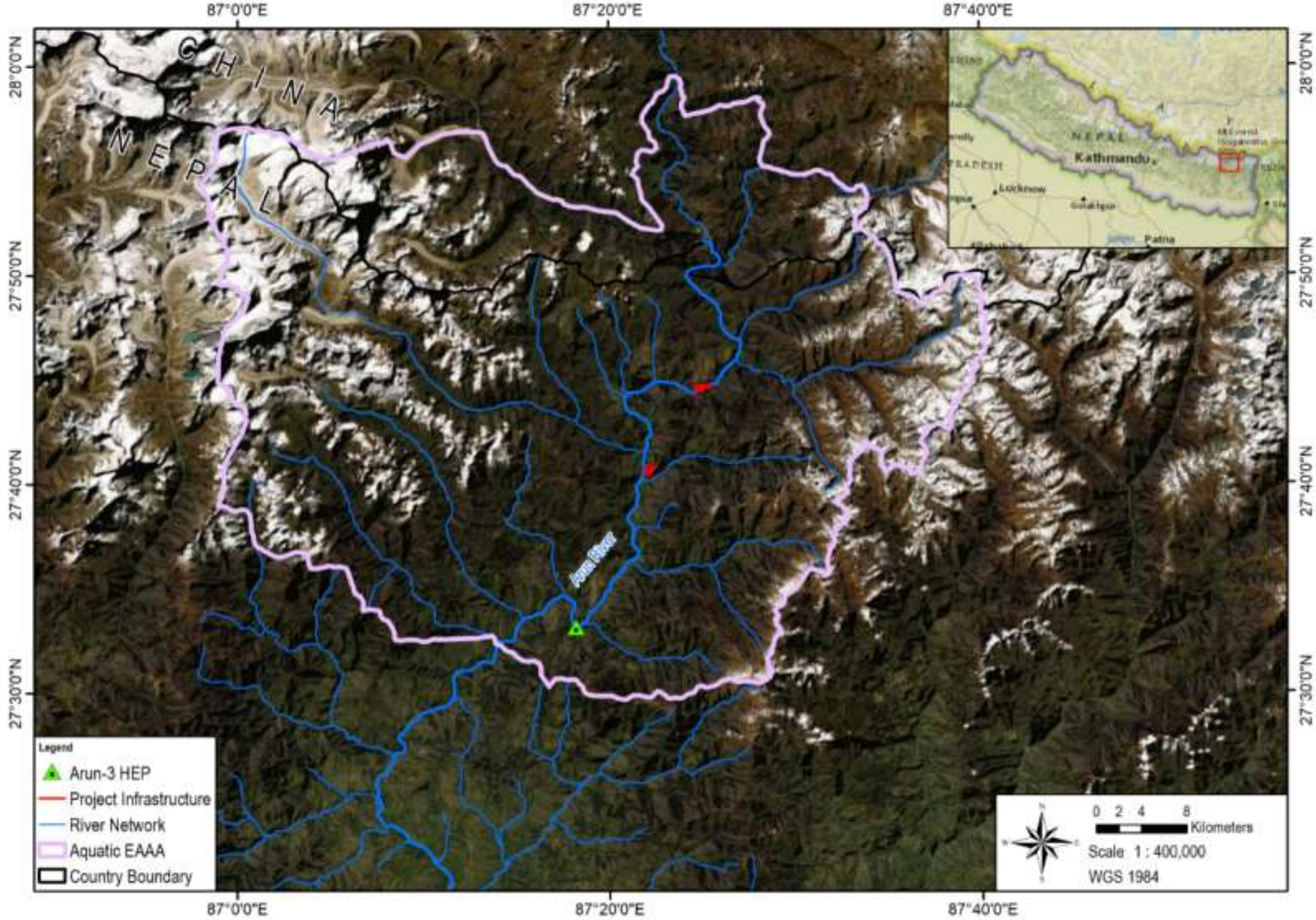
The aquatic EAAA for the Project is, therefore, defined based on the river basin boundary to a lower elevation of 700 m elevation, given that this would represent the extent of the river that would host potential aggregations of golden mahseer during spawning. This is based on literature (WWF 2019) that indicates that the extent of the species is between 0 and 1,200 m elevation, with spawning occurring generally between elevations 700–1,000 m. The species spawning areas are likely to occur downstream from the DIA (which has a lower elevation of 1,000 m) (***Figure 6.40***). The upper boundary is set at approximately 2,300 m elevation and approximately 25 km upstream from the UAHEP dam, which is well above the range of any of the long range migrants found in the Arun River and sufficiently high enough to include the temperature range of the common snow trout. The aquatic EAAA encompasses an area of approximately 130,000 ha and includes the currently under construction Arun-3 HEP.

Aquatic Habitat in the EAAA

The Arun River is a cold, turbid, snow-fed river, as are some of its major tributaries (e.g., Barun River) that drain the high Himalayas. Other tributaries that only drain lower elevations tend to have slightly warmer and less turbid water (e.g., Leksuwa Khola, Ikhuwa Khola), and are referred to herein as the “warm tributaries”. The Upper Arun River is fast flowing with relative rough ecological conditions and low number of aquatic species compared to the lower section of the river. The larger perennial warm tributaries probably play an important role in the Upper Arun aquatic ecosystem and especially for the life cycles of the fish and other aquatic species inhabiting the area. These warm tributaries seem to be of particular importance as spawning habitats and nursery areas for fish species of the region, as the torrential nature of the main river and the variations in water volume and suspended particulate levels do not provide suitable habitat conditions for fish spawning or juvenile fish rearing.

The Upper Arun River has been poorly studied and limited data on aquatic biota were found. The only data found were associated with downstream Arun-3 HEP aquatic surveys. No studies on the river upstream in China were found. The clear water (i.e., not glacial fed) tributaries are especially important as most upstream migrating fish (e.g., golden mahseer and common snow trout) likely prefer these streams for spawning because they have clean gravel substrate, which are more suitable for spawning, and have slightly warmer water temperatures.

Figure 6.40: Aquatic EAAA for the Project



Aquatic Species Screening

Table 6.32 lists the aquatic species of conservation significance that are potentially present within a 50 km radius from the Project based on the IBAT search results. They include the IUCN Red List Endangered golden mahseer (*Tor putitora)*, and three IUCN Red List Vulnerable species, including the migratory common snow trout (*Schizothorax richardsonii*), a freshwater snail *(Tricula mahadevensis),* and a dragon fly *(Chloropetalia selysi)*. In addition, six other migratory fish species are included.

Table 6.32: Aquatic Species of Conservation Significance Potentially Present in the EAAA Based on IBAT Results

S/N	Class	Scientific Name	Common Name	IUCN Listing	National Listing[1]	Endemic/ Restricted Range	Migratory	CITES[2]
1.	Fish	*Tor putitora*	Golden mahseer	EN	-	No	Yes (LM)	-
2.	Fish	*Schizothorax richardsonii*	Common snow trout	VU	-	No	Yes (MM)	-
3.	Fish	*Psilorhynchus pseudecheneis*	Stone carp	LC		No	Yes	-
4.	Fish	*Labeo dero*	-	LC		No	Yes (MM)	-
5.	Fish	*Neolissochilus hexagonolepis*	Copper mahseer	NT	-	No	Yes (MM)	-
6.	Fish	*Schizothorax progastus*	-	LC		No	Yes (MM)	-
7.	Fish	*Tor tor*	Putitor mahseer	DD	-	No	Yes (LM)	-
8.	Fish	*Anguilla bengalensis*	Bengal eel	NT	-	No	Yes (MM)	-
9.	Gastropod	*Tricula mahadevensis*	Freshwater snail	VU	-	No	No	-
10.	Insect	*Chloropetalia selysi*	Dragonfly	VU	-	No	No	-

[1] Nepal does not have a National red list of threated fish species.

[2] Convention on International Trade in Endangered Species of Wild Fauna and Flora

Notes: LC = Least Concern; VU = Vulnerable; EN = Endangered; NT = Near Threatened; DD = Data Deficient; LM = Long-range Migrants; MM = Mid-range Migrants

Direct Impact Area Baseline Conditions

A range of targeted biodiversity surveys were conducted by Nepal Environmental and Scientific Services (NESS) Shah Consult International (SCI) and SWECO. ***Table 6.33*** summarizes the aquatic biodiversity field surveys undertaken. Chapter 5 provides details on the methodologies that were used in conducting each of these terrestrial surveys.

Table 6.33: Aquatic Survey Dates

S/N	Surveyor	Survey Focus	Number of Sample Sites	Survey dates
1	NESS	Fish sampling: cast nets and gill nets; Water quality	11 sites over 1 sample period	April 27 to May 9 2019 April 2 to April 6 2019
2	SCI	Fish sampling: cast nets and gill nets; Phytoplankton sampling; Periphyton survey Zooplankton sampling; Macroinvertebrate sampling; Water quality	8 sites over 4 sample periods	December 21 2017 to January 7 2018 April 15 to April 31 2018 July 15 to July 31 2018 September 23 to October 10 2018
3	SWECO	Drift nets	3 sites over 1 sample period	December 2019 to January 2020

Phytoplankton and Periphyton

Taxonomic analysis of the phytoplankton samples identified 11 species and 10 genera were identified during the four surveys. The population density of the phytoplankton identified during the surveys is presented in Appendix F, Annex FB-3. The *Lyngbya* genus had the greatest overall density (28,000/L) and the following species/genera had the lowest density with just 1,000/L recorded for 11 species. The research in Nepal is not sufficient to characterize this phytoplankton relative to habitat or water quality.

The 2019 surveys identified 17 periphyton genera. A total of 2,649 periphyton were collected. The *Frustulia* was the most abundant periphyton genus followed by *Fragillaria* and *Cymbella.* The 2017–2018 surveys identified 33 periphyton genera (Appendix F, Annex FB-3). The *Lyngbya* was the most abundant of all periphyton (159,000/L). *Denticula* was the least abundant periphyton (5,000/L). The research in Nepal is not sufficient to characterize this phytoplankton relative to habitat or water quality.

Zooplankton

A total of 8 zooplankton genera were identified (Appendix F, Annex FB-3). The *Daphnia* genus had the greatest density in the sampling exercises in the upper river section at sampling station 1 and 2 while *Diaptomus sp.* and *Keratella sp.* had the highest density in the lower sampling stations. The presence of *Daphnia* is a well-established indicator of good water quality (Le *et al*. 2016), whereas *Diaptomus* is a generalist species and not necessarily indicative of water quality. Keratella is generally found where some nutrient enrichment is present.

Macroinvertebrates

The 2019–2020 surveys identified ten (10) macroinvertebrate genera, 14 macroinvertebrate families, and six (6) macroinvertebrate orders. A total of 273 macroinvertebrate individuals were collected (see Appendix F, Annex FB-3). *Rhyacophila* was the most abundant macroinvertebrate genus followed by *Baetis.*

During the 2017–2018 surveys, 39 macroinvertebrate genera were identified. Baetis was the most abundant macroinvertebrate genus with 70 individuals identified. The following genera were the least prevalent with only one (1) individual identified: *Himalopsyche sp., Indonemoura sp.* and *Neoephemera sp.* These species are indicative of aquatic habitat in good condition.

Fish

Table 6.34 presents the results of the fish surveys. The location of the sampling and results are shown for the separate surveys in ***Figure 6.41*** (NESS Survey) and ***Figure 6.42*** (SCI Survey). The combined results of the surveys indicate that a total of 35 species were either collected or reported during all survey events. Thirteen of these species where collected during the sampling missions, while an additional 22 species were reported by local fishers to be found in the river. Appendix F, Annex FB-3 includes profiles of several common fish species.

Data from all sampling events show a low number of species in the upper part of the Arun River between the UAHEP dam site (1,570 m) and powerhouse (1,080 m), with fish diversity increasing in a downstream direction, as well as in warm tributaries (i.e., Ikhuwa Khola) (***Table 6.36***):

- Upstream from the UAHEP dam site (Station S1) – 2 species (*Schizothorax richardsonii* and *Nemacheilus botia*)
- UAHEP proposed diversion reach (Stations S2 and S3) – 2 species (*Schizothorax richardsonii* and *Psilorhynchus psuedecheneis*)
- Downstream from UAHEP powerhouse to Ikhuwa Khola (Stations S4 and S7) – 4 species
- Ikhuwa Khola tributary (Stations S5 and S6) – 5 species
- Downstream from proposed Arun-3 HEP (Station S8) – 11 species

Schizothorax richardsonii (IUCN VU) was by far the most abundant species in the collected fish samples in the upper part of Arun River, representing over 80% of all individuals caught. The few other relatively common species included the mid-range migrants *Psilorhynchus pseudecheneis* (IUCN LC) and *Neolissochilus hexagonolepis* (IUCN NT). The abundance of fishes collected is shown in ***Table 6.35*** and ***Table 6.36****.*

Of the long migratory species, information from local fishers indicates that species including golden mahseer (IUCN EN) and *Tor* (IUCN DD) may utilize the Arun River, most likely below elevation 900 m, but potentially up to elevation 1,100 m (confluence of Leksuwa Khola and the Arun River). Golden mahseer was collected at the confluence with Sabha Khola downstream from Khandbari at approximately elevation 280 m (Shrestha *et al.* 2015) and is reported to be found near the confluences of Sankhuwa Khola at approximately elevation 350 m, Pikhuwa Khola at approximately elevation 560 m, and Apsuwa Khola at approximately elevation 650 m (Arun-3 HEP 2015). The Arun-3 HEP concluded that the upper limit of upstream migration of *Tor* species in the Arun River was likely Apsuwa Khola, which was consistent with an NEA study (NEA 1991). As part of the UAHEP fish survey, one fisherman reported catching golden mahseer at the mouth of the Ikhuwa Khola at approximately elevation 900 m about 15 years ago (NESS 2019). Other than this single observation, no individuals of golden mahseer have been caught or observed upstream from the Arun-3 HEP. Leksuwa Khola, at approximately elevation 1,100 m, is the only tributary stream upstream from Ikhuwa Khola, but below the approximately 1,200 m upper migratory limit, that is potentially suitable for golden mahseer spawning. Both Ikhuwa Khola and Leksuwa Khola have larger boulders, steep gradients, and relatively shallow water depths all of which combine to make these streams less suitable for golden mahseer spawning. *Anguilla bengalensis* (IUCN NT) is also currently found in this part of the river. In the Upper Arun River (above approximately 1,000 m), no long migrating fish species were collected.

The survey results, therefore, show that there is an ecological gradient from about elevation 400 m and up to the dam site of UAHEP (approximately elevation 1,640 m). An indicator of the gradient is water temperature that differed by 2.3°C in wintertime sampling in 2019. Temperature plays an important role in the eco-dynamic process and functionality and may act as a barrier for several species due to the physiological borders of metabolism and energy output. Water temperature results from April 2019 are shown in ***Table 6.37***.

It should be noted that the fish sampling was limited to one sampling event per season using cast nets and gill nets, at a limited number of sites. Additional sampling is ongoing with additional methods such as electrofishing, and at additional sites, to better understand the fish presence/absence and distribution in the area (see Appendix C, ESMP, Annex C3, Biodiversity Management Plan, Section 4.5).

Table 6.34: Fish Species Identified during Field Surveys

Scientific Name	NESS Surveys (N)		SCI Surveys (S)		Characteristics		
	Sampling Site Station No.	Collected or Reported	Sampling Site Station Number	Collected or Reported	IUCN RL status	Endemic to Nepal/ Restricted Range	Migratory
Tor putitora	7	Reported	-	-	EN	No	Yes (LM)
Schizothorax richardsonii	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12	Collected	1,2,3,4	Collected	VU	No	Yes (MM)
Anguilla bengalensis	-	-	1,2,3,4	Reported	NT	No	Yes (MM)
Neolissochilus hexagonolepis	1, 2, 3, 4, 5, 6, 7, 11, 12	Reported	1,2,3,4	Collected	NT	No	Yes (MM)
Labeo dero	7	Reported	1,2,3,4	Collected	LC	No	Yes (MM)
Psilorhynchoides pseudecheneis	1, 2, 3, 4, 5, 6, 7, 10, 11, 12	Collected	1,3,4	Collected	LC	No	No (R)
Schizothorax progastus	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12	Collected	1,2,3,4	Collected	LC	No	Yes (MM)
Barilius barila	7	Reported	3,4	Collected	LC	No	No (R)
Barilius bendelisis	6, 7	Reported	2,3,4	Reported	LC	No	No (R)
Barilius vagra	6, 7	Reported	2,3,4	Reported	LC	No	No (R)
Balitora brucei	-	-	2,3,4	Reported	NT	No	No (R)
Barilius shacra	-	-	2,3,4	Reported	LC	No	No (R)
Tor chelynoides	-	-	2,3,4	Reported	VU	No	No (R)
Botia dario	1, 2, 3, 4, 5, 6, 7, 11, 12	Reported	2,3,4	Collected	LC	No	No (R)
Botia almorhae	1, 2, 3 , 4, 5, 6, 7, 11, 12	Reported	-	-	LC	No	No (R)
Clupisoma garua	-	-		Reported	LC	No	Yes (LM)

Scientific Name	NESS Surveys (N)		SCI Surveys (S)		Characteristics		
	Sampling Site Station No.	Collected or Reported	Sampling Site Station Number	Collected or Reported	IUCN RL status	Endemic to Nepal/ Restricted Range	Migratory
Channa gachua	-	-	1,2,3,4	Reported	LC	No	No (R)
Euchiloglanis hodgarti	1, 2, 3, 4, 5, 6, 7, 11, 12	Collected	2,3,4	Collected	LC	No	No (R)
Exostoma blythi	-	-	2,3,4	Reported	DD	No	No (R)
Garra annandalei	1, 2, 3, 4, 5, 6, 7, 11, 12	Reported	1,2,3,4	Collected	LC	No	No (R)
Garra gotyla	1, 2, 3, 4, 5, 6, 7, 11, 12	Reported	1,2,3,4	Collected	LC	No	No (R)
Glyptothorax pectinopterus	1, 2, 3, 4, 5, 6, 7, 10, 11, 12	Reported	1,2,3,4	Collected	LC	No	No (R)
Glyptothorax telchitta	1, 2, 3, 4, 5, 6, 7, 10, 11, 12	Reported	1,2,3,4	Reported	LC	No	No (R)
Glyptothorax cavia	-	-	2,3,4	Reported	LC	No	No (R)
Glyptothorax trilineatus	-	-	2,3,4	Reported	LC	No	No (R)
Heteropneustes fossilis	-	-	2,3,4	Reported	LC	No	No (R)
Schistura beavani	-	-	1,2,4	Reported	LC	No	No (R)
Nemacheilus botia	1, 2, 3, 4, 5, 6, 7, 11, 12	Collected	4	Collected	LC	No	No (R)
Schistura rupecula	-	-	2,3,4	Reported	LC	No	No (R)
Pseudecheneis sulcatus	1, 2, 3, 4, 5, 6, 7, 11, 12	Reported	1,3,4	Collected	LC	No	No (R)
Puntius sarana	-	-	2,3,4	Reported	LC	No	No (R)
Schistura rupecula	1, 2, 3, 4, 5, 6, 7, 10, 11, 12	Reported	2,3,4	Reported	LC	No	No (R)

Scientific Name	NESS Surveys (N)		SCI Surveys (S)		Characteristics		
	Sampling Site Station No.	Collected or Reported	Sampling Site Station Number	Collected or Reported	IUCN RL status	Endemic to Nepal/ Restricted Range	Migratory
Schistura savona	1, 2, 3, 4, 5, 6, 7, 10, 11, 12	Reported	2,3,4	Reported	LC	No	No (R)
Schizothorax plagiostomus	-	-	2,3,4	Reported	Not Evaluated	No	No (R)
Tor tor		Reported	-	-	DD	No	Yes (LM)

Notes: LC = Least Concern; VU = Vulnerable; EN = Endangered; NT = Near Threatened; DD = Data Deficient; LM = Long-range Migrants; MM = Mid-range Migrants

Figure 6.41: Fish Species collected from Specific Sampling Sites during NESS Surveys

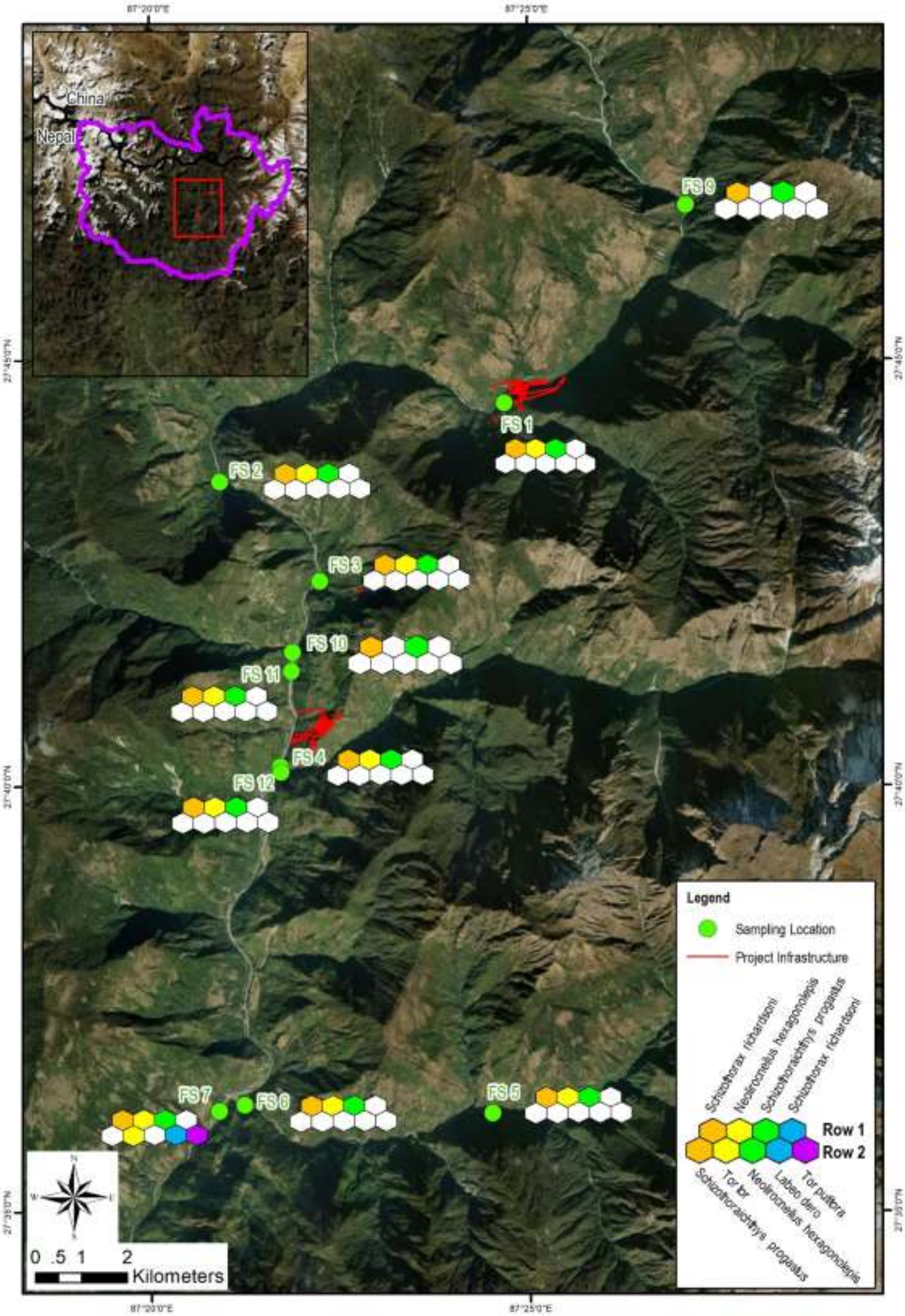


Figure 6.42: Fish Species Collected from Specific Sampling Sites during SCI Surveys

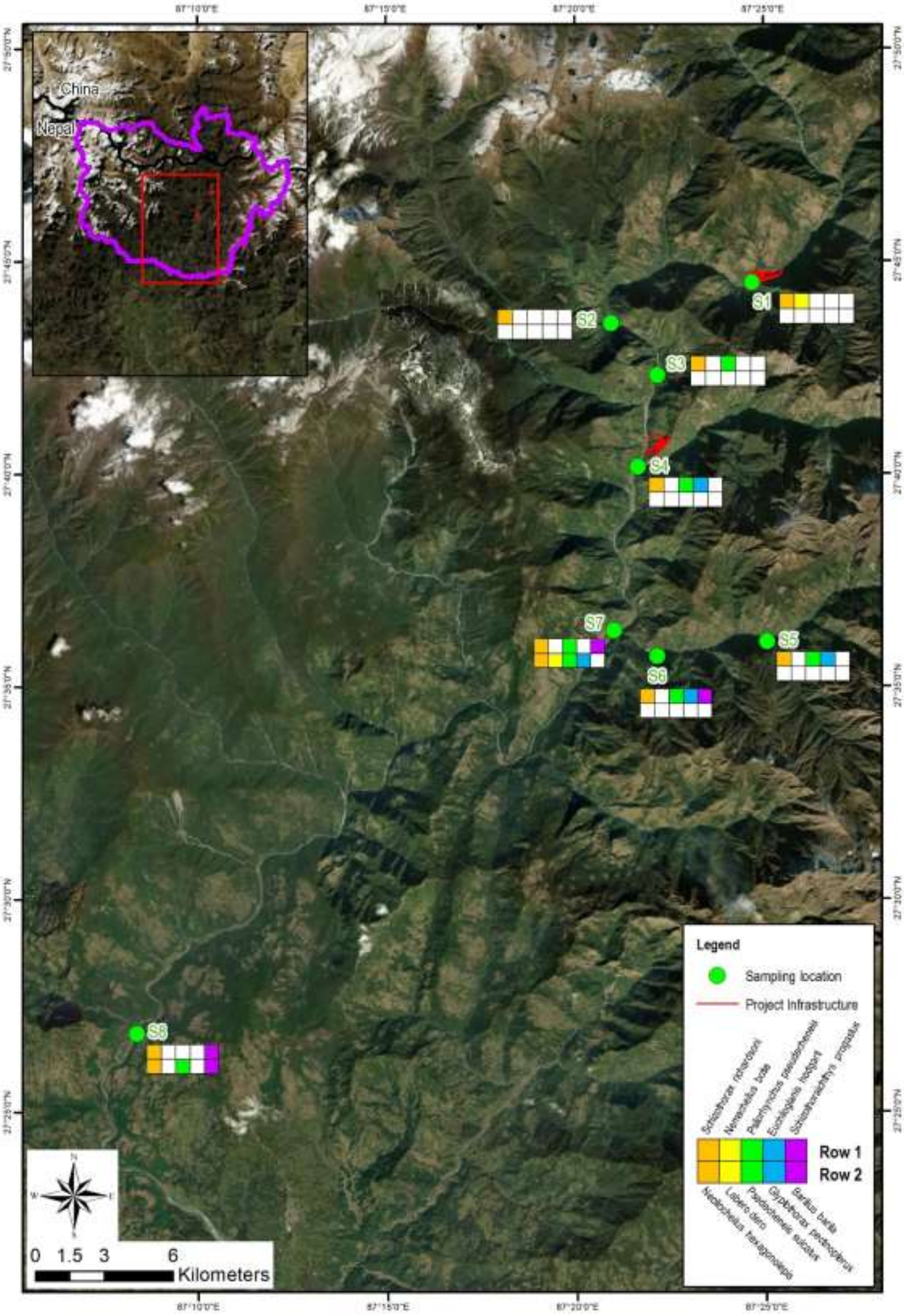


Table 6.35: Fish Abundance by Season and Sampling Sites (SCI 2017–2018)

Sites \ Surveys	Approximate Elevation (m)	Winter Survey (Dec 2017–Jan 2018)	Spring Survey (April 2018)	Summer Survey July 2018	Fall Survey Sept–Oct 2018	Total
S1 – Upstream from UAHEP dam	1,590	13	15	2	16	**46**
S2 – UAHEP diversion reach	1,300	4	21	6	25	**56**
S3 – Barun confluence	1,140	14	14	4	22	**54**
S4 – Leksuwa confluence	1,080	8	16	4	18	**46**
S5 – Ikhuwa Khola – upper reach	1,640	1	14	9	18	**42**
S6 – Ikhuwa Khola – lower reach	1,130	3	26	9	11	**49**
S7 – Ikhuwa confluence	900	6	24	17	20	**67**
S8 – Sankhuwa confluence	390	18	32	11	30	**91**
Total		**67**	**162**	**62**	**160**	**451**

Table 6.36: Fish Abundance by Species (SCI 2017–2018)

S/N	Species Name	# of Individuals Collected				Total
		Winter	Spring	Summer	Fall	
1.	*Barilius barila*	0	0	2	0	**2**
2.	*Botia geto*	0	1	0	0	**1**
3.	*Euchiloglanis hodgarti*	0	6	0	3	**9**
4.	*Garra annandalei*	0	2	0	0	**2**
5.	*Garra gotyla*	0	1	0	0	**1**
6.	*Glyptothorax pectinopterus*	0	1	0	3	**4**
7.	*Labeo dero*	0	3	0	0	**3**
8.	*Nemacheilus botia*	0	0	0	1	**1**
9.	*Neoliocheilus hexagonolepis*	3	8	1	9	**21**
10.	*Psedecheneis sulcatus*	0	2	3	0	**5**
11.	*Psilorhynchoides pseudecheneis*	1	4	5	23	**33**
12.	*Schizothorax richardsonii*	62	133	51	118	**364**
13.	*Schizothorax plagiostomus*	1	0	0	0	**1**
14.	*Schizothorax progastus*	1	1	0	3	**5**

Table 6.37: Water Temperatures (April 2019)

Site	Elevation	Temperature (°C)
Station 1 – Arun River (Dam site UAHEP)	1,670 m	7.2
Station 2 – Arun River (confluence Ikhuwa)	900 m	8.9
Station 3 – Arun River (downstream Arun-3 HEP)	700 m	9.5
Station 4 – Ikhuwa Khola	1,600 m	7.8
Station 5 – Ikhuwa Khola	950 m	8.5

6.2.3 Critical Habitat Assessment

This section identifies critical habitat candidate species within the terrestrial and aquatic EAAAs based on the critical habitat criteria defined in the WB ESF ESS 6, the IFC PS 6 Guidance Note (GN), and the EIB Guidance Note for Standard 3 on Biodiversity and Ecosystems. The IFC PS 6 GN is used as there are no published thresholds for the WB ESF ESS 6. Thresholds from the PS 6 GN are used as a substitute where appropriate data are available, but are not mandatory requirements for WB critical habitat determination as defined in WB ESS 6.

Critical Habitat Criteria

Critical habitat is defined in the WB ESF ESS 6 as "areas with high biodiversity importance or value, including: (a) habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches; (b) habitat of significant importance to endemic or restricted-range species; (c) habitat supporting globally or nationally significant concentrations of migratory or congregator species; (d) highly threatened or unique ecosystems; (e) ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described in (a) to (d)."

The EIB Standard 3 on Biodiversity and Ecosystems has similar, but slightly different standards for critical habitat than the WB ESF ESS 6. In addition to the criteria listed above, EIB also includes the following as critical habitat:

- Habit of significant importance to a population of Vulnerable Species, in addition to the Critically Endangered or Endangered species categories included in the WB ESF ESS 6
- Biodiversity and/or ecosystems with significant social, economic, or cultural importance to local communities and indigenous groups
- Habitat of key scientific value and/or associated with key evolutionary processes

IFC PS 6 GN paragraph 59 (***Table 6.38***) and EIB Guidance Note for Standard 3 provide details of the qualifying requirements for critical habitat criteria.

These criteria are "triggers" in that if an area of habitat meets any one of the criteria, it will be considered critical habitat irrespective of failing to meet any other criterion. Each criterion is applied separately and not in combination. Critical habitat values are of the highest importance among habitat categories.

This assessment of critical habitat was undertaken as a screening process against criteria 1–5 in ***Table 6.38*** below involving GIS analysis, desk-based data collection, and field biodiversity surveys. Screening for criteria 6–7 is provided below.

Table 6.38: Critical Habitat Criteria

WB ESF ESS 6/EIB 3 Criteria	IFC PS6 GN Thresholds
1) Habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches. EiB includes Vulnerable species as well.	a) Areas that support globally-important concentrations of an IUCN Red-listed EN or CR species (0.5% of the global population AND 5 reproductive units of a CR or EN species); b) Areas that support globally-important concentrations of an IUCN Red-listed VU species, the loss of which would result in the change of IUCN Red List status to EN or CR and meet the thresholds in (a). As appropriate, areas containing nationally/regionally-important concentrations of an IUCN Red-listed EN or CR species.
2) Habitat of significant importance to endemic or restricted-range species	Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.
3) Habitat supporting globally or nationally significant concentrations of migratory or congregatory species	Areas known to sustain, on a cyclical or otherwise regular basis, ≥1% of the global population of a migratory or congregatory species at any point in the species' lifecycle and areas that predictably support ≥10% of the global population of a species during periods of environmental stress.
4) Highly threatened or unique ecosystems	Areas representing ≥ 5% of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN and other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.
5) Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)	No set criteria
6) Biodiversity and/or ecosystem with significant social, economic, or cultural importance to local communities and indigenous groups	Areas of semi-natural and natural habitat used by indigenous peoples and local communities to obtain essential or priority benefits will be considered critical from an ecosystem service perspective. Criteria for identifying priority ecosystem services should be developed for each project, with input from social specialists and the relevant users and beneficiaries. Priority ecosystem services are services (including cultural services) on which people depend strongly for their livelihood or wellbeing, with limited access to acceptable alternatives. Impacts must be compatible with sustained and sustainable use of priority ecosystem services and mitigation measures must be identified as necessary to ensure that a) ecosystems retain the capacity to supply the services on which indigenous people or local communities depend or b) to ensure that they are able to obtain essential benefits. In some circumstances communities may accept alternative benefits to those derived from ecosystem services affected by a project, but those alternatives should not be imposed on people without meaningful consultation.
7) Habitat of key scientific value and/or associated with key evolutionary processes	a) Landscapes with high spatial *heterogeneity* and, therefore, high levels of species diversity; b) *Environmental gradients*, also known as *ecotones*, that produce transitional habitat which is associated with the process of speciation and high species and genetic diversity; c) *Edaphic interfaces* that juxtapose soil types (e.g. serpentine outcrops, limestone and gypsum deposits), which have led to the formation of unique plant communities; d) *Connectivity* between habitats (e.g. biological corridors) with importance for species migration and gene flow, which is especially important in fragmented habitats and for the conservation of metapopulations (this also includes biological corridors across altitudinal and climatic gradients and from "crest to coast"); e) Sites of demonstrated importance to *climate change adaptation* for either species or ecosystems.

Critical Habitat Consultation

ERM completed consultations with species experts to determine the current populations, and global/regional distribution and concentrations in the EAAA to inform the species assessments so as to understand if the Project is located in critical habitat. The list of experts consulted in relation to the species is shown in ***Table 6.39***.

Table 6.39: Critical Habitat Experts Consulted

SN	Person	Assessment of Species	Affiliated Organization
1	Arjun Thapa	Red panda and alpine musk deer	Small Mammals Conservation and Research Foundation
2	Bhupendra Yadav	Himalaya black bear	IUCN Bear Specialist Group – Asiatic Black Bear
3	Dinesh Neupane	Hog deer	Resources Himalaya Foundation
4	Halvard Kaasa David Philipp and Julie Claussen	Golden mahseer and Stone carp	SWECO Norge AS Fisheries Conservation Foundation
5	Krishna Bhushal	Baer's pochard, white-rumped vulture, slender-billed vulture, Pallas's fish-eagle, and red-headed vulture	Bird Conservation Nepal
6	Tulshi Laxmi Suwal	Chinese pangolin	Small Mammals Conservation and Research Foundation
7	Sagar Dahal	Dhole and Himalayan musk deer	Small Mammals Conservation and Research Foundation
8	Sanjan Thapa	Mandelli's mouse-eared myotis and black musk deer	Small Mammals Conservation and Research Foundation

Critical Habitat Species Screening Results

Critical Habitat Assessment

Critical habitat is defined in the World Bank ESS 6 as "areas with high biodiversity importance or value, including: (a) habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches; (b) habitat of significant importance to endemic or restricted-range species; (c) habitat supporting globally or nationally significant concentrations of migratory or congregatory species; (d) highly threatened or unique ecosystems; (e) ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described in (a) to (d)." These criteria were used to screen species and habitats potentially present in the Ecologically Appropriate Area of Analysis (EAAA), which identified four mammal fauna species that trigger critical habitat. These were as follows:

- **Himalayan red panda** (*Ailurus fulgens*) – This species is categorized by the IUCN Nepal and Global Red List as Endangered and has been captured by camera trappings carried out for the UAHEP ESIA. It has also been reported in Sankhuwasabha District where the Project is located. It prefers moist montane forest, but can also use high altitude shrub land. Habitat types include temperate and subalpine forest zones of the Himalayan ecosystem between 2,400–4,000 m elevation in Nepal (Thapa *et al.* 2020). This species was identified during field surveys conducted for the Project, considering its preferred habitat preference (high altitude with a core elevation range of 2,800–3,200 m), it is present in the EAAA (elevation range of 410–4,410 m).
- **Himalayan black bear** (*Ursus thibetanus*) – This species is categorized by the IUCN Red List as Vulnerable, and the National Red List as Endangered. It has a large distribution range, extending

from Iran, Northern Pakistan, India, Nepal, Bhutan, Northeast India, and mainland Southeast Asia. The EAAA contains suitable habitat for this species. Habitat types include forest, wetlands (inland), grassland, shrubland, artificial/terrestrial, with a lower and upper elevation limit of 0 m and 4,300 m respectively. This nationally Endangered species was observed in the project area. Interviews with locals and expert consultations revealed that this species is recorded.

- **Clouded leopard** (*Neofelis nebulosa)* – This species is categorized by the IUCN Nepal as Endangered and by IUCN Global as Vulnerable. It has been observed in the project area. Also called mainland clouded leopard, the clouded leopard (*Neofelis nebulosa*) is a wild cat inhabiting dense forests from the foothills of the Himalayas through Northeast India and Bhutan to mainland Southeast Asia and into South China. The clouded leopard is the first cat that genetically diverged 9.32 to 4.47 million years ago from the common ancestor of the pantherine cats. Today, the clouded leopard is locally extinct in Singapore, Taiwan, and possibly in Hainan Island and Vietnam. The wild population is believed to be in decline with fewer than 10,000 adults and no more than 1,000 in each subpopulation. It has been listed as Vulnerable on the IUCN Global Red List since 2008. The population is threatened by large-scale deforestation and commercial poaching for the wildlife trade.
- **Spotted linsang** (*Prionodon pardicolor*) – This species is categorized by the IUCN Nepal as Endangered and by IUCN Global as Least Concern. Native to much of Southeast Asia, the spotted linsang has been observed in the project area. It is widely distributed, although usually sparsely recorded. The range of the spotted linsang includes eastern Nepal, Sikkim, Assam and Bengal in India, Bhutan, northeastern Myanmar, northern Thailand, Laos, northern Vietnam, and western Sichuan, Yunnan and Guizhou and southwestern Guangxi in southern China. It is uncommon to rare throughout this range. It primarily inhabits evergreen forests and shrubland. A large portion of this habitat is not protected, and this may cause the spotted linsang to be threatened with extinction due to habitat loss.

Highly Threatened or Unique Ecosystems

As described in Section 6.2.1 on the terrestrial EAA, the EAAA is largely covered in forests, interspersed with grassland, rock/scree, agriculture, and built up areas. The Arun River and its tributaries also run through the EAAA. While forest, rangeland, wetland and especially mountain ecosystems have generally been recognized as high priorities for conservation at the national level, these ecosystems are widely distributed across the High Mountains and Middle Mountains physiographic zones that stretch from east to west of Nepal. Furthermore, forests in the Middle Mountains, which represent the majority ecosystem in the EAAA, appear to be better conserved, even leading to increased forest cover. This is unlike the Terai lowlands and Siwalik Hills physiographic zones located outside the EAAA, which suffer from high rates of deforestation and degradation over the last few decades (e.g., Terai lowlands – 0.44% annually from 2001–2010) (MoFE 2014).

No formal IUCN Red List of Ecosystems assessment have been performed for the ecosystems found in the EAAA. Nevertheless, considering the widespread distribution of these ecosystems across the Nepalese landscape, and that the forest ecosystem does not appear to be declining at rates that meet the Critically Endangered or Endangered risk status thresholds under the IUCN Red List of Ecosystems criteria, it is unlikely that they will qualify under the WB ESF ESS 6/EIB 3/IFC PS6 criteria.

Ecological Functions or Characteristics that are Needed to Maintain the Viability of the Biodiversity Values Identified

Significant biodiversity values have been identified under the various WB ESF ESS 6/EIB 3/IFC PS6 criteria 1–4, and include four mammal species as listed in subsection on Critical Habitat Species Screening Results in Section 6.2.3. As most of the species, except for the Chinese pangolin, are dependent on a specific habitat for their survival, this criterion assesses the functions or characteristics of these habitat types within the EAAA in the context of the wider landscape to understand if they are critical for the viability of the species.

All terrestrial species, except for the Chinese pangolin, prefer forest habitats, at specified altitudinal ranges. With regard to the Chinese pangolin, this species is not a habitat specialist, and can be found in a diverse array of vegetation and land use types found within and beyond the EAAA. As assessed in the subsections on Highly Threatened or Unique Ecosystems and Habitat of Key Scientific Value (in Section 6.2.3), these ecosystems are unlikely to be sufficiently threatened, unique or distinctive enough such that their presence in the EAAA are crucial for ensuring the long term survival of these significant biodiversity values. It is, therefore, unlikely that the Project is located in an area that qualifies as critical habitat under this criterion.

Biodiversity and/or Ecosystem with Significant Social, Economic, or Cultural Importance to Local Communities and Indigenous Groups

The biodiversity of the project impact area does provide a variety of ecosystem services used by local indigenous people, primarily related to the collection of edible wild plants, medicinal herbs for personal use or sale, forage/fodder for livestock, springs for potable water, timber, and firewood. Most of these services are provided within the community forests and other government-owned forests. These ecosystem services, however, are not considered critical, as local residents do not depend strongly on them for their livelihoods or wellbeing. Any effects on project springs will be mitigated by the Project (see Section 7.1). As discussed in Section 7.3, the Project will only impact on about 1.4% of the land within the affected community forests. Further, the local indigenous people do little hunting or fishing, so do not depend strongly on fish or wildlife for their livelihoods or wellbeing; nor do they rely heavily on plant species for food or their livelihoods. The more significant aspect of biodiversity to local indigenous people is related to the traditional cultural use and importance of these resources. Chapter 7 describes how the Project will affect these ecosystem services and the proposed mitigation and management measures to reduce these impacts.

Habitat of Key Scientific Value and/or Associated with Key Evolutionary Processes

The Project is located in the Eastern Himalayan Broadleaf Forest and the Eastern Himalayan Conifer Forest ecoregions, which cover an area of 100,000 km^2 across Nepal, India, and Bhutan, and are recognized for high levels of species richness and endemism, especially for plants. Of note, the high altitude rangelands in Nepal are important for a variety of endemic flora and fauna, of which 63% and 38% of Nepal's flowering plants are located in the High Mountains and Middle Mountains physiographic zones, respectively. However, high altitude rangelands comprising 1.7 million hectares, or nearly 12% of the country's land area, have only been generally identified as important areas for Nepal's species endemism, are widespread in the northern belt of Nepal bordering Tibet, and represent less than 1% of the rangelands found in the wider Hindu Kush Himalayan Region.

Altitudinal connectivity is also a notable feature of the ecoregions, as various birds and mammals exhibit seasonal movements up and down the Himalayan mountain range slopes. The Arun River is also serves as an important bird flyway for migratory water birds that follow the river corridor and gorge to avoid the higher Himalayas during migration. Given the extensiveness of the Himalayan belt, which stretches from Nepal to India, and the Arun River, which stretches from north to south of Nepal, it is unlikely that there are unique spatial features at the scale of the EAAA that are not also represented in the wider landscape. Similarly, the Project lies within the Arun River Basin and the aquatic ecosystem serves as a corridor for the gene flow of migratory fish species, but the DIA is not a unique or isolated basin that is key to the genetic diversity of the fish species.

The DIA does not have any edaphic interfaces that have led to the formation of unique plant communities, or any sites of demonstrated importance to climate change adaptation, although the larger Himalayan region is a focus for evaluating climate change impacts (e.g., on glaciers).

Although the project impact area has relatively high species diversity, elevation gradients, and is a bird flyway, it has not been subject to significant scientific study and is not distinctive enough to be considered of key scientific value and/or associated with key evolutionary processes.

Legally Protected Areas and Internationally Recognized Areas for Biodiversity Conservation Screening Results

The WB ESF ESS 6 requires that a project that could potentially result in adverse impacts on legally protected areas and internationally recognized areas for biodiversity conservation are subject to the same requirements for areas of critical habitat, natural habitat, and modified habitat if they encompass such habitat types. As described in the subsection on Critical Habitat Criteria in Section 6.2.1, the only legally protected and internationally recognized area for biodiversity conservation that will be affected by the Project will be the MBNP Buffer Zone and associated IBA.

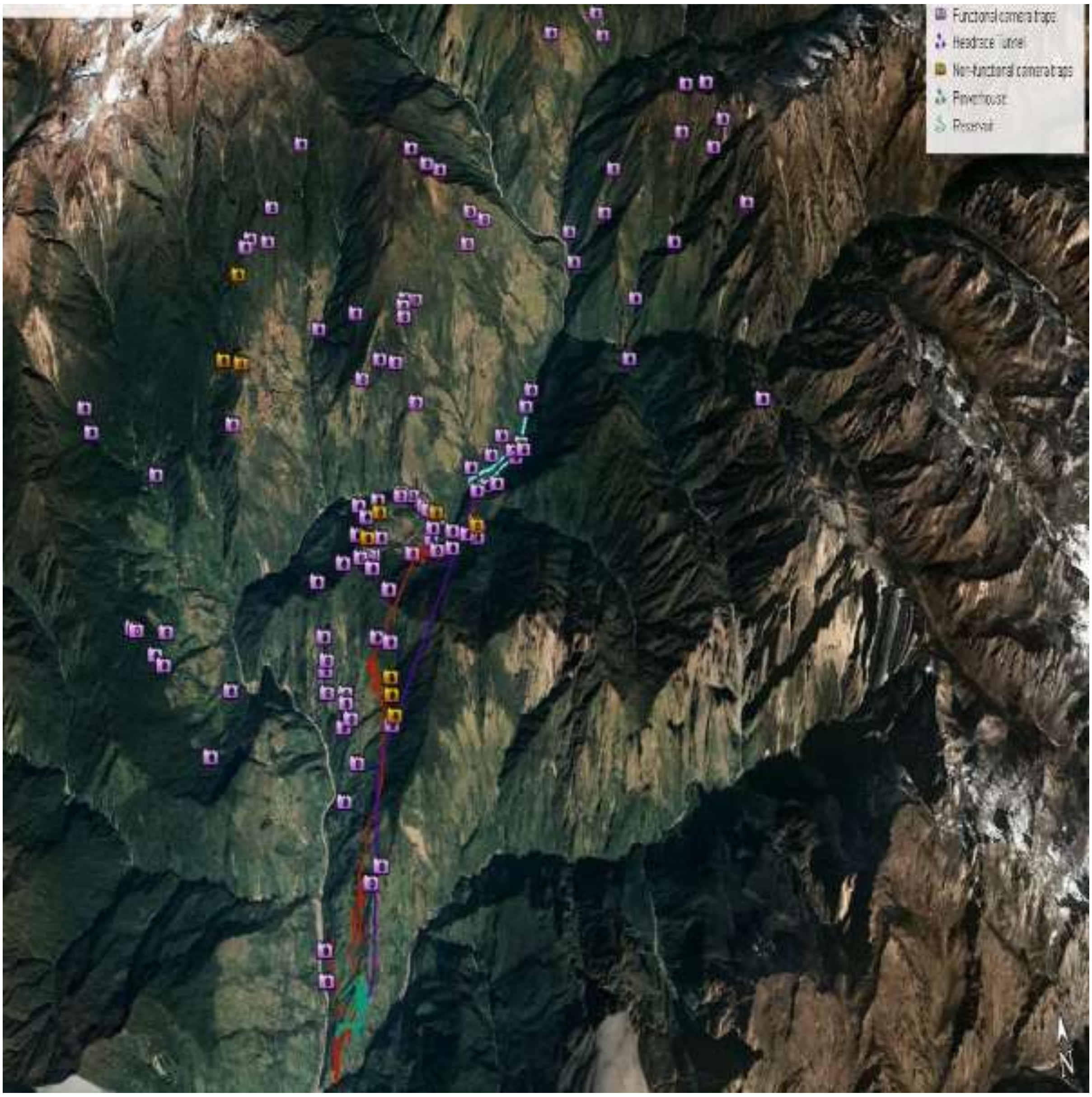
The terrestrial areas of the MBNP Buffer Zone/IBA qualify as critical habitat, as they are likely to maintain populations of the four critical habitat-qualifying terrestrial species. In the case of the section of the Arun River located within the MBNP Buffer Zone, it is unlikely to contain suitable habitat for the golden mahseer. Therefore, only the terrestrial areas of the MBNP/IBA are subject to the same requirements as areas of critical habitat.

Critical Habitat Assessment of the Upper Arun Hydro-electric Project

An additional critical habitat assessment was conducted in the wider Upper Arun Hydro-electric Project (UAHEP) area in March 2022 with the objective to identify critical habitat mammal species and to develop a Biodiversity Management Plan (BMP) for critical habitat features/species that would meet WB's ESS 6 requirements for net gain. This assessment was carried out to gather additional primary baseline data specifically on the status of the Makalu Barun National Park complex and the presence/absence of various endangered mammals (red panda, Himalayan black bear, Chinese pangolin, musk deer, Mandelli's mouse-eared myotis, and others), advise on opportunities for their protection, and address risks associated with the project access road and the hydropower plant. The methods used to achieve the objectives of the study were a literature review, line transects (145 km), and indirect signs such as tracks, hair, skin, feces. Further interviews and stakeholder group interactions and camera trapping between 1,165 m and 4,097 m asl were used. A total of 145 cameras were installed, of which 110 were working after some were vandalized or stolen by local people. Images were collected over 4,822 camera trap days over an area of 482 km^2. Harp trapping and mist nets, as well as echolocation calls recordings, were used to trap and identify bats; 10 species of bats were identified.

The Direct Impact Area of the proposed UAHEP and the access road, as defined in the ESIA, lacks occurrence of Mandelli's mouse-eared myotis (*Myotis sicarius*); Chinese pangolin (*Manis pentadactyla*); or musk deer (*Moschus spp*). The presence of Himalayan black bear (*Ursus thibetanus*) and Himalayan red panda (*Ailurus fulgens*) has been confirmed in the project's direct impact area. Two other endangered terrestrial mammals – the clouded leopard (*Neofelis nebulosa*) and spotted linsang (*Prionodon pardicolor*) were identified as additional critical habitat species in the project site. (see section Critical Habitat Species Screening Results above) The proposed project area qualifies for critical habitat status due to the presence of these four species. The area is currently in a natural state and faces significant levels of human-wildlife conflict due to crop raiding and livestock depredation behavior by some of the critical habitat species, which ultimately result in persecution and retaliatory killing of these species. The other impacts identified, which are expected to intensify with the Project, include habitat loss and fragmentation, disturbance of wildlife movement, illegal trade and poaching, and road kills due to increased vehicular movement (Separate document: Red Panda Network Nepal. 2023. *Critical Habitat Assessment of the Upper Arun Hydro-electric Project.* Unpublished report, submitted to UAHEL).

Figure 6.43: Locations of Camera Traps, Dam and Reservoir Area, Tunnel in the Access Road, and Powerhouse



The relative abundance index and the presence record of critical habitat species in the UAHEP project site are presented below.

Figure 6.44: Relative Abundance Index

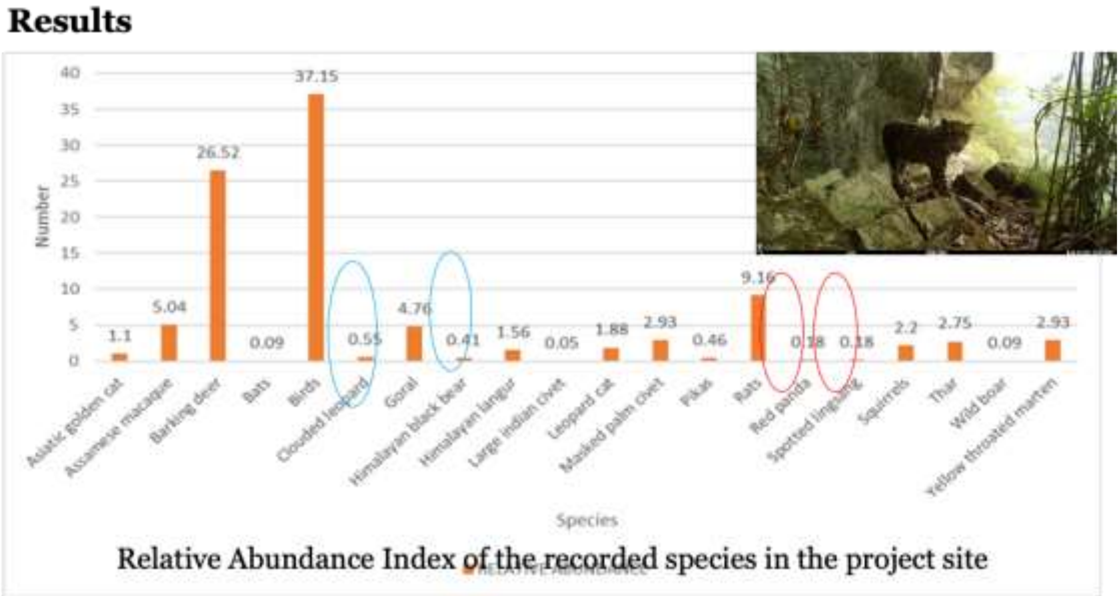
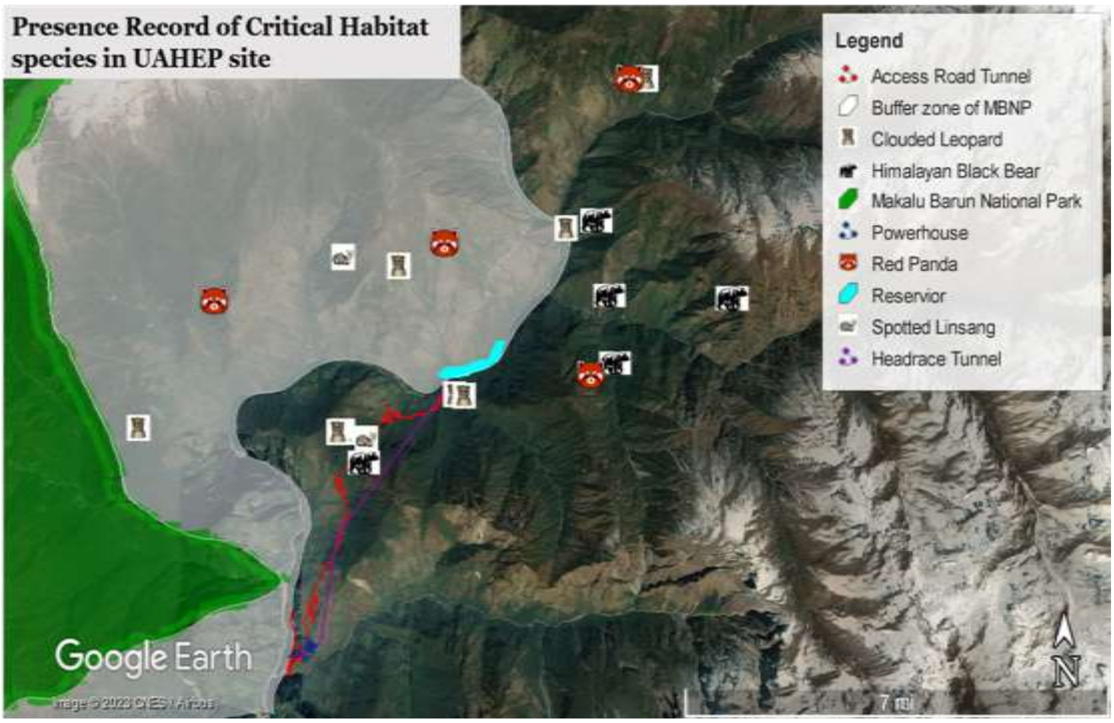


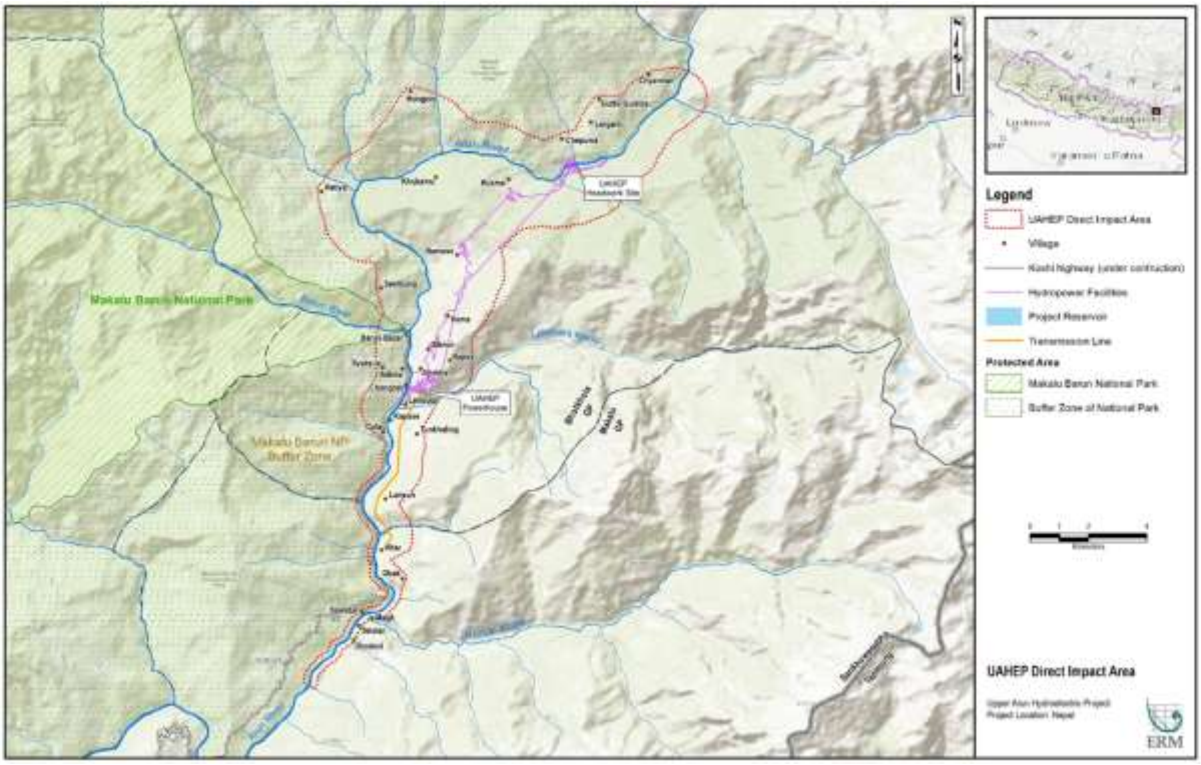
Figure 6.45: Presence Record of Critical Habitat Species in UAHEP Project Site



6.3 Social Baseline

The following sections outline the baseline assessment of socioeconomic, health, political, ethnic, and cultural conditions in the DIA of the UAHEP.[15] The Project DIA includes all areas of direct impact, which are those areas located within the project footprint or area of disturbance, as well as those villages and households directly affected by project construction and operation, as well as the area within which ecosystem services could be affected. ***Figure 6.46*** shows the project DIA, which totals approximately 67.2 km^2, and identifies the villages and settlements included within the project DIA. Additional details concerning the project DIA are provided in Chapter 5 (Section 5.2).

Figure 6.46: UAHEP Direct Impact Area



To the extent possible, sections specific to the DIA draw on information collected during the socioeconomic survey conducted by ERM in 2019 and 2020 (ERM 2020) (see Chapter 5, Section 5.3.2, sub-section on Social Baseline Studies), as well as the results of the FGDs and KIIs conducted at the same time. Where necessary to elucidate topics not covered by the socioeconomic survey, ERM has relied upon municipal or ward level statistics collected in the most recent national census available at the time the assessment was done.[16]

The social baseline parameters covered in this section include:

- Administration, governance and political context
- Demography and ethnicity

[15] Two limitations to the data presented here warrant mentioning. First, the baseline data collected and represented in this chapter dates back to 2019–2020; therefore, prior to project implementation. The Project may need to conduct a rapid update of this baseline information if there is reason to believe that socioeconomic/demographic trends have changed significantly since the original baseline data was collected. Second, the socioeconomic baseline data collected was not conducive to deep analysis of dependence between vulnerable populations and ad-hoc resource gathering, the role of subsistence farming and exchange systems in livelihoods, and intra-group social dynamics. These nuanced characteristics may, therefore, need to be incorporated into planning for specific programmatic interventions by the Project and its implementing partners.

[16] There is no more recent information available at either the rural municipality or ward level, as the office which stored such information was bombed in an armed attack in 2019, destroying its contents and debilitating its ability to collect new statistics.

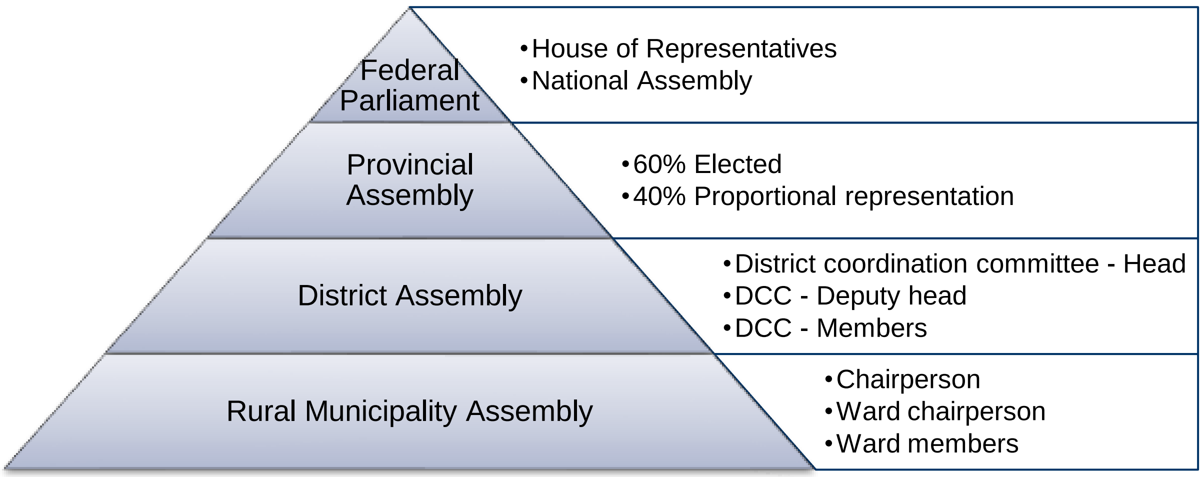
- Ethnic profile of key groups, including traditional cultural beliefs, practices, rituals, and festivals
- Religion, lifestyle, family life, and social organization
- Education[17]
- Economic environment and working population
- Land ownership and its significance
- Livelihood practices
- Household income and expenditure
- Dietary habits and food security
- Physical living conditions
- Community health and wellbeing
- Cultural heritage

The baseline will also present a summary overview of vulnerability within the DIA.

6.3.1 Administration, Governance and Political Context

The political organization of Nepal is provided for in the Constitution of 2015, which establishes a three-tier governance system consisting of the following levels: federal, provincial, and local (which encompasses rural municipality/municipality and the district-level assembly). The Constitution also details the relative authority of each level of governance in a set of schedules and provisions for concurrent/shared power.[18] ***Figure 6.47*** shows the basic structure of political hierarchy within Nepal and the authorities contained therein.

Figure 6.47: Governance and Political Hierarchy in Nepal



The UAHEP is primarily located in Bhotkhola Rural Municipality, in Sankhuwasabha District of Koshi Province, Nepal.[19] In Sankhuwasabha, there are 10 local bodies (9 rural municipalities and 1 municipality[20]) consisting of 76 wards. Sankhuwasabha represents 1 constituency in the House of Representatives of the Federal Parliament and 2 constituencies (1 and 2) in the Koshi Province

[17] The socioeconomic survey did not collect information on skills.

[18] Article 58 states that powers relating any subject that are not mentioned in the list of powers of the federation, province or local level entity, or in the concurrent/shared powers of federation and the province, or not stated in this Constitution, shall rest with the federation as residual powers.

[19] Only a small part (~1km) of the transmission line is located in Makalu-4, Sankhuwasabha District.

[20] These terms refer to rural municipalities and urban municipalities, respectively.

Assembly. Bhotkhola Rural Municipality consists of 5 wards, each of which is comprised of multiple clusters of households referred to as villages.[21]

6.3.2 Demography and Ethnicity

This section offers a brief overview of the demographic and ethnic composition of Sankhuwasabha District, followed by a more detailed description of Bhotkhola Rural Municipality.

Demographic Characteristics: National and Sankhuwasabha District Levels

According to the most recent national census for Nepal (CBS 2012; CBS 2014), the total population of Nepal in 2011 was 26.5 million people (5.4 million households), representing a population increase of 14.4% between 2001 and 2011 (see ***Table 6.40***).[22, 23] The ratio of men to women in Nepal was 94 males per 100 females, the lowest in the South Asian Association for Regional Cooperation (SAARC) region.[24] The population of Sankhuwasabha District in 2011 was 158,742 people, with a sex ratio of approximately 90 men for every 100 women. ***Table 6.40*** provides additional demographic information at the national and Sankhuwasabha District levels.

Table 6.40: National and District Level Demographic Comparison

Demographic Parameter	Sankhuwasabha	Nepal
Total population	158,742	26,494,504
Male population	75,225	12,849,041
Female population	83,517	13,645,463
Sex ratio	90.07	94.16
Average household size	4.60	4.88
Population <15 years	36%	38%
Population in age group 15–59 years	55%	57%
Population >60 years	9%	5.3%

Source: CBS 2014, Vol. 1

Migration out of Nepal is an important factor influencing the demographic makeup. According to the 2011 Census, 12,198 (7.7% of the population) persons migrated out of Sankhuwasabha District in 2011 (CBS 2012). This is significantly higher than the migration rate for Nepal as a whole, which in 2011 was 423,912 people, or 4% of the total population. Of those migrating out of Nepal in 2011, 12.4% were women. See Section 6.3.3 for migration data for the surveyed population within the DIA.

In Sankhuwasabha District, the population is concentrated in urban areas such as Khandbari, the district capital. Sixty-eight percent (68%) of the total population of the district lives in municipality, while 31% live in rural municipalities.

The major ethnic groups in Sankhuwasabha are Chhetree, Rai, Tamang, Kulung, Limbu, Sherpa, and Gurung (as per the results of the 2011 Census). ***Table 6.41*** provides a comparison of the major ethnic groups in Sankhuwasabha District, as compared to the national level. As this table shows, Sankhuwasabha District has a higher percentage of each of the major ethnic groups, than Nepal does

[21] Although a detailed discussion of the particularities of local governance structures is beyond the scope of this document, it is important to note that local systems of organization continue to exist and operate within this and other areas in Nepal and that, often, these local systems overlap with newer, more formal systems of governance indicated above. It is equally important to note that local governance in the Upper Arun Valley may be further distinguished from that of Nepal more generally due to its proximity to the Chinese border and interlinkages between communities therein.

[22] The 2011 Census (CBS 2012) is the most recent set of comprehensive national census data available; Nepal has undergone significant changes over the past decade; thus, while the general trends indicated by this data likely still hold, the data should be seen as indicative rather than definitive in terms of providing an accurate description of current-day Nepal.

[23] CBS. 2014. *Population Monograph of Nepal 2014*, Vol. 1, draws on data from the most recent national census in 2011 (CBS 2012).

[24] SAARC is the regional intergovernmental organization and geopolitical union of states in South Asia. Its member states are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

nationally, with Rai representing the biggest gap (8.4% more representation than at the national level) and Chhetree representing the smallest (1.8% more representation within the district than at the national level). Sankhuwasabha District's percentage of the population that is Brahman-hill and Newar, however, is lower than that of Nepal as a whole.

Table 6.41: Ethnic Groups in Sankhuwasabha and Nepal[25]

Name of Ethnic Group	Sankhuwasabha		Nepal	
Chhetree	18.40%	29,125	16.6%	43,98,053
Rai	10.70%	16,928	2.3%	6,19,994
Tamang	10.40%	16,574	5.8%	15,39,830
Kulung	6.20%	9,755	0.1%	28,561
Sherpa	5.80%	9,257	0.4%	1,12,902
Limbu	5.50%	8,682	1.5%	3,87,243
Gurung	5.40%	8,623	2.0%	5,22,641
Brahman-Hill	5.30%	8,479	12.2%	32,26,903
Newar	4.80%	7,537	5.0%	13,21,933
Dalit*	8.25%	13,091	0.6%	1,55,354
Others	19.33%	30,691	53.5%	1,41,81,090
Total	**100%**	**1,58,742**	**100%**	**2,64,94,504**

Note: * In Sankhuwasabha District the major Dalit castes are Kami, Damai/Dholi, Sarki, and Badi.
Source: CBS 2014, Vol. 1

Bhotkhola Rural Municipality

Bhotkhola Rural Municipality consists of five wards[26] covering an area of 639.01 sq km with a population of 11,440, as per the 2011 National Census (CBS 2014). ***Table 6.42*** provides the basic demographic parameters of Bhotkhola Rural Municipality in 2011, disaggregated by ward.

Table 6.42: Basic Demographic Parameters of Bhotkhola Rural Municipality

Ward No.	No. of Households	Population			Sex Ratio (Females per 100 Males)	Average Household Size
		Total	Male	Female		
1	72	368	183	185	101	5.11
2	404	1,739	849	890	105	4.30
3	661	3,073	1,477	1,596	108	4.65
4	718	3,253	1,609	1,644	102	4.53
5	566	3,007	1,512	1,495	99	5.31
Total	**2,421**	**11,440**	**5,630**	**5,810**	**103**	**4.77**

Source: CBS 2014, Vol. 6

[25] It is important to note that, within individual ethnic groups, there is significant homogeneity in terms of socioeconomic status.

[26] The current Wards 1, 2, 3, 4 and 5 roughly correspond, respectively, to the following former Village Development Committees: Kimathanka, Chepuwa, Hatiya, Pathibhara, and Pawakhola.

As shown in the table above, four out of five Wards in Bhotkhola Rural Municipality had more females than males in the population in 2011. This trend was most pronounced in Ward 3 where the sex ratio was 108 females to every 100 males. The average household size in Bhotkhola Rural Municipality in 2011 was approximately five persons.

Aadibasi/janajati (AJ)[27] groups constituted approximately 35% of the total population of Nepal in 2011.[28] Historically, aadibasi/janajati groups tended to group together in specific areas; however, over the years they have begun to disperse to different parts of the country where they now live interspersed with other aadibasi/janajati and non-aadibasi/janajati groups. As per the most recent national census, these groups have come to constitute a majority of the population in 27 of 75 districts in Nepal.

In Bhotkhola Rural Municipality in particular, the aadibasi/janajati population comprised 95% of the total population in 2011, as shown in ***Table 6.43***. The major ethnic groups in Bhotkhola Rural Municipality are Bhote, Rai, Yamphu, Tamang, Lhomi, Sherpa, and Gurung. Among these, the Bhote community is the most numerous at 28% of the total population, followed by Rai (16%), Yamphu (15.8%), and Tamang (11%).

[27] The term aadibasi/janajati is the functional equivalent of the term ‘indigenous peoples’ in English, but in Nepali it is also synonymous with ‘ethnic minorities’.

[28] CBS 2014.

Table 6.43: Ethnic Profile of the Bhotkhola Rural Municipality and its Constituent Wards (2011 Census Data)

Category		Ward-1		Ward-2		Ward-3		Ward-4		Ward-5		Bhotkhola Rural Municipality		Grand Total	Percentage
	Name of Ethnic Group	Population	% of Ward Population	Population	% of Ward Population	Population	% of Ward Population	Population	% of Ward Population	Population	% of Ward Population	Population in Rural Municipality	% of Rural Municipality Population		
Aadibasi/janajati (AJ) groups	Sherpa	330	92%			72	2%			442	14%	844	7.4%	10,886	95.2%
	Bhote	27	8%	1,381	81%	1,770	58%	49	2%			3,227	28.2%		
	Lhomi			314	18%	532	18%					846	7.4%		
	Tamang					203	7%	1,000	32%	82	3%	1,285,	11.2%		
	Gurung					148	5%	217	7%	286	9%	651	5.7%		
	Rai					206	7%	1,502	48%	123	4%	1,831	16.0%		
	Limbu									26	1%	26	0.2%		
	Kulung					17	1%					17	0.1%		
	Yamphu							67	2%	1,740	54%	1,807	15.8%		
	Damai									59	2%	59	0.5%		
	Newahang									29	1%	29	0.3%		
	Topkegola							217	7%			217	1.9%		
	Newar					25	1%	22	1%			47	0.4%		
Non-AJ groups	Kami					65	2%	65	2%	173	5%	303	2.6%	553	4.8%
	Chhetri			16	1%					188	6%	204	1.8%		
	Brahmin									46	1%	46	0.4%		
Total		357		1,711		3,038		3,139		3,194		11,439		11,439	100%

Source: CBS 2014, Vol. 6

Project DIA

While the above sections relied on a combination of National Census and socioeconomic data collected as part of the December 2019–February 2020 ESIA baseline survey, the following sections are more specific to the DIA (see Chapter 5, Section 5.2 for description of the DIA) and, therefore, draw exclusively upon the socioeconomic survey data, unless stated otherwise.

Each of the five wards within Bhotkhola Rural Municipality is comprised of multiple smaller villages or settlements (locally referred as *tola* or *danda*). The DIA encompasses 25 such villages in total, with the transmission line alignment affecting four of these. ***Table 6.44*** shows a list of the project-affected villages, along with their ethnic composition, the total number of households contained therein, and the sample size covered during the socioeconomic survey conducted by ERM in 2019–2020.

Table 6.44: List of Villages in the Project DIA

Rural Municipality - Ward No.	Village	Ethnic Composition	HHs Surveyed	Total HHs	Sample Size
		UAHEP			
Bhotkhola-2	Chyamtan	Bhote	21	135	16%
	Guthi Gumba	Bhote	8	10	80%
	Lingam	Bhote	11	15	73%
	Chepuwa	Bhote	105	125	84%
	Rukma	Bhote	27	27	100%
Sub-total (Bhotkhola-2)			**172**	**312**	**55%**
Bhotkhola-3	Hatiya	Bhote	34	135	25%
	Hongon	Bhote	41	250	16%
	Khukamu		0	5	0%
Sub-total (Bhotkhola-3)			**75**	**390**	**18%**
Bhotkhola-4	Adima	Tamang, Rai, Gurung	5	10	50%
	Barun Bazar	Bhote	6	6	100%
	Chongrak	Rai, Gurung	5	5	100%
	Gola	Gurung, Rai, Tamang, Newar, Kami (Bishowkarma)	24	27	89%
	Hema	Tamang	25	25	100%
	Jijinkha	Sherpa, Bhote, Newar	6	6	100%
	Limbutar	Rai, Newar	6	6	100%
	Namase	Bhote	71	71	100%
	Sembung	Bhote	5	45	11%
	Sibrun	Bhote, Rai, Gurung, Tamang, Kami (Bishowkarma)	73	75	97%
	Syaksila	Bhote	35	135	26%
Sub-total (Bhotkhola-4)			**261**	**411**	**64%**

Rural Municipality - Ward No.	Village	Ethnic Composition	HHs Surveyed	Total HHs	Sample Size
Bhotkhola-5	Rapsa	Tamang, Rai	4	8	50%
	Kapase	Rai	8	10	80%
Sub-total (Bhotkhola-5)			**12**	**18**	**67%**
Total UAHEP			**520**	**1131**	**46%**
		Transmission line			
Bhotkhola-5	Tunkhaling	Rai, Bhote, Newar	51	95	54%
	Lunsun	Rai	8	25	32%
Sub-total (Bhotkhola-5)			**59**	**120**	**49%**
Makalu-4	Haitar	Rai	3	7	43%
	Obak	Tamang, Rai	11	85	13%
Sub-total (Makalu-4)			**14**	**92**	**15%**
Total transmission line			**73**	**212**	**34%**

Source: ERM Socioeconomic Survey, 2019–2020

A total of 593 households participated in the socioeconomic census, 73 of which are located along the transmission line corridor. The total population represented by these 593 households was 3,422 persons (1,671 males and 1,751 females). ERM collected household level data for all survey questions; however, ERM also collected (via the head of household) basic demographic data at the individual level for each person within these households, including relationship to head of household, ethnicity, age, marital status, occupation, and whether or not they were currently living in the household.

The sex ratio among surveyed households is 105 females for every 100 males, and the average household size is 6 persons per household. Further disaggregation of these demographic trends among the surveyed households is available in ***Table 6.45***.

Table 6.45: Demographic Details of Surveyed Households

Rural Municipality	Ward No.	Village/ Settlement Name	# of Males	# of Females	Total Population	Sex Ratio	# of HHs	Average HH Size
Bhotkhola	**Ward2**	Chepuwa	311	323	634	104	105	6
		Chyamtan	63	68	131	108	21	6
		Guthi Gumba	31	29	60	94	8	8
		Lingam	26	34	60	131	11	5
		Rukma	86	87	173	101	27	6
	Ward 2 total		**517**	**541**	**1058**	**105**	**172**	**6**
	Ward 3	Hatiya	84	97	181	115	34	5
		Hongon	111	134	245	120	41	6
	Ward 3 total		**195**	**231**	**426**	**118**	**75**	**6**
	Ward 4	Adima	13	14	27	107	5	5
		Barun Bazar	15	23	38	153	6	6
		Chongrak	16	14	30	88	5	6

Rural Municipality	Ward No.	Village/ Settlement Name	# of Males	# of Females	Total Population	Sex Ratio	# of HHs	Average HH Size
		Gola	68	65	133	96	24	6
		Hema	80	74	154	93	25	6
		Jijinkha	13	18	31	138	6	5
		Limbutar	12	12	24	100	6	4
		Namase	180	197	377	109	71	5
		Sembung	16	10	26	62	5	5
		Sibrun	229	222	451	97	73	6
		Syaksila	110	83	193	76	35	6
	Ward 4 total		**752**	**732**	**1,484**	**97**	**261**	**6**
	Ward 5	Kapase	19	24	43	126	8	5
		Lunsun	20	18	38	90	8	5
		Rapsa	10	15	25	150	4	6
		Tunkhaling	122	145	267	118	51	5
	Ward 5 total		**171**	**202**	**373**	**118**	**71**	**5**
Bhotkhola total			**1,635**	**1,707**	**3,342**	104	579	**6**
Makalu	**Ward 4**	Haitar	7	9	16	129	3	5
		Obak	29	35	64	121	11	6
	Ward 4 total		**36**	**44**	**80**	**122**	**14**	**6**
Makalu total			**36**	**44**	**80**	122	14	6
Grand total			**1,671**	**1,751**	**3,422**	**105**	**593**	**6**

Source: ERM Socioeconomic Survey, 2019–2020

The socioeconomic survey found that aadibasi/janajati households constitute ~ 99% of the total households surveyed (***Table 6.46***). Specifically, Bhote households constitute 68% of total surveyed households, followed by Rai (15%) and Tamang (11%). The 1% of the surveyed households that are non-aadibasi/janajati consists of households from Kami (Bishowkarma) ethnic groups.[29]

[29] Note: According to conversations with the community, there are an additional six Kami (Bishowkarma) households in the project DIA (one each in Chepuwa, Chyamtan, and Hongon, and three in Hatiya). These were not included in the survey as the survey was done according to stratified – random sampling of a statistically significant percentage of the total population that did not target any specific segment of the population. All households deemed to be vulnerable (see Section 6.3.12) will be entitled to benefits designed to support vulnerable populations, including those identified, but not included, in the survey.

Table 6.46: Ethnic Composition of Surveyed Households[30]

Rural Municipality	Ward No.	Village	Aadibasi/Janajati (AJ)							Non-AJ	
			Bhote	Gurung	Newar	Pradhan	Rai	Sherpa	Tamang	Kami (Bishowkarma)	Grand Total
Bhotkhola	**Ward 2**	Chepuwa	105								105
		Chyamtan	21								21
		Guthi Gumba	8								8
		Lingam	11								11
		Rukuma	27								27
	Ward 2 total		**172**								**172**
	Ward 3	Hatiya	34								34
		Hongon	41								41
	Ward 3 total		**75**								**75**
	Ward 4	Adima		1			2		2		5
		Barun Bazar	6								6
		Chongrak		2			3				5
		Gola	5	7	1		7		3	1	24
		Hema							25		25
		Jijinkha	2		1			3			6
		Limbutar			1		5				6
		Namase	71								71
		Sembung	5								5
		Sibrun	34	5		1	1		26	6	73
		Syakshila	34							1	35
	Ward 4 total		**157**	**15**	**3**	**1**	**18**	**3**	**56**	**8**	**261**

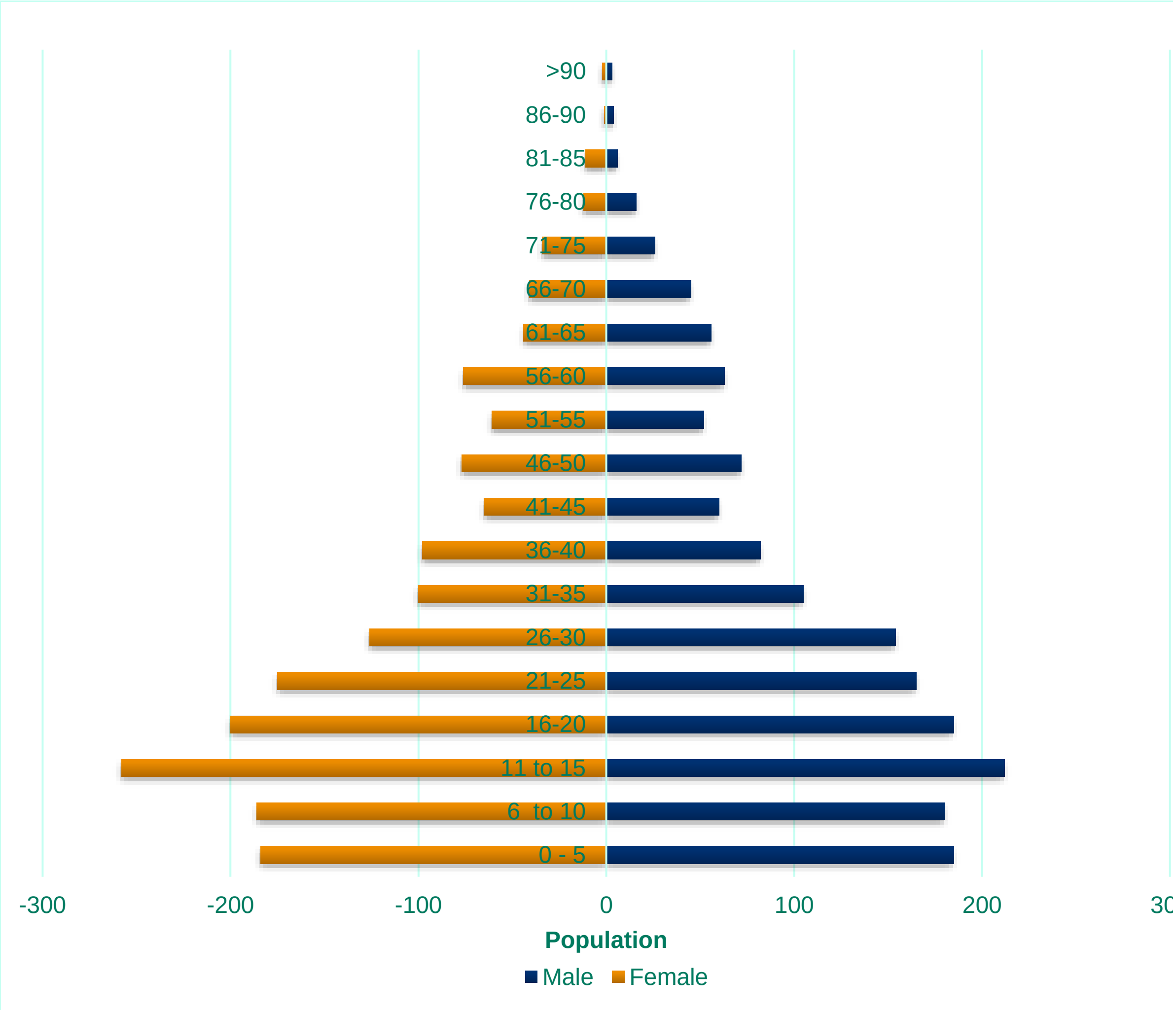
[30] This is according to the household head.

Rural Municipality	Ward No.	Village	Aadibasi/Janajati (AJ)							Non-AJ	
			Bhote	Gurung	Newar	Pradhan	Rai	Sherpa	Tamang	Kami (Bishowkarma)	Grand Total
	Ward 5	Kapase					8				8
		Lunsun					8				8
		Rapsa					1		3		4
		Tunkhaling	2		2		47				51
	Ward 5 total		**2**		**2**		**64**		**3**		**71**
Bhotkhola total			**406**	**15**	**5**	**1**	**82**	**3**	**59**	**8**	**579**
Makalu	**Ward 4**	Haitar					3				3
		Obak					5		6		11
	Ward 4 total						**8**		**6**		**14**
Makalu total							**8**		**6**		**14**
Grand total			**406**	**15**	**5**	**1**	**90**	**3**	**65**	**8**	**593**
Percentage			585							8	100%
			99%							1%	

Source: ERM Socioeconomic Survey, 2019–2020

Figure 6.48 shows the age distribution among the surveyed population. Three trends are of note: first, there is a wider base to the age pyramid, indicating a growing population overall. First, there is a large youth population (i.e., between 11 and 20 years old) and then the pyramid tapers gradually as the age ranges increase, indicating a high rate of dependency on the middle-age groups. Second, there is a noted contraction in the first two age-bands, which represent the youngest age segments of the population. This is likely explained by a combination of factors, including decreasing birth rates, out-migration of adults of child-bearing age, and increasing child mortality rates.

Figure 6.48: Age Distribution Pyramid for Surveyed Households



Source: ERM Socioeconomic Survey, 2019–2020

In so far as it relates to seasonal migration, 76% of individuals within the surveyed households remain in their villages throughout the year, while 24% venture out to urban centers for at least part of the year seeking employment, to trade, or for other purposes (***Table 6.47***).[31] Households within villages at higher elevations (i.e., those in Bhotkhola Ward 2) reported practicing seasonal migration – along with their livestock – from higher to lower elevations in winter months. The dependence on livestock keeping among these households has reduced; however, many still reported going to urban centers in lower elevation areas to escape the cold months and taking up wage employment or trade in herbs collected from higher elevations, which are not available in lower elevations. These migration patterns may

[31] Although responses to this question were provided by the head of household, (s)he was specifically asked to report how many of the people – including children – living within the household engaged in this practice of seasonal migration. Thus, it is possible to report these figures at the individual level.

explain why the percentage of the population reporting having left their village in the past year was higher in Bhotkhola Ward 2 (where elevations are highest) than in other wards in Bhotkhola.

Table 6.47: Seasonal Migration in Project DIA

Rural Municipality - Ward No.	Live in Village Year Round (# people and % of HHs)	Do not Live in Village Year Round (# people and % of HHs)	Grand Total[32]
Bhotkhola-2	667	392	1,059
	63%	37%	100%
Bhotkhola-3	307	119	426
	72%	28%	100%
Bhotkhola-4	1,202	282	1,484
	81%	19%	100%
Bhotkhola-5	345	28	373
	92%	8%	100%
Bhotkhola total	**2,521**	**821**	**3,342**
	75%	**25%**	**100%**
Makalu -4	68	12	80
	85%	15%	100%
Grand total	**2,589**	**833**	**3,422**
	76%	**24%**	**100%**

Source: ERM Socioeconomic Survey, 2019–2020

In terms of longer-term migration patterns, the results of the socioeconomic survey revealed that the vast majority (87%) of surveyed households have been living in their current village for more than three generations, while only 5% are the first generation to arrive (***Table 6.48***). This trend is striking and important in terms of assessing the potential adaptability of a household and, thus, its vulnerability to project impacts. No information was collected on from where the households migrated.

Table 6.48: Duration of Time in Current Village

Duration in Current Village	No. Households (% of Total Households)
More than 3 generations	515 (87%)
3 generations	27 (5%)
2 generations	19 (3%)
1 generation	32 (5%)
Total	**593 (100%)**

Source: ERM Socioeconomic Survey, 2019–2020

[32] The survey specifically asked how many within the household migrated (i.e. just the head of household? The head of household with wife? Wife with children?). Therefore, while the responses in this table are that which the survey respondent (usually the head of household) reported, they nevertheless do reflect an individualized migration dynamic within the population.

As shown in ***Table 6.49***, among those who reported having migrated to their current village, the reasons given for migration are varied. Of the 27 households stating reasons for having migrated, those who have been there for three or more generations all migrated for livelihood, while those who have been in their current villages for one generation reported having moved there for social/marital reasons (two households), natural calamities (six households), and livelihood (13 households). None of the households that have been in their current village for two generations offered any reason for their migration.

Table 6.49: Reason for Migrating to Current Village

Reason for Migrating to Current Village	No. Households (% of Total Households Giving Reasons)
Livelihoods	19
Natural calamity	6
Social/marital	2
Total	**27 (100%)**

Source: ERM Socioeconomic Survey, 2019–2020

6.3.3 Ethnographic Profile of Key Aadibasi/Janajati Groups

The following sections provide a brief ethnographic account of the major aadibasi/janajati groups located within the DIA (as represented by the surveyed households).[33]

Bhote

Most people in the DIA self-identify ethnically as Bhote. While Bhote are also known as Shingshaba[34] or Lhomi[35] in the upper reaches of Arun Valley, legal documents such as citizenship cards and land documents simply state this ethnic identity as "Bhote". In Nepal, Bhote is a common term, which refers to people living in the "Bhot", which is the Himalayan region that falls within Xizang (also known as the Tibet Autonomous Region) in China, or who are of Tibetan origin. Bhote speak a Tibetan dialect and believe that their ancestors came from the Tibetan Plateau and settled in their present location.

Villages and Settlements

In the project-affected villages of Namase, Rukma, Chepuwa, Lingam, Chyamtan, Hungong, Khukmu, Hatiya, Sembung, and Syaksila, the vast majority of households belong to the Bhote ethnic group. Sibrun, Barun Bazar, and Gola have a mixed ethnic composition consisting of Bhote, Tamang, Rai, and Gurung ethnic groups. Several predominantly Bhote villages also have Kami (Bishowkarma)

[33] The FGDs and KIIs conducted by ERM in 2019 were focused on the ethnic characteristics of the aadibasi/janajati groups that constitute 98% of the surveyed households (and 95% of Bhotkhola Rural Municipality, according to the 2011 National Census as described in earlier sections; CBS 2014). An assumption was made here that non-aadibasi/janajati groups' ethnic and cultural characteristics would resemble those of the broader Nepali population and, therefore, did not need to be subject to specific exploration/analysis. Thus, ERM did not generate a unique ethnic profile for non-aadibasi/janajati groups, such as Kami (Bishowkarma).

[34] Bhote are also known as Shingshaba or Lhomi in the upper reaches of the Arun Valley. Some spelling variations are also seen, such as Shingsawa/Shingshaba. Bhote from Walung, a village situated in the eastern fringe of the Arun Valley in Taplejung district call themselves "Shingsaba" or "Shingsapa". This ethnonym of Bhote is not popular in the project impact area. As reported, local people believe that the term "Shingsaba" has an outside origin – Darjeeling, India. Many Shingasaba migrated to Darjeeling in search of a better life and there are still a good number of Shingasaba living in Darjeeling.

[35] Bhote who have recently adopted Christianity are sometimes referred to by the name Lhomi. According to local people, Christianity was introduced first in Chepuwa during mid-1980s when a Finish couple named Alabi and Mariam stayed for 4 to 5 years to study Shingsaba Bhote people and their language for the Summer Institute of Linguistics (SIL). Local people said that the Finish couple not only studied the Shingsaba Bhote language, but also encourage them to follow Christianity. Jyabu Lama of Chepuwa village was the first person to adopt the Christian religion in the village. Currently, followers of the Christian religion are distributed in all villages in the UAHEP area, but their main concentration is in Chepuwa, Gumba/lingum, and Chyamtan and Hongon villages. A Christian "Mandali" has been established in each major village with a community building for weekly services.

households. For, example, Sibrun has five such households, Hatiya has three, and Chepuwa, Hongon, Chyamtan, and Syaksila villages have one each.[36]

Lineage and Clan Composition

Bhote are divided into a number of patrilineal, exogamous lineages and clans. The broad structure of internal social sub-divisions and their distribution among project-affected villages is provided in ***Table 6.50***. The following sections offer descriptive details of these lineages and clans, drawing on information gathered during the FGDs and KIIs conducted by ERM during field research in 2019.

Table 6.50: Lineage and Clan Composition of Bhote

Lineage	Clan	Village
Thikkepa	Pechhiring, Raptemba, Pubukamma, Pubuthujba, and Uchchentesi	Hongon, Namase, Syaksila and Sembung
Nuppa	Chyaba, Mapchya, Nawa, Thaguwa	Chepuwa and Chyamtan
Ponsuwa		Chyamtan
Khamba & Nawa	Migrated groups from Kham, Xizang (Tibet Autonomous Region of China)	Hatiya and Hungong

Source: ERM Socioeconomic Survey, 2019–2020, FGDs and KIIs

Traditional knowledge and local legend say that the Thikkepa are the descendants of early settlers in the upper Arun Valley, while others came from different places in the Tibetan Plateau (Tibet Autonomous Region). There are various local legends, tracing the origins of the Bhote to the Tibet Autonomous Region. For example, the Khamba and Nawa came from Kham only two to three generations ago to settle in Hatiya and Hongon.

There is a level of sociocultural interdependence among Bhote clan groups; for example, they are often interconnected through marriage relations. There are several instances of marriage between individuals hailing from Chepuwa (Nuppa) and Hongon (Thikkepa), while other villages such as Chyamtan, Rukma, Namase, and Sibrun are mixed settlements of various Bhote clans. These villages are connected through a nested web of marital relations. A marriage requires the support, sympathy, and best wishes of both affinal and consanguineal kin groups; thus, marriages between clans and kin groups often result in the developing of close bonds – both sociocultural and familial. Similarly, strong social ties relating to death rituals also exist among the Bhote clan groups. For example, in Bhote culture, if a woman's parent were to die, it would be her husband (son-in-law) who would attend the funeral and cremate the deceased. This further increases sociocultural interdependence when husband and wife are from different clans.

Another factor contributing to sociocultural clan interdependence is that Bhote people still practice communal work/reciprocal labor exchange, particularly relating to the construction of houses. The Bhote people possess unique sociocultural institutions (i.e., Ming, Fabu, Khadukpa) that are based on the reciprocal exchange of labor and communal work, often between clans. These practices of sociocultural interdependence (based on kinship, residential proximity, and economic cooperation between clans) mean that, if households were to move to a new area, they would require adjustment and adaptation to new a sociocultural milieu. The implications of this are discussed further in Chapter 7.3 (Social and Environmental Risks, Impacts, and Mitigation) as well as in the UAHEP Resettlement Action Plan (RAP).[37] While the FGDs and KIIs did not reveal the existence of any food stock/exchange groups in the area, the borrowing of staples such as food grains, salt, and kerosene during times of shortage is common among kin groups and neighbors.

[36] While the survey only included eight Kami (Bishowkarma) households, conversation with communities identified another six Kami (Bishowkarma) households within the surveyed communities.

[37] See UAHEP RAP for a discussion on the socioeconomic and cultural rationale for the various proposed resettlement strategies for physically displaced households.

Traditional Beliefs, Practices and Culture

Most Bhotes follow Lamaism and Shamanism and identify themselves as Buddhists, however a small percentage have converted to Christianity. There are two categories of Shamans: Lopen and Khendam. Bhotes also have Lamas who perform rituals related to Buddhism, which is often mixed with animism and the Tibetan Bon religion. It is a popular belief that Bhotes adopted Buddhism during the rule of Sikkim. Von Fürer-Haimendorf, who chronicled this area in the mid-twentieth century, wrote that the traditional way of life of the Bhote does not conform to Buddhism; rather, it resembles tribal cultures similar to Kirati (those who believe in nature worship). Blood sacrifice (pigs, sheep, fowls and yak) forms an essential part of their traditional sociocultural life (Von Fürer-Haimendorf 1975).

Until the Makalu Barun Conservation Area was established in 1991, hunting also constituted an important feature of the Bhote traditional life in the DIA. Bhote used to hunt with bow and arrow and locally made guns. They would worship local deities for success before leaving for a hunt (Bista 1967).

In terms of festivals and rituals, Bhotes observe Lhosar, Dabla, Torchyak, Chhichyu, Aita (Bhumi Puja in Nepali), and other religious festivals. When members of the Bhote ethnic group die, their relatives cremate the body of the deceased and collect some ashes and remains (such as *astu* – unburnt bone remains) of the dead body. They build a small monument of stone with a *dhaja* (flag), under which they put the ashes and other remains. Cremation sites are usually found at high elevations located near Bhote settlements (see Section 0) (Bista 1967).

Seasonal Migration

In the Upper Arun Valley, it is common practice for Bhote households to engage in seasonal migration to sell herbs collected in and around their villages. Some Bhote residents from Chyamtan, Guthi Gumba, Lingam, Chepuwa, Hungong, and Rukma practice seasonal migration during the winter months to escape from extreme cold weather at higher elevations. A few decades ago, a great number of households used to migrate, essentially vacating the whole village. Now it is only a select few individuals from each household who migrate seasonally, leaving the villages relatively intact. In FGDs and KIIs, local residents indicated that improved access to markets, due to the recent construction of the Koshi Highway, and better economic conditions in the villages, due to the increased presence of cardamom farming, are the main reasons why seasonal migration has declined in recent years.

Much of the seasonal migration that does occur is aimed at cities such as Kathmandu, Khandbari, Dharan, and Darjeeling (India), where there is greater access to employment and economic opportunities. Among those who continue to migrate, the primary “push” factors are poverty, the remoteness of villages, extreme climatic conditions, and lack of access to jobs, hospitals, and schools within their own villages. During FGDs, participants expressed the belief that migration is the only way to escape from the economic and social hardships of village life. One FGD participant who had been living in Kathmandu since 2007 estimates that more than 40% of the Bhote people living in Kathmandu have migrated from their original villages. The migrants living in Kathmandu and elsewhere are employed mainly in the tourism sector and small businesses. However, they continue to show an attachment to their place of origin (Upper Arun) and many still own their ancestral lands and have relatives living in these villages.[38] Thus, spiritual connection to the land/region is not limited to those still living in the region.

Customary Land Ownership and Land Tenure

One of the historical and customary land tenure systems of the Bhote is the Kipat system, a communal form of land ownership. Even after the subjugation of Arun Valley into the Gorkhali Kingdom in the 1770s, the Kirati and Bhote people enjoyed a greater degree of cultural and political autonomy, in comparison to others in the kingdom. This is because the Gorkhali kings did not invade their lands or violate their customs. For hundreds of years, both Kirati Rai and Bhote people followed the Kipat system

[38] Information relating to ‘absentee’ land owners within the project DIA is not available, as the socioeconomic survey was only conducted among those who were present within the project DIA.

and were referred to as *kipatiya* (kipat holders). Within this system, *gobas* (Bhote chief or headman) and Rais were considered “chiefs” who wielded political power over a territory, demanding obedience and allegiance from all who lived there. Under the Kipat system, the entire Upper Arun region was governed by a *goba* who lived in Shyakshila. The *goba* acted as a tax-collector for the area and was supported by *gembu ming* and *gaurung* (official titles in the Kipat system), who helped him perform his socio-political duties. The position of *goba* was hereditary. Although the Kipat system was abolished in 1964 under the Second Amendment of the Land Reforms Act, the descendants of these headmen still play a significant sociocultural role in their communities (Von Fürer-Haimendorf 1975).

After the abolishment of the Kipat system, land was registered in the name of individuals and land ownership documents (*lal purja*) were issued. During the FGDs and KIIs, many local people reported not having formal ownership documents for the lands they have been cultivating, as some of them were not present in their villages when the land survey process was conducted in the 1990s. In the socioeconomic survey, 35 households also reported not having a registration certificate for their house, and two stated that they did not know the status of their land.[39] No specific question was asked about whether or not households have land ownership papers.[40]

The practice of cultivating land by tenancy (legal tenant, sharecropper, fixed term cultivator) is also practiced in the area. “*bandagi”* is a type of informal lease agreement commonly practiced by Bhote peoples.[41] Under a *bandagi* arrangement, the land is given to someone for use (farming and building houses to stay on farmland if necessary) after he or she pays a certain amount of money to the land owner. The *bandagi* amount paid to the landowner serves as collateral and the owner can ask the tenant to vacate the land after paying back the *bandagi* amount.

Another important characteristic of land ownership in the DIA relates to male and female ownership patterns. According to the socioeconomic survey ERM conducted in 2019–2020, nearly one fifth (19%) of surveyed households reported that land is owned by female household members. While FGDs revealed a perception among participants that possession of land by women has increased in recent years, typically women own much less land than the male members of their family. This is perceived to be the case, even despite a government land tax subsidy offered to those who are willing to put land into a women’s name when purchasing or otherwise acquiring land. See Section 6.3.7 (specifically ***Table 6.68***) for additional details pertaining to the gender dynamics of land ownership in the DIA.

The socioeconomic survey also revealed differences in the average size of land ownership between ethnic groups: the average landholding size in the DIA is approximately 48 ropani (2.4 hectares) per household, while the average land ownership for Bhote households is approximately 51 ropani (2.6 hectares). See Section 0, subsection on Land Ownership, for additional break-down of land ownership by ethnic group.

Rai (Kirati) Groups

Another aadibasi/janajati group present in the DIA in significant numbers (approximately 15% – see ***Table 6.46*** above) is the Rai community. Rai, a sub-category of the Kirat people, is one of the major ethnic groups in Nepal. Kirati is a common term used to describe ethnic groups such as Rai, Limbu, Sunuwar, and Yakkha. The term Rai was used for those who collected taxes on behalf of kings or the ruler under the Kipat system. As a result, numerous different linguistic and cultural groups are referred to as Rai. Within the Rai cultural group, there are numerous groups such as Yamphu, Khaling, Chamling, and Kulung. These groups are culturally different from each other and speak distinct dialects (Bista 1967). Among these linguistic and cultural groups, Yamphu are more numerous in the Rai community and are referred to as the “*kipatiya*” – original landholder – of the DIA. Other sub-ethnic

[39] The lack of formal ownership papers will have implications for those being physically displaced as a result of project-related land acquisition. This is dealt with in the Project’s RAP.

[40] It is important to note the distinction between land ownership papers and house registration certificates. The former applies to the land itself, while the latter applies only to the right to build/inhabit a residential dwelling (regardless of whether or not the person to whom that dwelling belongs owns the land on which it rests).

[41] Also spelt “*bandaki*” and “*bandagee*”.

groups of Rais such as Khaling, Chamling, and Kulung are thought to be later settlers in the area, having migrated from the Majh Kirat.[42] The Yamphus identify themselves as “Yakkhaba” and their language is Yakkhaba Khap.

Traditional Beliefs, Practices and Culture

The Rai of the DIA have a rich oral tradition known as *Mindum* or *Mudhum*. These oral sources describe them as aboriginal people of Arun Valley. They believe that their ancestors, nature spirits, and evil spirits have influence on the health of people, the success of the clan, the bounty of their harvest, the fertility of cattle, and in maintaining harmony within the community. Each type of ancestor and supernatural spirit is associated with a location and believed to wield a particular type of power to influence the lives of human beings. Rituals are performed to connect with their ancestors and maintain a harmonious relationship between human, ancestor spirits and supernatural spirits. It should be noted that Yamphu and Shingsaba Bhote have long inhabited the Arun Valley and have a special relationship with their ancestral land. This attachment is manifest and maintained through their sacred, cultural sites, which continue to reinforce their ethnic history and identity. Many of these religious and cultural sites are shared “cultural resources” of aadibasi/janajati in Upper Arun Valley.[43]

Rai villages are found at lower elevations in the Arun Valley. The Rai are in the majority and are culturally dominant in the villages of Chongrak, Adima, Kapase, Tungkhaling, and Lunsun. A few Rai households are also present, along with other ethnic groups, in Gola, Obak, and other neighboring villages. Rai villages tend to be less densely organized than other villages in the vicinity. Their houses have walls of stone and mud, with corrugated iron sheets for roofs. In a few cases, stone slabs may be used to construct the roof. Most Rai houses are two-story structures; the upper floor is generally used for the storage of grain and other household possessions, and the ground floor has the kitchen, dining area and bedroom/s.

The Rai are primarily subsistence farmers. Land is mostly not irrigated and agriculture is rain-fed. People practice labor exchange (*parma*) as a way of helping each other with agriculture and related activities. While the FGDs and KIIs did not reveal the existence of any food stock/exchange groups in the area, the borrowing of staples such as food grains, salt, and kerosene during times of shortage is common among kin groups and neighbors. For farming, the Rai use simple agricultural equipment: ploughs, sickles, and hoes, with traditional manure as fertilizer, although a very small number also use modern fertilizers. They supplement their household income with livestock rearing; some households run small tea shops and other small businesses along the roadside. The major crops grown by Rais are maize, millet, wheat, barley, and potatoes. More recently, cardamom is being grown as a cash crop and has contributed to the growers’ incomes. Rai households tend to keep livestock in small numbers, including cows, oxen, goats, chickens, and pigs. Some people also take up daily wage work, such as unskilled labor in construction activities.

Tamang

In the DIA, Tamang is the third most common aadibasi/janajati community. The term Tamang is made up of two words — “Ta”, which means horse, and “Mang”, which means rider or trader. This suggests that the Tamang are descendants of horse traders or riders (Bista 1967). It is said that their ancestors migrated to the Arun Valley from Tamsaling in western Nepal six or seven generations ago. The Tamang speak their own language (Tibeto-Burman) and have their own distinct culture and traditions. They follow Buddhism and put colorful flags (printed Buddhist mantra cloths) in various places, including all Tamang homes.

The Tamang have their own traditional socio-political institutions to maintain social cohesion and perpetuate their own cultural norms and values. They are divided into sub-clans. Kinship clans are

[42] Martin Gaenzsle describes the Majh Kirat as southern part of Sankhuwasabha District in his publication: *Origin and Migrations: Kinship Mythology and Ethnic Identity among Mewahang Rai of East Nepal* (Gaenszle, 2000.

[43] See 6.3.14 for further information on cultural heritage sites.

exogamous clans with complex intermarriage restrictions. ***Table 6.51*** sets out the six types of customary leaders among Tamang, and their sociocultural roles.

Table 6.51: Customary Leaders of Tamang and their Roles

Tamang Customary Leader Title	Sociocultural Role
Ganba	The Ganba is the overall leader who participates in all types of social, political, and religious events and keeps a check on other leaders.
Tamba	The Tamba is responsible for cultural aspects and plays an important role in marriage ceremonies.
Bonbo	The Bonbo provides treatments to the sick and needy of clan deities and propitiates the local gods and goddesses.
Labonbo	The Labonbo (Laptaba) keeps the history of the clan and lineage alive through the worship of clan deities.
Lama	The Lama carries out death rites (Ghewa) and officiates rituals related to the Buddhist religion.
Choho	The Choho looks into internal conflicts and dispenses justice maintaining peace, security, and wellbeing in the society.

Source: ERM Socioeconomic Survey, 2019–2020, FGDs and KIIs

The major festivals celebrated by the Tamang are Buddha Jayanti (also known as Saga Dawa in their language), Sonam Losar (New Year), Tihar, and Dashain. Tamang have a rich tradition of songs and dance and a favorite musical instrument is the damphu drum (tambourine). Tamang selo is one of the most popular forms of folk music in Nepal.

In the DIA, Tamang live in Hema, Sibrun, and Rapsa villages. Hema is a predominantly Tamang village, while Sibrun is a mix of Tamang, Bhote, Gurung, and Kami. Rapsa is a mix of Tamang and Rai people.

Gurung/Tamu

The name Gurung is derived from the Tibetan word “Grong”, which means farmer. Gurung refer to themselves as “Tamu”, or horseman, in Tibetan language. Their numbers are greatest in Kaski, Lamjung, Mustang, Manang, Gorkha, Parbat, and Shyanja districts, but Sankhuwasabha District also has a significant Gurung population (Bista 1967). The Gurung currently living in the DIA (primarily in Gola and Sibrun villages) migrated from the districts mentioned above several generations ago and have established a harmonious relationship with other aadibasi/janajati communities in the area. These groups rarely use their mother tongue, instead preferring to speak Nepali.

Historically, Gurungs practiced their ancient religion known as Bon, which is Shamanistic and animistic in terms of its beliefs, but later adopted Tibetan Buddhism. Some Gurung people also consider themselves to be Hindu; however, they celebrate their festivals and carry out the ceremonies and practices related to worship, birth, death, and marriage in accordance to the Bon and Buddhist religions. Loshar (New Year, as per the traditional calendar of Xizang and western China, which falls at the end of December) is the biggest festival celebrated by Gurungs.

The traditional priest of the Gurung, known as *ghyabre*, who officiates at birth rites of newborn babies on the eleventh day after the birth, at funeral services, and at post-funeral rituals called *pa-ye* (Bista 1967). Gurungs may either cremate or bury their dead, depending on the position of the constellations at the moment of death. The Gurungs of Gola village usually cremate their dead in Mani Danda, which is located in Gola Lingum, just uphill from the village. Some Gurungs from Gola, however, have recently started to cremate their dead on the bank of Barun River at Barun Dovan. The Gurung of Sibrun cremate their dead along the banks of Arun River downhill from the village. Some Gurung who have adopted Buddhism accept the Lama as their priest.

Like other communities in the area, the Gurung depend on subsistence agriculture (e.g., staple crops, off-season vegetables, and cardamom, which is an important cash crop in the area).[44] Families who do not have enough income often engage in daily wage labor in both agricultural and non-agricultural sectors. During the planting and harvesting season, people work as agricultural labor in the field. During other seasons, people may be engaged in different jobs such as construction workers, porters, masons, and carpenters in nearby villages and beyond. Their earnings from performing these tasks help to maintain their livelihoods. Some families also receive remittances from family members working outside the village, while others have established small shops and other business activities.

Newar

The Newar (also Nepa or Newa) are found in every part of Nepal. They are considered to be the original inhabitants of the Kathmandu Valley. The socioeconomic survey conducted by ERM in 2019–2020 revealed a total of five Newari households living in the DIA: one household each in Gola, Limbutar, and Jijinkha, and two in Tunkhaling village. These Newars had migrated from different parts of the district, approximately one generation ago. The Newari people in these villages do not speak their mother tongue, opting instead to speak Nepali. They practice Hinduism and Buddhism, and, as such, their culture is heavily influenced by both religious, along with remnants of the ancient Kirat culture. They tend to be more interconnected with other ethnicities within their villages than with other Newars outside of the project impact area.

Like other aadibasi/janajati in the Upper Arun Valley, these Newars mainly practice subsistence agriculture and animal husbandry, at times supported by small shops and businesses. The major subsistence crops grown by Newari households are maize, millet, wheat, barley, and potatoes, while cardamom is an important cash crop. In terms of livestock, Newari households tend to rear cows, oxen, goats, chickens, and pigs. Families without a steady source of income also engage in daily wage labor, and some receive remittances from other parts of the country/abroad to supplement their household earnings.

Sherpa

According to linguists, the term Sherpa means easterner in Tibetan language. There are four Sherpa households in Jijinkha village, all of which reported in the FGDs/KIIs having migrated there from Tintale Dingla (currently located in Bhojpur District) four generations ago.[45]

Sherpas have a distinct language, religion, and culture. The Sherpa language and script are derived from the Tibetan language and belong to the Tibeto-Burman language family. Sherpa follow Buddhism and, although their culture, rituals, festivals, and customs are based on the Buddhist religion, they retain some animist beliefs such as the worship of mountains, lakes, and forests as the abode of gods, goddesses, or souls and spirits. Sherpa celebrate their major cultural festival Lhosar (New Year's Day) with much fanfare. The Lama (priest) plays a significant role among the Sherpa at key occasions, such as births, marriages, and deaths. After the death of a person, the Lama recites the sacred text and gives instructions as to whether the deceased will be cremated or buried.

The houses of the Sherpa are similar to those of the other communities In the area and their traditional dress is similar to that of Tibetans. Like other aadibasi/janajati groups in the area, Sherpa households practice subsistence agriculture and keep livestock in small numbers. They supplement their income by collecting and selling medicinal and edible herbs and by working as guides in the trekking-tourism sector. Seasonal migration to Tibet Autonomous Region of China is a recent practice for many Sherpa.

6.3.4 Religion, Family Life, and Social Organization

As shown in ***Table 6.52***, the majority (80%) of the households surveyed reported following Buddhism, while approximately 9% of households follow Hinduism, and 8% follow Kirat or animism, considered by

[44] Livelihoods tend to vary depending on geospatial, more than ethnic, factors. See Section 6.3.7 for more details.

[45] All four Sherpa households were included in the socioeconomic survey.

many as the original form of religion among aadibasi/janajati households (before the adoption of Buddhism, Hinduism, or Christianity).

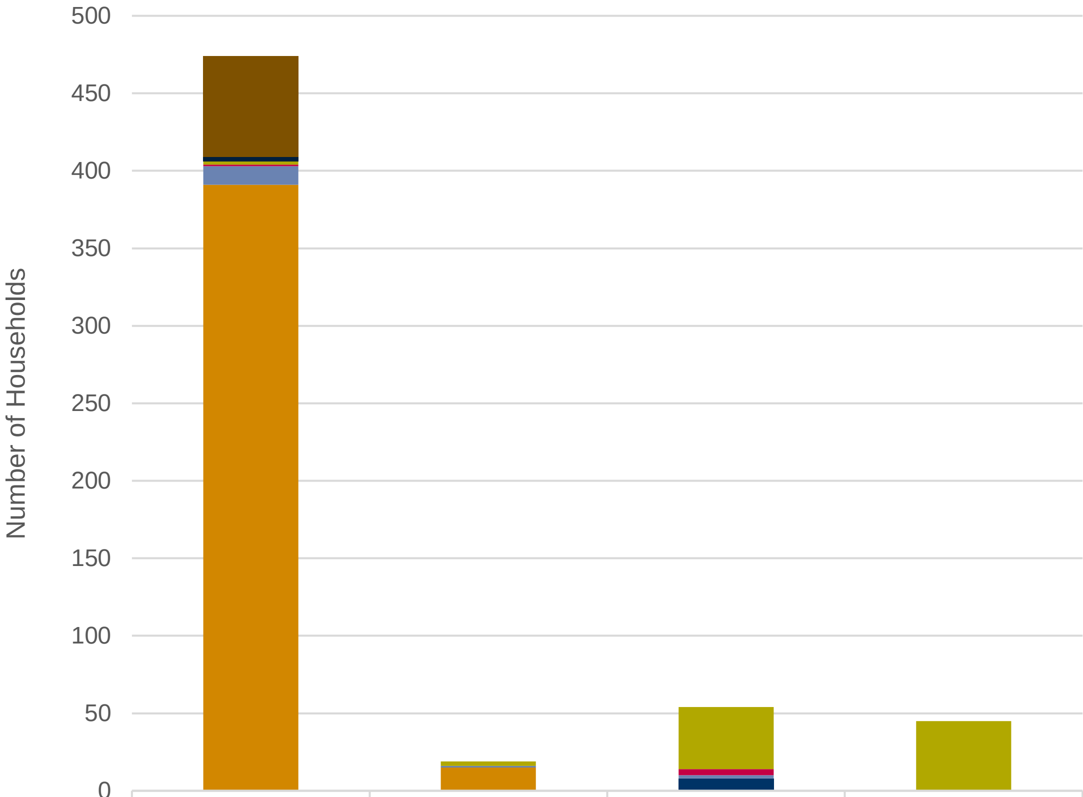
Table 6.52: Religion Followed by Surveyed Households

Rural Municipality	Ward No.	Village	Buddhism	Hindu	Kirat	Christian	Grand Total
Bhotkhola	**Ward 2**	Chepuwa	97			8	105
		Chyamtan	21				21
		Guthi Gumba	6			2	8
		Lingam	8			3	11
		Rukma	25			2	27
		Ward 2 total	**157**			**15**	**172**
	Ward 3	Hatiya	34				34
		Hongon	41				41
		Ward 3 total	**75**				**75**
	Ward 4	Adima	3		2		5
		Barun Bazar	6				6
		Chongrak	2		1	2	5
		Gola	13	6	5		24
		Hema	25				25
		Jijinkha	6				6
		Limbutar		5	1		6
		Namase	71				71
		Sembung	5				5
		Sibrun	64	7	1	1	73
		Syaksila	34	1			35
		Ward 4 total	**229**	**19**	**10**	**3**	**261**
	Ward 5	Kapase	1	4	3		8
		Lunsun		4	4		8
		Rapsa	3	1			4
		Tunkhaling	3	26	22		51
		Ward 5 total	**7**	**35**	**29**		**71**
Bhotkhola total			**468**	**54**	**39**	**18**	**579**
Makalu	**Ward 4**	Haitar		1	2		3
		Obak	6		4	1	11
		Ward 4 total	**6**	**1**	**6**	**1**	**14**
		Makalu total	**6**	**1**	**6**	**1**	**14**
		Grand total (percentage of total)	**474 (80%)**	**55 (9%)**	**45 (8%)**	**19 (3%)**	**593 (100%)**

Source: ERM Socioeconomic Survey, 2019–2020

As shown in ***Figure 6.49***, Bhote households mostly follow Buddhism, although recently some of them have adopted Christianity (see ethnographic profile of Bhote in Section 6.3.3 for more information).[46] Rai households either identify themselves as followers of Hinduism or Kirati, a form of belief in nature worship. The non-aadibasi/janajati households primarily reported following Hinduism.

Figure 6.49: Religion Followed by Different Ethnic Groups



	Budhism	Christian	Hindu	Kirat
Tamang	65			
Sherpa	3			
Rai	2	3	40	45
Newar	1		4	
Gurung	12	1	2	
Bhote	391	15		
Kami			8	

Religious Groups

Source: ERM Socioeconomic Survey, 2019–2020

As shown in ***Table 6.53***, 88% of non-aadibasi/janajati households are nuclear families (in which a married couple live with their children) and the remaining 12% live in joint family situations (in which elderly parents live with their adult children and their offspring). By comparison, only 62% of aadibasi/janajati households live in a nuclear family situation, compared to 29% living in a joint family structure and 10% living in an extended family structure (i.e., family includes members outside of immediate kin group, for example a cousin from spouse's side). Therefore, one can reasonably conclude that aadibasi/janajati ethnic groups show more propensity than non-aadibasi/janajati groups to live in a non-nuclear family structure.

[46] It is important to note that some households may, in addition to formal religious practices, also engage in traditional practices which are similar to one another. This suggests that, culturally speaking, Bhote households of different religious may be similar in terms of beliefs and ceremonies.

Table 6.53: Types of Family among Different Ethnic Groups

Caste/Ethnicity Group	Caste/Ethnicity Name	Nuclear Family	Joint Family	Extended Family	Total Households
AJ group	Bhote	246	118	42	406
	Gurung	6	5	4	15
	Newar	5			5
	Pradhan	1			1
	Rai	63	19	8	90
	Sherpa	3			3
	Tamang	36	24	5	65
	AJ group total	**360**	**166**	**59**	**585**
	AJ group percentage	**62%**	**28%**	**10%**	**100%**
Non-AJ group	Kami (Bishowkarma)	7	1		8
	Non-AJ group total	**7**	**1**		**8**
	Non-AJ group percentage	**88%**	**13%**		**100%**
	Grand total	**367**	**167**	**59**	**593**
	Grand total percentage	**62%**	**28%**	**10%**	**100%**

Source: ERM Socioeconomic Survey, 2019–2020

In Nepal, the legal marrying age without parental permission is 20, although people between the ages of 18 and 20 can be married with the permission of their parents.[47] As shown in ***Table 6.54***, the survey found that there are 20 people between the age of 15 and 18 who are either married or divorced, suggesting a prevalence of early marriage (defined as marriage under the age of 18) among 5% of this demographic. This suggests a lower prevalence of early marriage than at the national level, where one study has estimated approximately 37% of females are married before they are 18 years old (Human Rights Watch 2016).

Table 6.54: Marital Status among 15–18 Year Olds

Rural Municipality	Ward No.	Married	Divorced	Unmarried	Grand Total
Bhotkhola	Ward 2	4		94	98
	Ward 3			41	41
	Ward 4	8		145	153
	Ward 5	6	2	40	48
Bhotkhola total		**18**	**2**	**320**	**340**
Makalu	Ward 4			9	9
Grand total	Number	**18**		**329**	**349**
	Percentage	5%	1%	94%	100%

Source: ERM Socioeconomic Survey, 2019–2020

[47] Marriage Registration Act, 2028 (1971), retrieved from http://www.lawcommission.gov.np/en/archives/13251.

As shown in ***Table 6.55***, 70% of those who are or were married early are female, while the remaining 30% are male. In the FDGs and KIIs, community members expressed their concern over the increasing number of early marriages, for which they blame the influence of social media and lack of education facilities at the secondary school level.

Table 6.55: Gender Disaggregation of Population Subject to Early Marriage

Rural Municipality	Ward No.	Male	Female		Grand Total
		Married	Married	Divorced	
Bhotkhola	Ward 2	1	3		4
	Ward 4	1	7		8
	Ward 5	4	2	2	8
Grand total		**6**	**12**	**2**	**20**
		30%	**70%**		**100%**

Source: ERM Socioeconomic Survey, 2019–2020

As shown earlier, the ethnic composition of the villages in the DIA varies. In general, the villages in the headworks area (Ward 2) are mostly inhabited by Bhote. The villages along the access road connecting the dam site and power-house site are heterogeneous, as Bhote, Tamag, Gurung, and Rai live together, along with a few non-aadibasi/janajati households. Moving downstream, Rai emerge as the major ethnic group. In general, clusters of households in these locations form a closely knit community, sharing a shrine and a reciprocal system of working on each other’s farmland; however, there are also strong inter-group relationships within villages During the FGDs and KIIs, community members identified three traditional social institutions:[48]

- Parma – a traditional institution through which households exchange labor
- Kiduk – through which households engage in reciprocal exchange and economic support in death and marriage rituals
- Gaun samaj – a village level committee formed every two or three years (the members of which are elected by the community), which plays a major role in conflict resolution and community development work

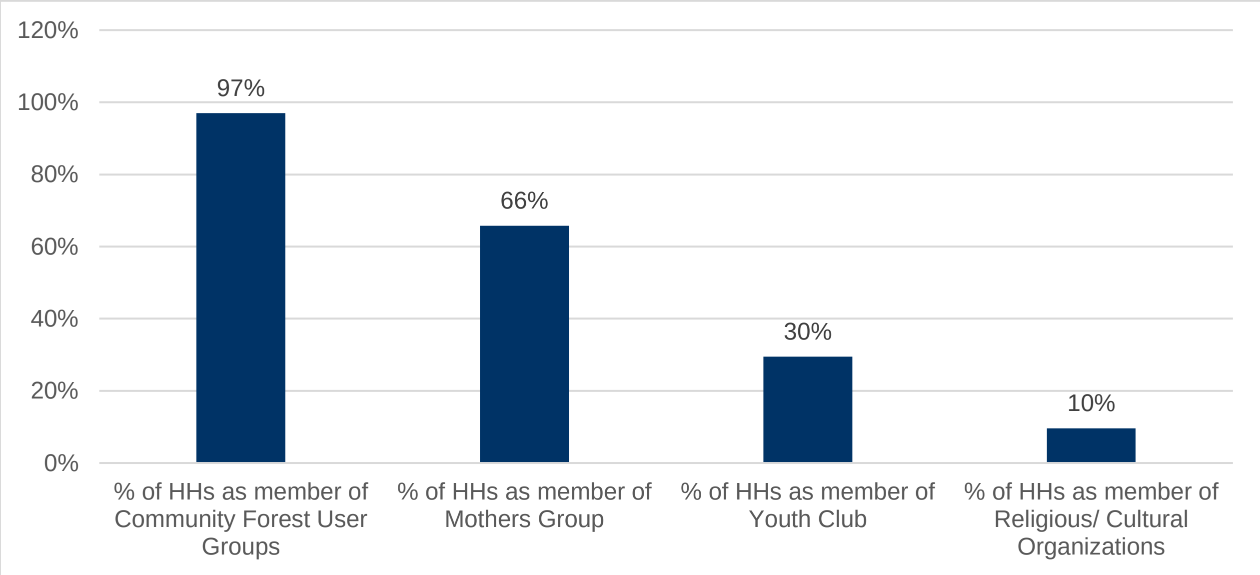
Apart from these traditional social institutions, the households surveyed are also members of some more modern institutions such as community forest user groups (CFUGs), mothers’ groups, youth groups, and other religious-cultural organizations. As expressed by participants in the FGDs and KIIs, these networks of modern institutions are potential forums for community engagement and partnership building within and between villages, and, therefore, play an important role in village life. For example, youth clubs are potential forums to engage in employment and skills development programs, while mothers’ groups can serve as a base for women-focused awareness campaigns. CFUGs facilitate households to work collectively towards forest conservation and enhanced household income from forest products.

Figure 6.50 shows the percentage of surveyed households in which at least one person reported being a member of one of the aforementioned modern institutions. The most common forms of organizational membership were CFUGs (97% of surveyed households[49]) and mothers’ groups (66% of surveyed households). Membership of youth clubs and other religious/cultural organizations was reported by 30% and 10% of the surveyed households, respectively.

[48] Two other social institutions – krijyang and gwaro – are also known to exist in the area. However, as participants in FGDs/KIIs did not mention them as relevant social institutions, they were not included above.

[49] There was no trend to note among the 3% who are not members of CFUGs – they are from 6 different villages and 4 different ethnic groups, none of which are non-AJ.

Figure 6.50: Household Membership in Modern Sociocultural Organizations



Source: ERM Socioeconomic Survey, 2019–2020

Table 6.56 provides a detailed analysis of surveyed households' membership in modern sociocultural institutions, disaggregated by village. Organizational membership patterns vary slightly between villages, but differences are not significant. The socioeconomic survey also investigated membership of occupation-specific groups such as farmers' and fishers' groups, but did not find evidence of any such groups in the DIA.

Table 6.56: Household Membership in Modern Sociocultural Organizations by Village

Rural Municipality	Ward No.	Village	No. of HH Surveyed	% of HHs with CFUGs Member	% of HHs with Mothers' Group Member	% of HHs with Youth Club Member	% of HHs with Religious Organization Member
Bhotkhola	**Ward 2**	Chepuwa	105	98%	61%	33%	12%
		Chyamtan	21	95%	52%	52%	14%
		Guthi Gumba	8	100%	88%	50%	50%
		Lingam	11	100%	55%	36%	36%
		Rukma	27	96%	81%	22%	4%
	Ward 2 sub-total		**172**	**98%**	**64%**	**35%**	**15%**
	Ward 3	Hatiya	34	100%	76%	32%	24%
		Hongon	41	100%	93%	34%	0%
	Ward 3 sub-total		**75**	**100%**	**85%**	**33%**	**11%**
	Ward 4	Adima	5	100%	20%	0%	20%
		Barun Bazar	6	83%	83%	50%	17%
		Chongrak	5	80%	0%	0%	0%
		Gola	24	88%	96%	42%	0%

Rural Municipalit	Ward No.	Village	No. of HH Surveyed	% of HHs with CFUGs Member	% of HHs with Mothers' Group Member	% of HHs with Youth Club Member	% of HHs with Religious Organization Member
		Hema	25	100%	88%	8%	0%
		Jijinkha	6	67%	83%	0%	0%
		Limbutar	6	100%	0%	0%	33%
		Namase	71	97%	61%	35%	20%
		Sembung	5	100%	60%	60%	20%
		Sibrun	73	96%	49%	32%	1%
		Syaksila	35	97%	54%	20%	6%
	Ward 4 sub-total		**261**	**95%**	**60%**	**28%**	**8%**
	Ward 5	Kapase	8	100%	38%	13%	0%
		Lunsun	8	100%	100%	0%	0%
		Rapsa	4	75%	25%	0%	0%
		Tunkhaling	51	100%	82%	25%	4%
	Ward 5 sub-total		**71**	**99%**	**76%**	**20%**	**3%**
Bhotkhola total			**579**	**97%**	**66%**	**30%**	**10%**
Makalu	**4**	Haitar	3	100%	0%	33%	0%
		Obak	11	100%	45%	18%	0%
	Ward 4 sub-total		**14**	100%	36%	21%	0%
Makalu total			**14**	**100%**	**36%**	**21%**	**0%**
Grand total			**593**	**97%**	**66%**	**30%**	**10%**

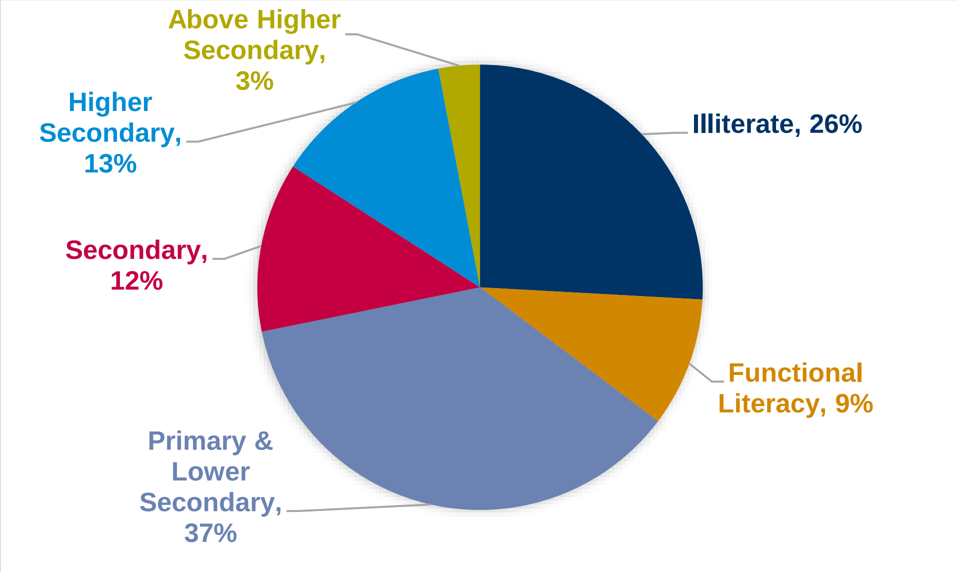
Source: ERM Socioeconomic Survey, 2019–2020

6.3.5 Educational Attainment

Literacy and education levels for survey respondents are shown in ***Figure 6.51***. This figure reveals that, of the 91% of the population above five years of age, 26% are illiterate and another 9% have only "functional literacy", i.e., they can only read and write basic sentences.[50] Most of the children of primary and lower secondary school age are enrolled in schools in the locality. Only one-third of those who pass lower secondary school, continue on to secondary education, which is often in nearby villages. The percentage continuing on to higher education is limited to only 3% of the population. Only 3% of the surveyed population have completed higher education.

[50] The term 'functional literacy' refers to those who, in the socioeconomic dataset, indicated that they have only 'basic reading and writing skills'. For the purposes of this document, it is assumed that those indicating functional literacy did not complete primary education (i.e., there is a spectrum of 'education' going from illiterate to functional literary to primary school completion and upwards). It is also assumed that all those who have obtained primary school education and above are literate.

Figure 6.51: Literacy and Education Levels[51] of Surveyed Households



Source: ERM Socioeconomic Survey, 2019–2020

Table 6.57 shows literacy/educational levels among the surveyed households, disaggregated by village.[52] The villages with the highest illiteracy rates were Lunsun (45%), Limbutar (40%), Rapsa (35%), Obak (34%), Hema (31%), and Rukma (31%). Those with the lowest illiteracy rates were Sembung (13%), Guthi Gumba (14%), Barun Bazar (15%), and Chongrak (15%). In terms of higher education, the villages with the highest percentage of the surveyed population having completed education beyond higher secondary were Chongrak (11%), Chyamtan (10%), Kapase (8%), and Guthi Gumba (7%).

Table 6.57: Literacy and Educational Attainment Levels, by Village

Rural Municipality	Ward No.	Village	Illiterate	Functionally Literate	Primary & Lower Secondary	Secondary	Higher Secondary	Above Higher Secondary	Total Population (>5 years)	Children 0–5 Years
Bhotkhola	**Ward 2**	Chepuwa	25%	9%	26%	15%	20%	4%	586	48
		Chyamtan	25%	9%	19%	17%	21%	10%	125	7
		Guthi Gumba	14%	12%	26%	14%	26%	7%	57	3
		Lingam	18%	2%	27%	12%	37%	4%	51	9
		Rukma	31%	9%	40%	8%	10%	2%	154	19
	Ward 2 total		**25%**	**9%**	**28%**	**14%**	**20%**	**5%**	**973**	**86**
	Ward 3	Hatiya	29%	9%	32%	12%	13%	4%	162	19
		Hongon	24%	6%	34%	15%	16%	4%	227	18

[51] According to the Government of Nepal, primary school goes from grades 1–5, lower secondary goes from grades 6–8, secondary goes from grades 9–10, and higher secondary goes from grades 11–12. Above higher secondary consists of any continued education beyond upper secondary (including vocational, professional, and university).

[52] As explained above, while the socioeconomic survey was primarily conducted at the household level, it also collected individual level information (via the head of household) for a number of basic demographic characteristics, including education. This made it possible to disaggregate educational information by individual.

Rural Municipality	Ward No.	Village	Illiterate	Functionally Literate	Primary & Lower Secondary	Secondary	Higher Secondary	Above Higher Secondary	Total Population (>5 years)	Children 0–5 Years
	Ward 3 total		**26%**	**7%**	**33%**	**14%**	**15%**	**4%**	**389**	**37**
	Ward 4	Adima	31%	8%	46%	8%	8%		26	1
		Barun Bazar	15%	9%	55%	12%	9%		33	5
		Chongrak	15%	7%	41%	22%	4%	11%	27	3
		Gola	17%	8%	31%	17%	26%	2%	121	12
		Hema	31%	9%	54%	2%	4%		127	27
		Jijinkha	27%	12%	42%	12%	8%		26	5
		Limbutar	40%		50%	10%			20	4
		Namase	24%	15%	38%	11%	10%	2%	344	33
		Sembung	13%	17%	52%	17%			23	3
		Sibrun	23%	10%	43%	13%	8%	3%	405	46
		Syaksila	32%	10%	36%	13%	8%	2%	183	10
	Ward 4 total		**25%**	**11%**	**41%**	**12%**	**9%**	**2%**	**1,335**	**149**
	Ward 5	Kapase	24%	11%	39%	16%	3%	8%	38	5
		Lunsun	45%	6%	42%		3%	3%	33	5
		Rapsa	35%	4%	39%	22%			23	2
		Tunkhaling	31%	8%	47%	9%	6%		238	29
	Ward 5 total		**32%**	**8%**	**45%**	**10%**	**5%**	**1%**	**332**	**41**
Bhotkhola total			**26%**	**9%**	**36%**	**13%**	**13%**	**3%**	**3,029**	**313**
Makalu	**Ward 4**	Haitar	27%	7%	53%	7%	7%		15	1
		Obak	34%	9%	46%	4%	7%		56	8
	Ward 4 total		**32%**	**8%**	**48%**	**4%**	**7%**		**71**	**9**
Makalu total			**32%**	**8%**	**48%**	**4%**	**7%**	**0%**	**71**	**9**
Grand total			**26%**	**9%**	**37%**	**12%**	**13%**	**3%**	**3,100**	**322**

Source: ERM Socioeconomic Survey, 2019–2020

An analysis of literacy levels by ward (***Figure 6.52***) shows that wards in higher elevations (i.e., Bhotkhola-2) have lower primary and lower secondary education levels than do wards in lower elevations (i.e., Makalu-4). This is likely due to lack of early access to primary schools in the more remote, elevated wards. However, this trend does not hold for the higher secondary level of education and beyond, as higher secondary and tertiary level educational institutions are only available in larger urban areas, therefore, remoteness due to elevation is not a determining factor. Access to higher education, therefore, is likely related more to the household's financial capacity to pay for hostels near higher education facilities or fees for residential schools.

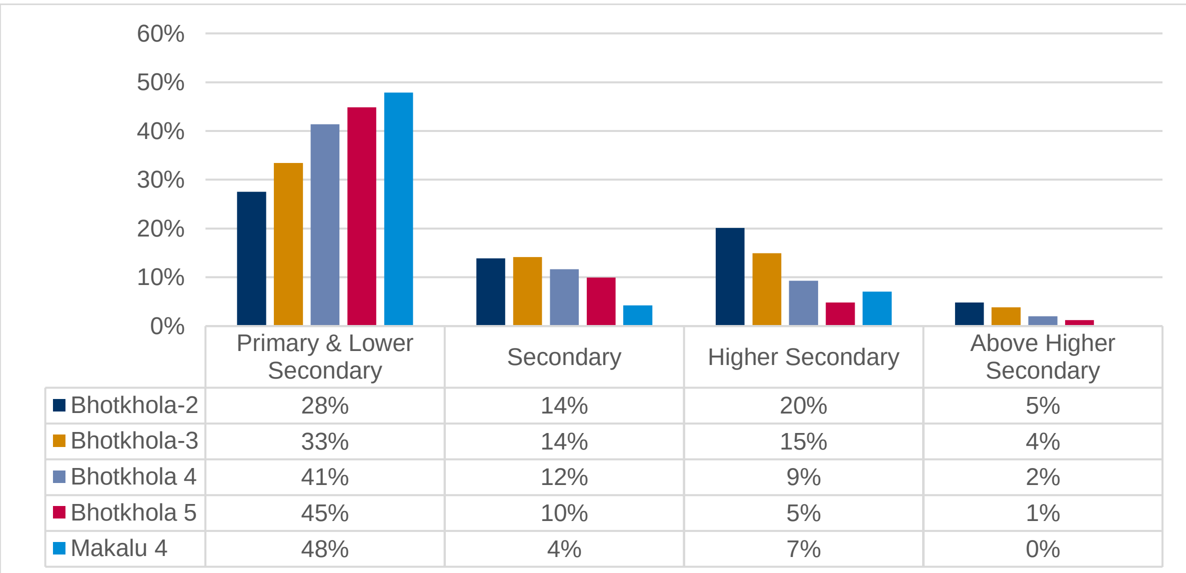
Table 6.58: Literacy and Educational Attainment Levels, by Ethnicity

Ethnicity	Illiterate		Can Read and Write	Primary & Lower Secondary	Secondary	Higher Secondary	Above Higher Secondary	Total Population (>5 years)	Children 0-5 years
Bhote	26%		10%	32%	13%	16%	4%	2,147	201
Kami (Bishowkarma)	16%		11%	62%	7%	4%	0%	45	4
Gurung	20%		9%	26%	24%	15%	6%	103	8
Newar	26%		7%	48%	19%	0%	0%	27	3
Pradhan	0%		0%	67%	33%	0%	0%	3	0
Rai	28%		9%	45%	9%	7%	1%	406	52
Sherpa	40%		10%	40%	10%	0%	0%	10	2
Tamang	28%		9%	51%	7%	5%	1%	353	52
Total	**26%**		**9%**	**37%**	**12%**	**13%**	**3**	**3,094**	**322**

Source: ERM Socioeconomic Survey, 2019–2020

As ***Table 6.58*** shows, there are no notable trends across ethnicities with respect to education level. While no Pradhan respondents reported illiteracy, there was a very small sample size of this group, which is unlikely to be representative of the broader population. Sherpa had a very high percentage (40%) of illiteracy, however their sample size was also quite small (10 households), which suggests that this also may not be a representative sample. For those with a larger number of respondents, trends across ethnic groups tend to mirror those at the village/ward level (***Table 6.57***), wherein the highest percentages of the population are either illiterate or have completed only primary and lower secondary schooling.

Figure 6.52: Literacy and Education Levels at Rural Municipality and Ward Level



Source: ERM Socioeconomic Survey, 2019–2020

The gender analysis of the illiterate and functionally literate population for each affected ward in the DIA is provided in ***Table 6.59*****.** As this table shows, about 73% of the population of the DIA are illiterate (78% of females and 66% of males). Each ward has a similar number of males and females who reported functional literacy, with the exception of Ward 2, in which there are significantly more females than males reporting functional literacy. However, among those individuals stating that they had achieved functional literacy through adult literacy programs, there is no notable difference between functional literacy rates of males and females, suggesting equal gender access to adult literacy programs.

Table 6.59: Illiterate and Functionally Literate Population, by Village and Gender

Rural Municipality	Ward No.	Illiterate		Total Illiterate	Functionally Literate		Total Functionally Literate	Total Sample
		Male	Female		Male	Female		
Bhotkhola	Ward 2	72	168	240	34	53	87	327
	Ward 3	32	70	102	16	13	29	131
	Ward 4	131	201	332	77	67	144	476
	Ward 5	39	66	105	14	11	25	130
Bhotkhola total		**274**	**505**	**779**	**141**	**144**	**285**	**1,064**
Makalu	Ward 4	8	15	23	4	2	6	29
Grand total		**282**	**520**	**802**	**145**	**146**	**291**	**1,093**
		66%	**78%**	**73%**	**34%**	**22%**	**27%**	**100%**

Source: ERM Socioeconomic Survey, 2019–2020

The gender disaggregation of the population that received primary, lower secondary and secondary education (***Table 6.60***) shows only a marginal disparity (51% male versus 49% female) among those who completed primary and lower secondary level education. However, the gender disparity increases at the secondary level, with 55% of men and 45% of women having completed this level of education.

Table 6.60: Gender Disparity in Primary, Lower Secondary, and Secondary Education Levels

Rural Municipality	Ward No.	Primary and Lower Secondary		Total Primary & Lower Secondary	Secondary		Total Secondary
		Male	Female		Male	Female	
Bhotkhola	Ward 2	148	120	268	70	65	135
		55%	45%	100%	52%	48%	100%
	Ward 3	57	73	130	29	26	55
		44%	56%	100%	53%	47%	100%
	Ward 4	285	267	552	92	64	156
		52%	48%	100%	59%	41%	100%
	Ward 5	69	80	149	18	15	33
		46%	54%	100%	55%	45%	100%
Bhotkhola total		559	540	1,099	209	170	379
		51%	**49%**	**100%**	**55%**	**45%**	**100%**
Makalu	Ward 4	15	19	34	3		3
		44%	56%	100%	100%	0%	100%
Grand total		574	559	1,133	212	170	382
		51%	**49%**	**100%**	**55%**	**45%**	**100%**

Source: ERM Socioeconomic Survey, 2019–2020

The gender disparity is even more pronounced at higher levels of education, at which 60% of those who reached higher secondary levels are male, and 62% of those having reached "above higher secondary level" are males (***Table 6.61***).

Table 6.61: Gender Disparity in Higher Secondary and Above Higher Secondary Education Levels

Rural Municipality	Ward No.	Higher Secondary		Higher Secondary Total	Above Higher Secondary		Above Higher Secondary Total
		Male	Female		Male	Female	
Bhotkhola	Ward 2	120	76	196	33	14	47
		61%	39%	100%	70%	30%	100%
	Ward 3	33	25	58	8	7	15
		57%	43%	100%	53%	47%	100%
	Ward 4	75	49	124	15	12	27
		60%	40%	100%	56%	44%	100%
	Ward 5	9	7	16	2	2	4
		56%	44%	100%	50%	50%	100%
Bhotkhola total		**237**	**157**	**394**	**58**	**35**	**93**
		60%	**40%**	**100%**	**62%**	**38%**	**100%**
Makalu	Ward 4	3	2	5			
		60%	40%	100%			

Rural Municipality	Ward No.	Higher Secondary		Higher Secondary Total	Above Higher Secondary		Above Higher Secondary Total
		Male	Female		Male	Female	
Grand total		**240**	**159**	**399**	**58**	**35**	**93**
		60%	**40%**	**100%**	**62%**	**38%**	**100%**

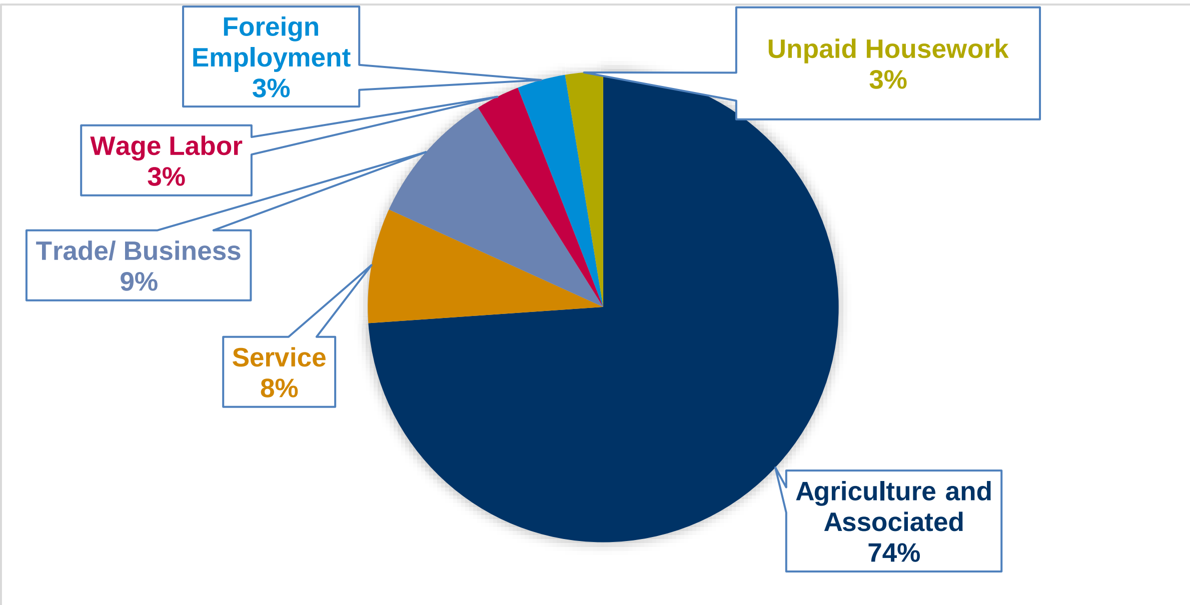
Source: ERM Socioeconomic Survey, 2019–2020

6.3.6 Economic Environment and Working Population

As part of the socioeconomic survey, ERM collected individual-level information for all household members (via the head of household) on certain basic demographic indicators, including occupation. Of the 3,422 persons for whom this information was collected, 1,768 individuals (52%) reported as being not economically active and are considered non-working members of the population. The non-working population consists of children (five years and younger), students (six years and above), people with disabilities, the elderly, and retired persons with a pension. A total of 1,654 persons (48%) were reported by their head of household as being economically active in a range of occupations, including agriculture and associated activities, services, trade/business, wage labor, foreign employment, and unpaid housework.

As shown in ***Figure 6.53***, among the households surveyed, approximately 74% of the working population reported being engaged in agriculture and associated activities such as livestock rearing and harvesting of forest products. Participation in trade/small business and services was reported by 9% and 8% of working population, respectively. Only 3% of the working population reported being engaged in wage labor, which includes both agricultural and construction work. About 3% of the surveyed population reported migrating outside of the country for employment[53], while another 3% (mostly women) reported doing unpaid housework.[54]

Figure 6.53: Occupation of Working Population in Project DIA



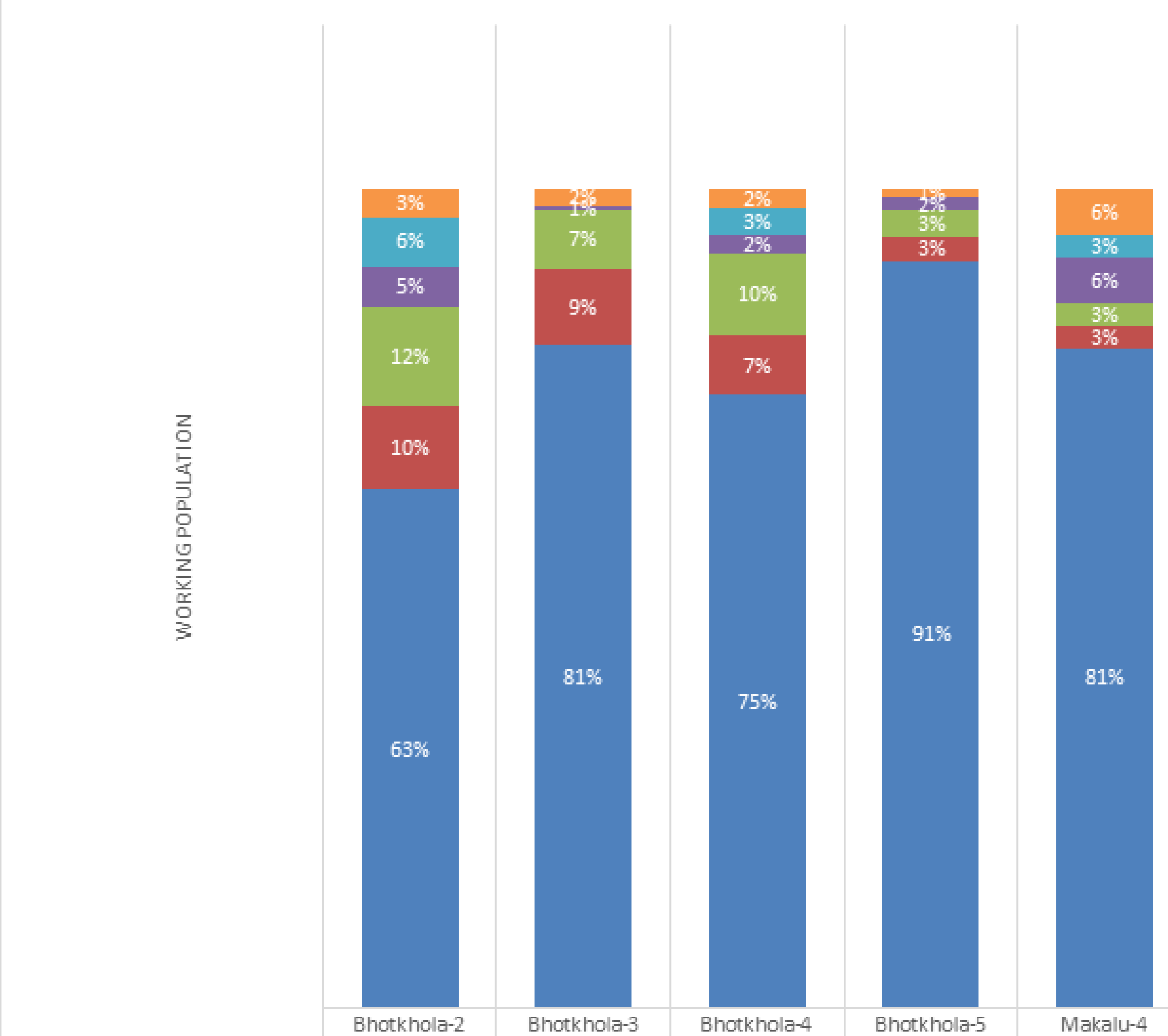
Source: ERM Socioeconomic Survey, 2019–2020

[53] This figure does not capture information concerning seasonal migration. See Section 6.3.3 for a discussion of migration patterns by ethnic groups, and Section 6.7.3 for a discussion of regional migration associated with agricultural production.

[54] It is extremely likely that more than 3% of women do unpaid housework, as housework is primarily the responsibility of women in the project DIA; therefore, it is possible that more women did not put ‘unpaid housework’ as their occupation, because they do not consider it their primary/only occupation (i.e., they also are engaged in agriculture and did not know they could put more than one occupation) or because they do not consider it an ‘occupation’ per se.

Comparing occupations across the project-affected rural municipality and wards (***Figure 6.54***) shows that the highest (91%) reliance on agriculture is found in Bhotkhola-5. Households in Bhotkhola-2 – the proposed location of the UAHEP dam – reported a lower reliance on agriculture and associated activities, and a higher percentage of people employed in trade/small business (12%), services (10%), and labor outside of Nepal (6%). Households in Bhotkhola-4 – the proposed site for the UAHEP access road and powerhouse – reported that 75% of the working population is reliant on agriculture, while 10% are engaged in trade/small business.

Figure 6.54: Working Population and Occupations



	Bhotkhola-2	Bhotkhola-3	Bhotkhola-4	Bhotkhola-5	Makalu-4
Unpaid Housework	3%	2%	2%	1%	6%
Foreign Employment	6%		3%		3%
Wage Labor	5%	1%	2%	2%	6%
Trade/ Business	12%	7%	10%	3%	3%
Service	10%	9%	7%	3%	3%
Agriculture and Associated	63%	81%	75%	91%	81%

GAUN PALIKA- WARD NUMBER

Source: ERM Socioeconomic Survey, 2019–2020

Further village-wide disaggregation of the working population is provided in ***Table 6.62***. Household engagement in agriculture and associated activities was found to be below 50% in the villages of Lingam, Barun Bazar, Chongrak, and Gola, all of which reported a higher percentage of their working population being engaged in trade and small business, relative to other project-affected villages.

Table 6.62: Disaggregation of Working Population Occupations, by Village

Rural Municipalit	Ward No.	Village	Agriculture and Associated Activities	Services	Trade / Business	Wage Labor	Foreign Employ-ment	Unpaid House-work
Bhotkhola	Ward 2	Chepuwa	62.2%	9.2%	12.9%	6.2%	6.5%	3.1%
		Chyamtan	70.4%	12.7%	9.9%		2.8%	4.2%
		Guthi Gumba	63.0%	11.1%	7.4%		18.5%	
		Lingam	41.2%	20.6%	17.6%	8.8%	8.8%	2.9%
		Rukma	72.0%	8.0%	8.0%	5.3%	1.3%	5.3%
	Ward 2 total		**63.3%**	**10.3%**	**11.8%**	**5.1%**	**6.0%**	**3.4%**
	Ward 3	Hatiya	85.7%	7.1%	7.1%			
		Hongon	77.3%	10.9%	7.3%	0.9%	0.0%	3.6%
	Ward 3 total		**80.9%**	**9.3%**	**7.2%**	**0.5%**	**0.0%**	**2.1%**
	Ward 4	Adima	82.4%		11.8%		5.9%	
		Barun Bazar	50.0%		50.0%			
		Chongrak	53.8%	7.7%	23.1%		15.4%	
		Gola	37.5%	7.8%	46.9%	1.6%		6.3%
		Hema	95.0%	1.7%			3.3%	
		Jijinkha	77.8%	11.1%				11.1%
		Limbutar	91.7%			8.3%		0.0%
		Namase	78.7%	10.4%	3.3%	1.6%	3.3%	2.7%
		Sembung	90.0%		10.0%			
		Sibrun	74.8%	7.3%	6.4%	5.5%	3.7%	2.3%
		Syaksila	81.1%	7.4%	7.4%		3.2%	1.1%
	Ward 4 total		**74.9%**	**7.2%**	**9.9%**	**2.4%**	**3.1%**	**2.4%**
	Ward 5	Kapase	90.9%		9.1%			
		Lunsun	81.0%	4.8%	4.8%	9.5%		
		Rapsa	87.5%	12.5%				
		Tunkhaling	93.3%	2.2%	2.2%	0.7%		1.5%
	Ward 5 total		**91.2%**	**3.1%**	**3.1%**	**1.6%**	**0.0%**	**1.0%**
Bhotkhola total			**73.8%**	**8.0%**	**9.4%**	**3.0%**	**3.3%**	**2.5%**
Makalu	Ward 4	Haitar	83.3%					16.7%
		Obak	80.0%	3.3%	3.3%	6.7%	3.3%	3.3%
	Ward 4 total		**80.6%**	**2.8%**	**2.8%**	**5.6%**	**2.8%**	**5.6%**
Makalu total			**80.6%**	**2.8%**	**2.8%**	**5.6%**	**2.8%**	**5.6%**
Grand total			**73.9%**	**7.9%**	**9.3%**	**3.0%**	**3.3%**	**2.6%**

Source: ERM Socioeconomic Survey, 2019–2020

Gender disaggregation of the working population's occupations (***Table 6.63***) reveals that more women are engaged in agriculture than men (54% versus 46% of all those engaged in agricultural and associated activities). In remote wards, such as Bhotkhola-2 and Bhotkhola-5, the survey found even greater participation of women in agriculture and associated activities.

The representation of women in services is low (30%) in comparison to men (70%). There are also more men than women in wage labor[55] (78% are men) and foreign employment (71% are men).[56] In trade and business, although more men (56%) are engaged, women (44%) are also well represented.

Table 6.63: Occupations and Working Population, by Gender

Rural Municipality-Ward No.	Agriculture and Associated Activities		Services		Trade/ Business		Wage Labor		Foreign Employment	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Bhotkhola-2	42%	58%	71%	29%	56%	44%	70%	30%	75%	25%
Bhotkhola-3	43%	57%	78%	22%	64%	36%	100%	0%	0%	0%
Bhotkhola-4	48%	52%	65%	35%	57%	43%	82%	18%	64%	36%
Bhotkhola-5	48%	52%	83%	17%	33%	67%	100%	0%	0%	0%
Makalu-4	41%	59%	100%	0%	100%	0%	100%	0%	100%	0%
Grand total	**46%**	**54%**	**70%**	**30%**	**56%**	**44%**	**78%**	**22%**	**71%**	**29%**

Source: ERM Socioeconomic Survey, 2019–2020

The age disaggregation of the working population (***Table 6.64***) reveals a small number of instances in which children (defined as those below 14 years[57]) are engaged in wage labor or agriculture activities. However, a considerable number of adolescents (15–18 years), youth (19–25 years), and the young working population (26–40 years) are working in agriculture and associated activities, although the latter two categories are also engaged in non-agricultural occupations in significant numbers. In the older age groups (41–65 and >65 years), almost 90% are engaged in agriculture and associated activities.

Table 6.64: Occupations and Working Population, by Age Group

Age-Group Working Population	Agriculture and Associated Activities	Services	Trade/ Business	Wage Labor	Foreign Employment	Unpaid Housework	Total
6–14 (Child)	2	0	0	3[58]	0	0	5
15–18 (Adolescent)	34	0	0	2	1	1	38
19–25 (Youth)	153	46	25	10	24	7	265

[55] This lower percentage of women engaged in wage labor reflects concerns expressed during FGDs that women do not have the same opportunity as men to engage in formal paid/wage labor.

[56] No information was collected on the nature of their foreign employment.

[57] Child Labor (Prohibition and Regulation) Act, 2000.

[58] Although no specifics were collected with respect to what type of labor these children are engaged in, local practice suggests it is likely to be agricultural labor.

Age-Group Working Population	Agriculture and Associated Activities	Services	Trade/ Business	Wage Labor	Foreign Employment	Unpaid Housework	Total
26-40 (Young working)	401	68	98	26	27	17	637
41–65 (Middle age)	552	14	27	9	2	13	617
>65 (Elderly)	82	2	2	1	0	5	92
Total	**1,224 (74%)**	**130 (8%)**	**152 (9%)**	**51 (3%)**	**54 (3%)**	**43 (3%)**	**1,654 (100%)**

Source: ERM Socioeconomic Survey, 2019–2020

The majority of the working population who migrate to other countries seeking employment (foreign employment) belong to the youth (19–25) and young working population (26–40) age groups.

6.3.7 Land Ownership and its Significance

Table 6.65 provides a disaggregation of land ownership by village. A total of 527 of the surveyed households shared land information with ERM during the socioeconomic survey (66 declined to answer). Of these 527, only 18 households (3%) reported not owning any land.[59] Of these, 13 were Bhote, 2 were Kami (Bishowkarma), 2 were Rai, and 1 was Gurung. The remaining 509 households that shared land information reported owning land, although some of them only own the land on which their residence is located (i.e., homestead land). The minimum land ownership reported in the survey was 0.005 ha and the maximum was 16.2 ha (or 318 ropani).[60] The average landholding in the DIA is 2.3 ha (or 46.5 ropani). The average landholding is higher in Bhotkhola-2 and Makalu-4. The average size of land ownership is highest in the villages of Chepuwa, Syaksila, Lunsun, and Obak. Information on "absentee" landowners (i.e., those who own land in the DIA, but do not live there) or those who own land in one village of the DIA, but live in another village within the DIA was not collected as part of the socioeconomic survey.

[59] Those who do not own land were those who responded as: leaseholding, living on customary land or community land, or not aware of the status of their land.

[60] 1 ropani = 508.74 m^2

Table 6.65: Land Ownership Patterns in Project-affected Villages

Rural Municipality	Ward No.	Village	Number of HHs Provided Land Details	Number of Landless Households	Number of HHs Owning Land	Maximum Landholding Area in m^2	Minimum Landholding Area in m^2	Average Landholding Area in m^2	Average Landholding Area in Ropani
Bhotkhola	**Ward 2**	Chepuwa	88		88	162,020	210	29,556	58
		Chyamtan	21	2	19	83,450	5,275	23,149	46
		Guthi Gumba	8	2	6	64,960	209	18,907	37
		Lingam	10		10	50,460	3,500	21,15	42
		Rukma	25	2	23	97,190	2,000	16,046	32
	Ward 2 total		**152**	**6**	**146**	**162,020**	**209**	**25,403**	**50**
	Ward 3	Hatiya	34	2	32	122,939	600	20,184	40
		Hongon	41	2	39	129,000	3,500	22,897	45
	Ward 3 total		**75**	**4**	**71**	**129,000**	**600**	**21,674**	**43**
	Ward 4	Adima	3		3	45,609	9,000	22,370	44
		Barun Bazar	6		5	38,495	5,000	20,399	40
		Chongrak	1		1	15,500	15,500	15,500	30
		Gola	24		24	142,621	90	22,915	45
		Hema	22	1	21	32,300	750	13,627	27
		Jijinkha	5		5	42,715	6,000	24,483	48
		Limbutar	6		6	18,000	50	10,688	21
		Namase	59	1	58	88,736	300	24,714	49
		Sembung	5	2	3	25,145	10,009	15,218	30
		Sibrun	60		60	114,500	116	20,306	40
		Syaksila	27	1	26	113,580	3,000	29,201	57
	Ward 4 total		**218**	**5**	**212**	**142,621**	**50**	**22,580**	**44**
	Ward 5	Kapase	8		8	67,115	1,900	18,127	36
		Lunsun	8		8	81,425	36,175	55,231	109
		Rapsa	1		1	17,088	17,088	17,088	34
		Tunkhaling	51	4	47	72,325	3,500	21,328	42
	Ward 5 total		**68**	**4**	**64**	**81,425**	**1,900**	**24,221**	**49**
Bhotkhola total			**513**	**18**	**495**	**162,020**	**50**	**23,619**	**46**
Makalu	**Ward 4**	Haitar	3		3	33,582	3,754	19,025	37
		Obak	11		11	111,790	3,250	27,619	54
	Ward 4 total		**14**		**14**	**111,790**	**3,250**	**25,778**	**51**
Grand total			**527**	**18**	**509**	**162,020**	**50**	**23,671**	**47**
			100%	**3%**	**97%**				

Source: ERM Socioeconomic Survey, 2019–2020

Land Ownership by Ethnic Group

The size of one's landholding(s) is one possible indication of economic wellbeing and social status, both because land acts as a source or base for productive livelihoods and because land can be used as collateral for a bank loan.[61]

Table 6.66 presents the average landholding by different communities across all project-affected villages. The communities are grouped into non-aadibasi/janajati communities and aadibasi/janajati communities, for the sake of comparison. The average landholding area of members of aadibasi/janajati communities ranges from 16,260 m^2 (Gurung) to 25,030 m^2 (Tamang), while the average landholding area of members of non-aadibasi/janajati communities (i.e., Kami [Bishowkarma]) is 4,213 m^2.

Among aadibasi/janajati communities, Bhote households in Bhotkhola have the highest average landholding area, at 22,788 m^2 (or 48 ropani). While Tamangs overall have a slightly higher average landholding area, at 25,030 m^2 (or 49 ropani), than Bhote households, this is because Tamangs in Makalu-4 own more land, an average of 41,099 m^2 (or 80 ropani), compared to the average landholding of Tamangs in Bhotkhola, which is 23,102 m^2 (or 45 ropani), thus bringing up the overall average. Tamang households in Adima and Hema, in comparison, own considerably smaller plots of land.

Rai households own an average landholding of 22,788 m^2 (or 45 ropani). The average landholding size of Rai households in Limbutar was the lowest of all the villages, at an average 9,226 m^2 (18 ropani) and highest at 55,231 m^2 (108 ropani) in Lunsun.

The average landholding size of Gurung households is 16,260 m^2 (32 ropani). The Sherpa households in Jijinkha also report an average landholding size of 17,733 m^2 (35 ropani). Gurung, Sherpa, and Tamang households in Hema own less lands compared to other major aadibasi/janajati communities such as Bhote and Rai.

[61] Other potential indications of economic wellbeing and status might include quality of land or proximity of land to desirable cultural / infrastructural features of the community.

Table 6.66: Average Land Ownership (m^2) of Households, by Ethnic Group and Village

Rural/ Municipality	Ward No.	Village	Average Land Area Owned by AJ Households (in m^2)							Average Land Area owned by Non-AJ Households (in m^2)	Grand Total
			Bhote	Gurung	Newar	Pradhan	Rai	Sherpa	Tamang		
Bhotkhola	Ward 2	Chepuwa	29,316								29,316
		Chyamtan	23,149								23,149
		Guthi Gumba	18,907								18,907
		Lingam	21,156								21,156
		Rukuma	16,046								16,046
	Ward 2 total		**25,421**								**25,421**
	Ward 3	Hatiya	20,184								20,184
		Hongon	22,897								22,897
	Ward 3 total		**21,674**								**21,674**
	Ward 4	Adima					29,055		9,000		22,370
		Barun Bazar	17,999								17,999
		Chongrak					15,500				15,500
		Gola	26,285	17,179	4,840		17,768		56,299	175	22,915
		Hema							13,627		13,627
		Jijinkha	42,715		26,500			17,733			24,483
		Limbutar			18,000		9,226				10,688
		Namase	24,714								24,714
		Sembung	15,218								15,218

Rural/ Municipality	Ward No.	Village	Average Land Area Owned by AJ Households (in m^2)							Average Land Area owned by Non-AJ Households (in m^2)	Grand Total
			Bhote	Gurung	Newar	Pradhan	Rai	Sherpa	Tamang		
Bhotkhola	**Ward 4**	Sibrun	21,515	14,117					27,642	5,525	22,632
		Syakshila	30,249							3,000	29,201
	Ward 4 total		**24,761**	**16,260**	**16,447**		**16,274**	**17,733**	**23,102**	**4,213**	**22,580**
	Ward 5	Kapase					18,127				18,127
		Lunsun					55,231				55,231
		Rapsa					17,088				17,088
		Tunkhaling	25,669		11,025		21,605				21,328
	5 Total		**25,669**		**11,025**		**25,550**				**25,099**
Bhotkhola total			**24,413**	**16,260**	**14,278**		**23,695**	**17,733**	**23,102**	**4,213**	**23,619**
Makalu	**Ward 4**	Haitar					19,025				19,025
		Obak					11,443		41,099		27,619
	Ward 4 total						**14,286**		**41,099**		**25,778**
Makalu total							**14,286**		**41,099**		**25,778**
Grand total			**24,413**	**16,260**	**14,278**		**22,788**	**17,733**	**25,030**	**4,213**	**23,679**
			103%	69%	60%	0%	96%	75%	106%	18%	100%
Area in ropani (1 ropani=508.74m^2)			48.0	32.0	28.1	-	44.8	34.9	49.2	8.3	46.5

Source: ERM Socioeconomic Survey, 2019–2020

As shown in ***Table 6.67***, land is fairly evenly distributed across the quintiles by aadibasi/janajati group, although there are small variations. For example, 30% of Gurung people are in the bottom quintile of landholding size (below 6,600 m^2) and only 10% are in the top quintile (above 34,633 m^2). The difference for non-aadibasi/janajati groups is, however, starker; these groups combined have 100% of their average landholdings in the bottom two quintiles, suggesting a significant disparity in the size of landholdings between aadibasi/janajati and non-aadibasi/janajati groups. It is important to note that the analysis below only includes those who reported owning land (i.e., 509 households).

Table 6.67: Average Landholding by Quintile, by Ethnic Group

Caste/ Ethnicity	Caste/ Ethnicity	Bottom Quintile (up to 6,600 m^2)	First Quintile (6,601 to 12,038 m^2)	Second Quintile (12,039 to 19,678 m^2)	Third Quintile (19,679 to 34,633 m^2)	Upper Quintile (above 34,633 m^2)
AJ groups	Bhote	19%	21%	20%	18%	23%
	Gurung	30%	10%	20%	30%	10%
	Newar	20%	20%	40%	20%	0%
	Rai	23%	17%	21%	17%	22%
	Sherpa	33%	0%	0%	67%	0%
	Tamang	18%	19%	23%	21%	19%
AJ groups total		**20%**	**20%**	**20%**	**19%**	**21%**
Non AJ group	Kami (Bishowkarma)	67%	33%	0%	0%	0%
Grand total		**20%**	**20%**	**20%**	**19%**	**21%**

Women and Land Ownership

Of the 509 households that reported owning land, only 93 (18%) have at least part of their landholdings registered in the name of a woman. The percentage of households where women own land ranges from 10% in Hongon to 67% in Adima. ***Table 6.68*** provides a village-wide analysis of women's land ownership in the DIA.

Consultations with community members revealed that women often become legal land owners through inheritance from their husbands or fathers. When land ceiling provisions came into force in Nepal (Land Reform Act, 1964), many families where male members owned in excess of the allowable limit of 75 ropani of land transferred the excess land to women in the family. It is important to note, however, that while women own land in their name, land transaction decisions are still usually made by male members of the family. Often times, women in these situations do not even know the area of the land they own. Women surveyed admitted that they were not familiar with legal procedures relating to land ownership and needed the help of male members to sort out any official acts such as obtaining land ownership documents or paying taxes. Thus, land is very much the domain of males in the DIA.

Table 6.68: Ownership of Land by Women,[62] by Village

Rural Municipality	Ward No	Village	Number of HHs Owning Land	Number of HHs Where Women Own Land	% of HHs Where Women Own Land
Bhotkhola	**Ward 2**	Chepuwa	88	13	15%
		Chyamtan	20	6	30%
		Guthi Gumba	6	3	50%
		Lingam	10	2	20%
		Rukma	23	4	17%
	Ward 2 total		**147**	**28**	19%
	Ward 3	Hatiya	32	7	22%
		Hongon	39	4	10%
	Ward 3 total		**71**	**11**	15%
	Ward 4	Adima	3	2	67%
		Barun Bazar	6	1	17%
		Gola	24	8	33%
		Jijinkha	5	1	20%
		Namase	58	14	24%
		Sibrun	60	14	23%
		Syaksila	26	3	12%
	Ward 4 total		**213**	**43**	**20%**
		Lunsun	8	2	25%
		Tunkhaling	47	5	11%
	Ward 5 total		**64**	**7**	11%
Bhotkhola total			**495**	**89**	**18%**
Makalu	**Ward 4**	Haitar	3	1	33%
		Obak	11	3	27%
	Ward 4 Total		**14**	**4**	29%
Makalu total			**14**	**4**	29%
Grand total			**509**	**93**	**18%**

Source: ERM Socioeconomic Survey, 2019–2020

[62] Land ownership by women means sole legal ownership with ownership certificate.

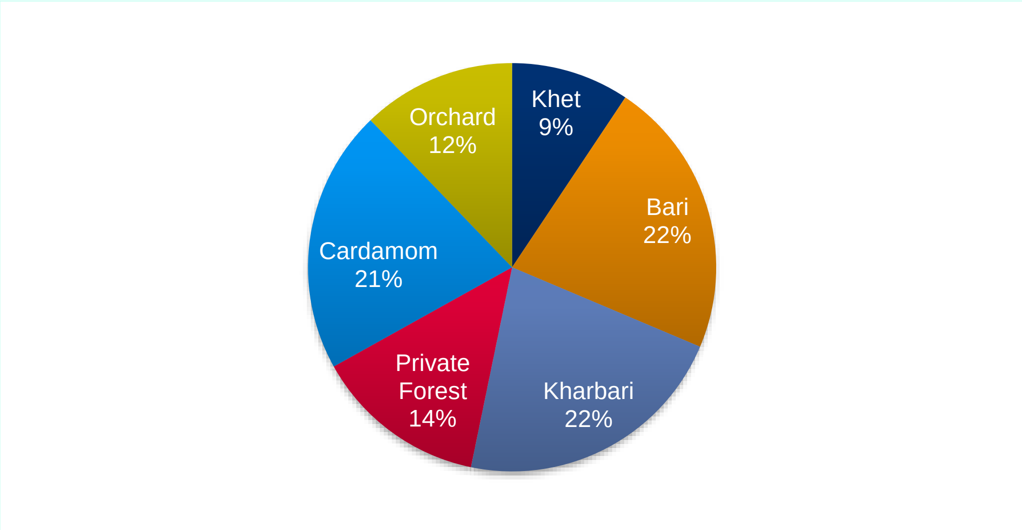
Land Types and Usage in the Project DIA

The communities in the DIA classify their landholdings into six broad categories:

- Khet: plain land that can hold water and is, therefore, suitable for rice cultivation
- Bari: land with a gentle slope terraced to hold some water and suitable for growing dry crops
- Kharbari: land with a steep slope that is used for sourcing fodder or grazing livestock
- Cardamom: sloping land (either bari or kharbari) where cardamom has been planted
- Orchard: sloping land where fruit trees are grown, but which is not used to grow other crops
- Private forest: land with stony outcrops not suitable for agriculture, but having natural vegetation growth – used to supply fuelwood, timber, and fodder for livestock

Figure 6.55 shows the typical composition of various categories of land owned by households surveyed in the DIA. *Khet* land owned by households is small in comparison to other categories. A typical household will have nearly equal proportion of *bari*, *kharbari*, and cardamom land. Most households own some private forest land and orchard. This composite use of different types of land is crucial for meeting the various requirements of households and helps make households more diverse and, therefore, self-sustaining.

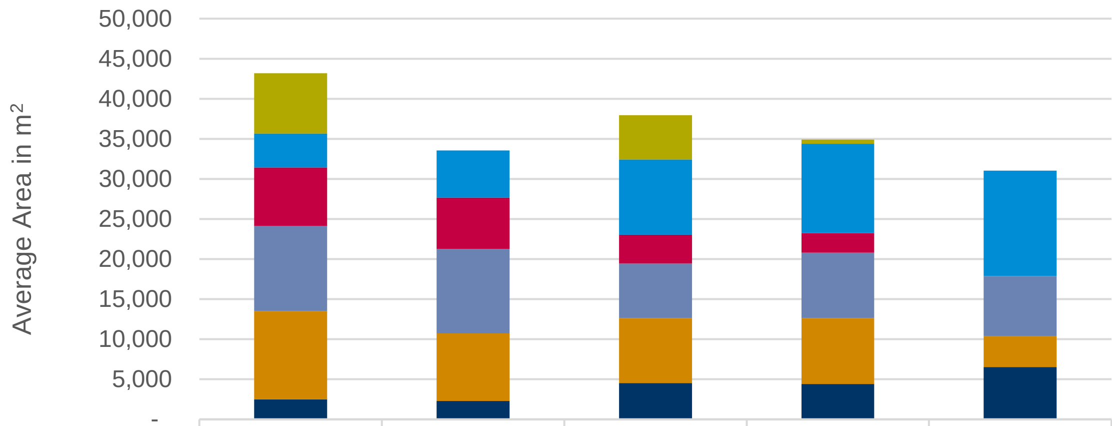
Figure 6.55: Average Type of Land Category Owned by Households



Source: ERM Socioeconomic Survey, 2019–2020

The composition of these categories of land among households in different wards is shown in ***Figure 6.56***. Households in Bhotkhola-2 have only a small amount of *khet* land in comparison to Bhotkhola-4 and Bhotkhola-5; however, the possession of private forest area by Bhotkhola-2 households is greater than in Bhotkhola-4 and Bhotkhola-5. Bhotkhola-4 households overall possess larger amounts of cardamom land than households in the other wards, while households in Ward 2 and Ward 4 own most of the orchard land. Overall, the most prominent land categories households own are *bari* and *kharbari*.

Figure 6.56: Category of Land and Average Area Owned by Households



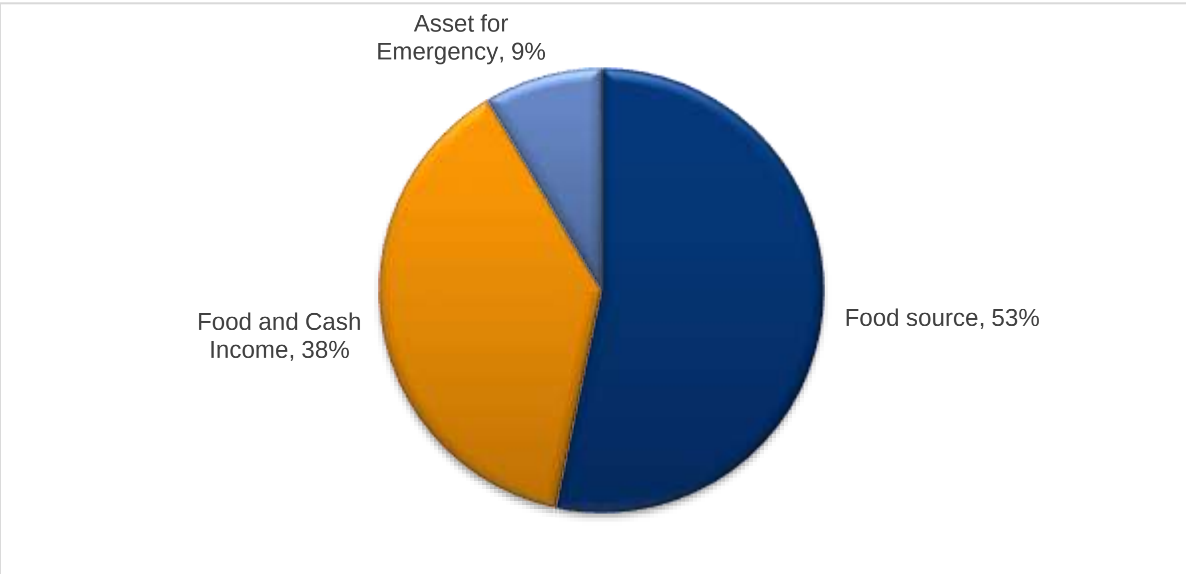
	Bhotkhola 2	Bhotkhola 3	Bhotkhola 4	Bhotkhola 5	Makalu 4
Orchard	7,513		5,529	505	
Cardamom	4,226	5,877	9,360	11,168	13,151
Private Forest	7,336	6,384	3,616	2,429	
Kharbari	10,598	10,583	6,806	8,149	7,469
Bari	11,040	8,413	8,106	8,256	3,891
Khet	2,478	2,306	4,532	4,394	6,534

Rural Municipality - Ward Number

Source: ERM Socioeconomic Survey, 2019–2020

During the socioeconomic survey, ERM asked households about the main role that land plays in their household economy. Of the 509 households that reported owning land, 55 did not reply to this question. Of those that did reply, over half (53%) considered their land as their primary source of food. Another 38% considered their land as both a source of food and a means to generate cash income by selling part of the agriculture produce grown. An additional 9% of responding households considered land as an important asset in a family emergency (see ***Figure 6.57***).

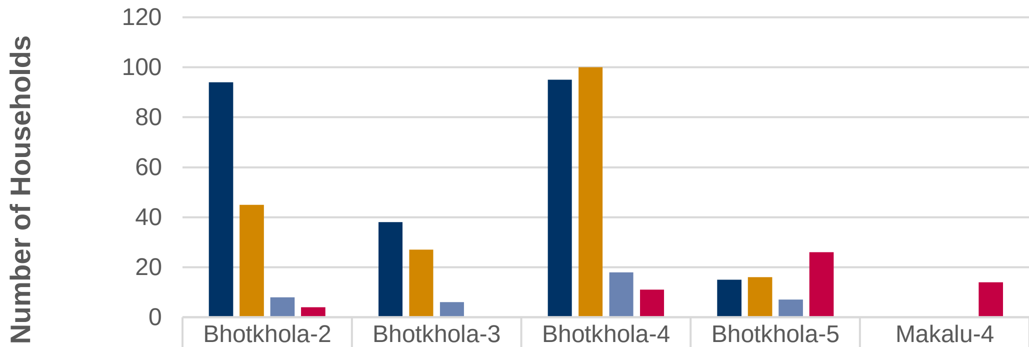
Figure 6.57: Significance of Land for Households



Source: ERM Socioeconomic Survey, 2019–2020

A comparison of the significance of land for the household economy across wards is provided in ***Figure 6.58***. A higher percentage of households in Bhotkhola-2 consider land as their main source of food and fewer households consider it important as a source to generate cash income. In comparison, more households in Bhotkhola-4 consider land as a source of cash income.

Figure 6.58: Value of Land as Source of Food and Cash Income



	Bhotkhola-2	Bhotkhola-3	Bhotkhola-4	Bhotkhola-5	Makalu-4
Food source	94	38	95	15	
Food and Cash Income	45	27	100	16	
Asset for Emergency	8	6	18	7	
DNR	4		11	26	14

Rural Municipality - Ward Number

Source: ERM Socioeconomic Survey, 2019–2020

Note: DNR = did not respond

Apart from cultivating their own land, some households cultivate additional land via share-cropping or on lease (*bandagi*). The details of these households and average area of share-cropping/leased land is provided in ***Table 6.69***.

Almost half of the households that provided their land to others for share-cropping live in Bhotkhola-2, particularly in Chepuwa village. The average land area lent out for sharecropping in Chepuwa is 2,120 m^2. Households in Barun Bazar and Gola also have provided land to others for share-cropping, at an average land area of approximately 1,021 m^2.

The number of households that have obtained land from others for share-cropping was highest in Rukma, where the average area for share-cropping taken by households was approximately 1,160 m^2. Other villages from which households reported obtaining land for share-cropping were: Gola, Hema, Lunsun, Sibrun, Haitar, and Obak.

Approximately 4% of total households also reported cultivating government land in addition to their own land. No households reported cultivating community forest land. In Bhotkhola-2, 22 households reported using government land for cultivation in addition to their own land. The only village outside of Bhotkhola-2 reporting using government land is Namase. The largest average area of government land used for cultivation by households, which was approximately 512 m^2, was reported in Guthi Gumba village. In Chyamtan, the average area of government land used for cultivation by households was 2,916 m^2 and in Lingam it was 2,200 m^2. The average area of government land used for cultivation by households in Namase was very small (46 m^2).[63]

[63] Note, this trend is also seen among PAHs affected by displacement, where four PAHs reported producing on government land (on a total land area of 7,146 m^2; see Section 7.5 of Project RAP for more details).

Table 6.69: Access to Additional Land for Cultivation by Households (Leasing and use of Government Land)

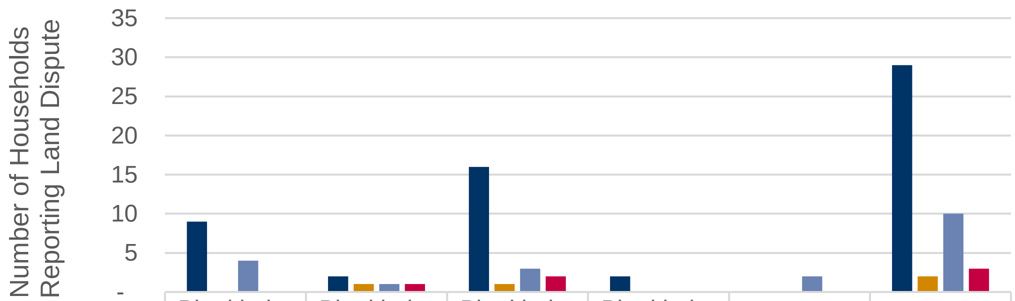
Rural Municipality	Ward No.	Village	Number of HHs	Number of HHs that have Given Land to Others for Cultivation	Average Land Area (m^2) Given to Others for Cultivation	Number of HH that have Taken Land from Others for Cultivation	Average Land Area (m^2) Taken from Others for Cultivation	Number of HHs that Cultivate Some Government Land	Average Government Land Area (m^2) Cultivated
Bhotkhola	**Ward 2**	Chepuwa	88	8	2120	1	11	3	40
		Chyamtan	21	1	258			10	2,916
		Guthi Gumba	8			1	750	7	5,125
		Lingam	10			1	50	2	2,200
		Rukma	25	1	42	5	1,160		
	Ward 2 total		**152**	**10**	**1,270**	**8**	**240**	**22**	**840**
	Ward 3	Hatiya	34	1	35				
		Hongon	41	2	98				
	Ward 3 total		**75**	**3**	**69**	**-**		**-**	
	Ward 4	Adima	3						
		Barun Bazar	6	1	1,000				
		Chongrak	1						
		Gola	24	1	1,042	3	625		
		Hema	22			3	509		
		Jijinkha	5						
		Limbutar	6						
		Namase	59	2	42			2	46
		Sembung	5						
		Sibrun	60	2	619	2	67		
		Syaksila	27						
	Ward 4 total		**218**	**6**	**324**	**8**	**139**	**2**	**12**
	Ward 5	Kapase	8						
		Lunsun	8			1	1,000		
		Rapsa	1						
		Tunkhaling	51	2	173	2	392		
	Ward 5 total		**68**	**2**	**130**	**3**	**412**	**0**	
Bhotkhola total			**513**	**21**	**541**	**19**	**185**	**24**	**254**

Rural Municipality	Ward No.	Village	Number of HHs	Number of HHs that have Given Land to Others for Cultivation	Average Land Area (m^2) Given to Others for Cultivation	Number of HH that have Taken Land from Others for Cultivation	Average Land Area (m^2) Taken from Others for Cultivation	Number of HHs that Cultivate Some Government Land	Average Government Land Area (m^2) Cultivated
Makalu	**Ward 4**	Haitar	3			1	5,333		
		Obak	11			2	321		
	Ward 4 total		**14**	0		3	1,395	0	
Grand total			**527**	**21**	**527**	**22**	**217**	**24**	**248**
				4%		**4.2%**		**4.6%**	

Source: ERM Socioeconomic Survey, 2019–2020

During the socioeconomic survey, ERM asked respondents whether the household had experienced any conflict or disputes related to their land over the previous decade (i.e., 10 years). Of the total 509 land-owning households, 44 households (8.6%) reported having experienced such disputes (***Figure 6.59***). ***Figure 6.59*** provides the distribution of these households and the reasons for the land dispute.

Figure 6.59: Land Disputes in Previous Decade, by Dispute Type and Location



	Bhotkhola-2	Bhotkhola-3	Bhotkhola-4	Bhotkhola-5	Makalu-4	Total
Boundary demarcation	9	2	16	2		29
Harvesting crops		1	1			2
Ownership Claims	4	1	3		2	10
Land transaction		1	2			3

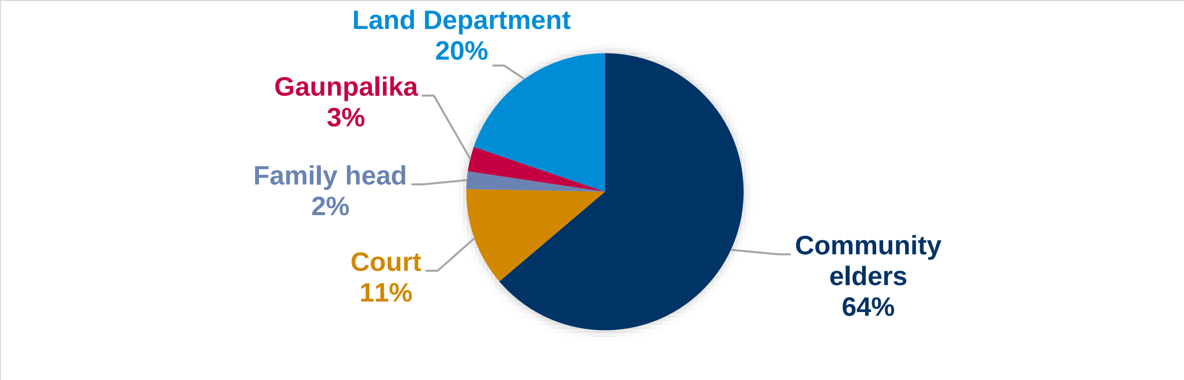
Rural Municipality - Ward Number

Source: ERM Socioeconomic Survey, 2019–2020

The number of households reporting land related disputes is relatively high in Bhotkhola-4, compared to a small number of disputes in Bhotkhola-5 and Makalu-4. In terms of reasons for land disputes, issues relating to boundary demarcation is the leading cause, constituting 66% of the total number of disputes. Competing ownership claims for the same piece of land makes up an additional 23% of cases. Other, less prominent, reasons for land disputes reported are related to disputes over agreed land value during land negotiations, and forceful harvesting of crops (i.e., claiming ownership of and harvesting crops on disputed land).

Figure 6.60 shows the responses of socioeconomic survey respondents on how their communities usually resolve land disputes. Of the total 527 households surveyed, 64% stated that community elders resolve disputes over land, while 20% of households cited the Government Land Department as the primary decision maker for land disputes. Only 11% indicated that land disputes were ultimately resolved through the courts. Thus, community leaders play an important role in the resolution of land disputes in the DIA.

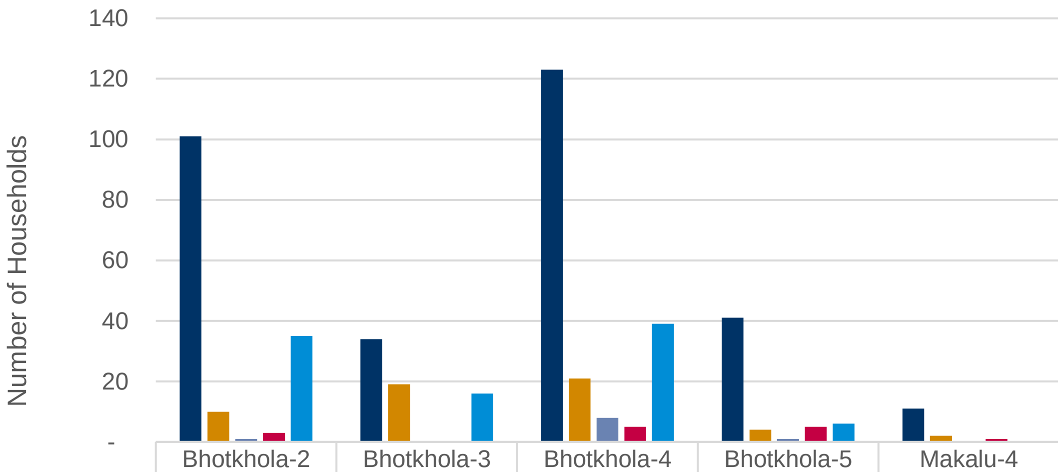
Figure 6.60: Forums for Resolving Land Disputes in Project DIA



Source: ERM Socioeconomic Survey, 2019–2020

Figure 6.61 presents the various forums that surveyed households reported using to resolve land disputes, and their relative use. This figure shows that households perceived community elders to be the most popular dispute resolution forum in all wards, but particularly so in Bhotkhola-5 and Makalu-4.

Figure 6.61: Forums for Land Dispute Resolution, by Ward



	Bhotkhola-2	Bhotkhola-3	Bhotkhola-4	Bhotkhola-5	Makalu-4
Community elders	101	34	123	41	11
Court	10	19	21	4	2
Family head	1		8	1	
Gaunpalika	3		5	5	1
Land Department	35	16	39	6	

Rural Municipality - Ward Number

Source: ERM Socioeconomic Survey, 2019–2020

6.3.8 Land-Based Livelihood Practices

The livelihood strategies of Upper-Arun Valley households mainly include subsistence and cash crop agriculture and livestock keeping, supplemented by the collection and sale of medicinal herbs, forest food, and working in trekking-tourism. Thus, the livelihoods of households in the DIA are typically a combination of the following options.

- Agriculture (crops, seasonal vegetables, and cardamom as cash crop)
- Livestock raising (for own consumption as well as to sell)
- Collection and sale of medicinal herbs
- Daily wage labor (agricultural and non-agricultural)
- Remittances (mostly from India, Gulf countries, and recently from Tibet Autonomous Region of China)
- Service sector
- Small shop keeping, small-scale hotel/homestay, and eateries business
- Working as field guide in trekking/tourism

Which of these options a household employs at any given time depends on their location, the availability of land, the skills and inputs available to the household, as well as the climatic and weather conditions in any particular year. The following sections address the primary land-based livelihoods in turn, demonstrating in each case the distribution of various livelihoods types across the DIA.

Farming Practices

The DIA is located in the mountain agro-ecological zone where maize, millet, rice, and barley are the main crops. As no irrigation facilities are available, so the agriculture is mostly rain-fed. In some places springs are tapped to provide the required irrigation. Thus, agricultural activities are not year-round and migration to more urban areas to pursue supplementary livelihoods such as sale of medicinal herbs (see Section 6.3.3 for seasonal migration patterns among Bhote, Rai, and Sherpa) is commonly done, in accordance with crop plantation and harvesting cycles. The agricultural calendar in the DIA is shown in ***Table 6.70***.

Table 6.70: Crop Calendar for the Project DIA

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			Activities:
Maize															Plantation
Millet															Growing phase
Rice															Harvesting
Barley															Out-migration
Migration															In-migration

Source: ERM Socioeconomic Survey, 2019–2020

As part of the socioeconomic survey, ERM collected information on crops grown by households in the DIA. The surveyed households reported growing the following crops: paddy (rice), maize, wheat, buck wheat, millet, barley, pulses, and oilseeds. In terms of vegetables, potatoes are grown by many households and most families grow green vegetables in a small area, mainly for household consumption. Only a few households have fruit trees. Cardamom is a widespread crop in the area. The number of households growing each crop and the average crop area for each is discussed below and shown in ***Table 6.71***.

Growing rice depends on having suitable land for rice. Approximately 35% of the total households in Bhotkhola grow rice paddy. Comparatively, more households in Bhotkhola-3 grow rice paddy than other crops. In Bhotkhola-2 and Bhotkhola-4, only 29% of the households grow rice paddy.

Table 6.71: Cereal Crops Grown by Households, by Ward

Rural Municipality-Ward No.	Number of HHs that provided Crop Details	Number of HHs Growing Paddy	Number of HHs Growing Maize	Number of HHs Growing Millet	Number of HHs Growing Wheat	Number of HHs Growing Barley	Number of HHs Growing Buck Wheat
Bhotkhola-2	152	44	140	146	54	14	2
	% of HHs	29%	92%	96%	36%	9%	1%
Bhotkhola-3	75	47	58	69	36	18	1
	% of HHs	63%	77%	92%	48%	24%	1%
Bhotkhola-4	215	63	187	163	68	29	25
	% of HHs	29%	87%	76%	32%	13%	12%
Bhotkhola-5	42	15	37	28	1	0	1
	% of HHs	36%	88%	67%	2%	0%	2%
Bhotkhola total	484	169	422	406	159	61	29
	% of HHs	35%	87%	84%	33%	13%	6%

Source: ERM Socioeconomic Survey, 2019–2020

The most common crop grown by surveyed households was maize. Overall, within Bhotkhola, 87% of households reported growing maize. Rates of maize growth differed across wards, ranging from 92% in Bhotkhola-2 to 77% in Bhotkhola-3. Millet was the next most popular crop reported in the DIA, with 84% of surveyed households reporting millet as one of their crops. Millet is a particularly prominent crop within Bhotkhola-2 and Bhotkhola-3, where 96% and 92% of households, respectively, grow millet crops. Conversely, few households cultivate wheat, barley, and buckwheat.

Apart from these cereals, households also reported growing pulses, vegetables, oilseeds, and fruits (***Table 6.72***). As mentioned previously, cardamom is a popular cash crop in the DIA, with approximately 85% of households cultivating cardamom. Although cardamom cultivation was particularly high in Bhotkhola-4 and Bhotkhola-5, all wards reported cardamom cultivation.

Table 6.72: Pulses, Oilseeds, Vegetables, and Cash Crops, by Ward

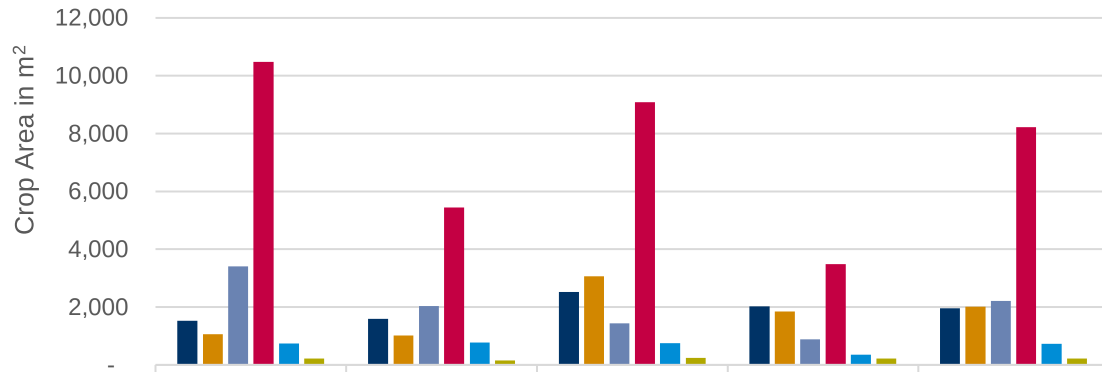
Rural Municipality-Ward No.	Number of HHs that Provided Crop Details	Number of HHs Growing Oil Crops	Number of HHs Growing Pulses	Number of HHs Growing Cardamom	Number of HHs Growing Potato	Number of HHs Growing Green Vegetables	Number of HHs Growing Fruit
Bhotkhola-2	152	0	2	86	140	113	2
		0%	1%	57%	92%	74%	1%
Bhotkhola-3	75	0		63	68	61	
		0%	0%	84%	91%	81%	0%
Bhotkhola-4	215	5	29	203	173	142	34
		2%	13%	94%	80%	66%	16%

Rural Municipality-Ward No.	Number of HHs that Provided Crop Details	Number of HHs Growing Oil Crops	Number of HHs Growing Pulses	Number of HHs Growing Cardamom	Number of HHs Growing Potato	Number of HHs Growing Green Vegetables	Number of HHs Growing Fruit
Bhotkhola-5	42	0	2	41	32	24	2
		0%	5%	98%	76%	57%	5%
Bhotkhola total	484	5	33	393	413	340	38
		1%	7%	81%	85%	70%	8%

Source: ERM Socioeconomic Survey, 2019–2020

Figure 6.62 provides the average area used by households for the cultivation of each crop at the rural municipality level and across different wards. At the rural municipality level, the average area cultivated by households for rice, maize, and millet is approximately equivalent; however, the average area for cardamom cultivation is four times higher. There is a variation in average crop area across different wards. For example, the average cardamom cultivation area is lower in Bhotkhola-3 and Bhotkhola-5, while the average area for maize cultivation is comparatively lower in Bhotkhola-2 and Bhotkhola-3. The average potato cultivation area is approximately equivalent across Bhotkhola-2, 3, and 4, but is significantly lower (less than half the size) in Bhotkhola-5. The average area in which vegetables are grown is comparatively less than other crop types, and is the lowest in Bhotkhola-3.

Figure 6.62: Comparison of Average Crop, by Ward



	Bhotkhola-2	Bhotkhola-3	Bhotkhola-4	Bhotkhola-5	Bhotkhola
Rice Area	1,521	1,589	2,523	2,029	1,958
Maize Area	1,056	1,014	3,063	1,842	2,009
Millet Area	3,412	2,032	1,436	879	2,209
Cardamom Area	10,474	5,446	9,080	3,484	8,218
Potato Area	745	773	757	350	724
Vegetables Area	221	152	239	225	216

Rural Municipality - Ward Number

Source: ERM Socioeconomic Survey, 2019–2020

Livestock Rearing

Livestock are an integral part of subsistence lifestyles in the DIA, kept by 96% of the households surveyed. The livestock kept by households in the DIA can be grouped into three categories: large domestic animals such as bullock/buffalo, cattle, yak, and mules; small livestock such as sheep, goats, and pigs, and poultry birds.

Large livestock such as bullocks and buffalo are used as traction animals in farming operations, while cows and yaks provide milk.[64] Mules (*khachad*) are used for the transportation of goods to places that cannot be reached by motor vehicle, due to the nature/condition of the roads. As shown in ***Table 6.73***, approximately 50% of the surveyed households keep bullock/buffalo (typically two to three animals) while only 30% of the households keep cows (typically three to four cows per household). Three households in Bhotkhola-3 reported keeping yaks, at an average of eight yaks per household. Three percent (3%) of total households keep mules (*khachad*), at an average of six to seven per household. When there are no standing crops, households owning large livestock allow them to free-graze; during the agricultural season, households either take these livestock away from the village or stall-feed them.

Table 6.73: Large Livestock Keeping Practices, by Ward

Rural Municipality-Ward No.	Number of HHs Surveyed	Number of HHs with Bullock/ Buffalo	Average Number of Bullock/ Buffalo per HH	Number of HHs with Cows	Average Number of Cows per HH	Number of HHs with Yaks	Average Number of Yaks per HH	Number of HHs with Mules/ Khachad	Average Number of Mules/ Khachad per HH
Bhotkhola-2	172	88	3.5	55	4.6			5	4.8
		51%		32%				3%	
Bhotkhola-3	75	45	2.6	19	4.3	3	8	3	5.0
		60%		25%		4%		4%	
Bhotkhola-4	261	121	2.6	92	3.4			7	9.0
		46%		35%				3%	
Bhotkhola-5	71	30	2.3	13	2.3			2	6.5
		42%		18%				3%	
Bhotkhola total	579	284	2.8	179	3.8	3	8	17	6.8
		49%		31%		1%		3%	
Makalu-4	14	11	1.8	3	3.0				
		79%		21%					
Grand total	**593**	**295**	**2.8**	**182**	**3.8**	**3**	**8**	**17**	**6.8**
		50%		**31%**		**1%**		**3%**	

Source: ERM Socioeconomic Survey, 2019–2020

[64] While yaks are used for transport in many areas of Nepal, this use does not characterize the project DIA due to its high elevation.

It is important to note that an analysis of large livestock ownership by income quintile did not reveal any trends indicating a correlation between the two variables. A slightly higher percentage of households in the top income quintile do in fact own large livestock (60% of all households in the top income quintile own large livestock, while other quintiles range between 47% and 51%); however, of the households with the highest number of large livestock (>5 animals), only 11% were in the highest income quintile, while 47% were in the lowest two income quintiles combined (see ***Table 6.74***). Therefore, there does not seem to be a correlation between wealth and large livestock ownership.

Table 6.74: Large Livestock Ownership by Income Quintile

Total Income from All Sources	Number of Large Livestock				Total HHs
	HH with No Large Livestock	HH with 1–2 Large Livestock	HH with 3–5 Large Livestock	HH with >5 Large Livestock	
328,400–590,600 NPR	47%	18%	13%	23%	100%
> 590,600 NPR	52%	13%	11%	24%	100%
Total HHs	**51%**	**18%**	**12%**	**18%**	**100%**

As shown in ***Table 6.75***, surveyed households also reported keeping goats (55% of households), pigs (48% of households), and sheep (2% of households). A higher percentage of households reported keeping goats in Makalu-4 and Bhotkhola-4, compared to in other areas. On average, these households kept six to eight goats. Households keeping pigs tended to keep them in small numbers (approximately two pigs per households). These pigs are mostly kept in a separate enclosure and stall-fed. The goats are taken out for free grazing as well as being stall-fed.

Table 6.75: Small Livestock Keeping Practices, by Ward

Rural Municipality-Ward No.	Number of HHs Surveyed	Number of HHs with Goats	Average Number of Goats per HH	Number of HHs with Pigs	Average Number of Pigs per HH	Number of HHs with Sheep	Average Number of Sheep per HH
Bhotkhola-2	172	65	7.9	87	1.4	2	60.0
		38%		51%		1%	
Bhotkhola-3	75	33	6.8	36	1.5		
		44%		48%			
Bhotkhola-4	261	176	7.9	114	2.0	8	2.5
		67%		44%		3%	
Bhotkhola-5	71	40	5.5	39	1.1	1	4.0
		56%		55%		1%	
Bhotkhola total	**579**	**314**	**7.5**	**276**	**1.6**	**11**	**13.1**
		54%		**48%**		**2%**	
Makalu-4	14	10	5.1	7	1.0		
		71%		50%			
Grand total	**593**	**324**	**7.4**	**283**	**1.6**	**11**	**13.1**
		55%		48%		2%	

Source: ERM Socioeconomic Survey, 2019–2020

Keeping a small number of poultry is also a very popular practice in the DIA (see ***Table 6.76***), with 85% of households reporting this practice. The number of households keeping poultry was relatively lower in Bhotkhola-3, compared to other areas. On average, these households kept around 10 birds per household. They keep these birds to produce eggs for consumption and also to sell their meat for cash income. Only 4% of the households reported keeping other birds, such as ducks and geese, in small numbers (approximately three to four birds per household).

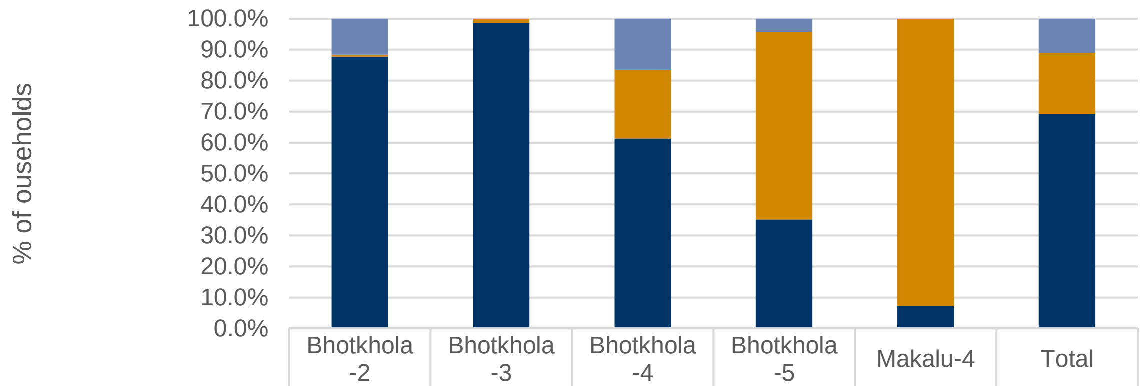
Table 6.76: Poultry and Bird Keeping Practices, by Ward

Rural Municipality-Ward No.	Number of HHs Surveyed	Number of HHs with Poultry	Average Number of Poultry Birds per HH	Number of HHs with Duck/Geese	Average Number of Duck/Geese per HH
Bhotkhola-2	172	138 (80%)	8.8	4 (2%)	3.0
Bhotkhola-3	75	48 (64%)	4.9	4 (5%)	2.5
Bhotkhola-4	261	238 (91%)	12.6	13 (5%)	3.8
Bhotkhola-5	71	68 (96%)	10.0		
Bhotkhola total	**579**	**492** (85%)	**10.4**	**21** (4%)	**3.4**
Makalu-4	14	13 (93%)	4.5		
Grand total	**593**	**505** **(85%)**	**10.3**	**21** **(4%)**	**3.4**

Source: ERM Socioeconomic Survey, 2019–2020

Of the 593 survey respondents that were asked if they have access to common grazing lands (***Figure 6.63***), 411 (69%) said that they did, while 29% said they did not. These common grazing lands are primarily on government owned and community forest land. A relatively low number of households (35%) in Bhotkhola-5 reported having access to common grazing land, compared to Bhotkhola-3, where 99% of the households reported having access to common grazing land. In Bhotkhola-4, only 61% of household's report having access to common grazing land.

Figure 6.63: Percentage of Households Accessing Common Grazing Land for their Domestic Livestock



	Bhotkhola -2	Bhotkhola -3	Bhotkhola -4	Bhotkhola -5	Makalu-4	Total
Did not Reply	11.6%	0.0%	16.5%	4.2%	0.0%	11.1%
Does not have Access	0.6%	1.3%	22.2%	60.6%	92.9%	19.6%
Has Access	87.8%	98.7%	61.3%	35.2%	7.1%	69.3%

Access to common grazing land

Source: ERM Socioeconomic Survey, 2019–2020

Consultations with communities (both FDGs and KIIs) revealed that households typically graze domestic livestock in community forests and on other government forest land. These grazing grounds are fairly dispersed and many of them have local names. The names of these grazing grounds and the time it takes for villagers to reach them is provided in ***Table 6.77***.

Table 6.77: Names of Grazing Grounds and Distance from Villages

Village/ Settlement	Names of Grazing Grounds <30 mins Distance	Name of Grazing Grounds <60 mins Distance	Name of Grazing Grounds >60 mins Distance
Adima			Longbang Tembang Samudayek Ban
Barun Bazar			Paich Kharka, Longbang Tembang Samudayek Ban, Riding Charan, Thangcham Charan Chhetra
Chepuwa	Chenchung, Chharkhkha, Chhesang, Chhinau, Dunlam, Ghungsa, Jharkakha, Pejung Danda, Samnom, Samungm, Yabbhotak	Salum, Rang Kharka, Chyathanga Kharka	Dunlam, Kalajhar, Ghunsang, Meningma
Chongrak			Gajure Nindagi
Chyamtan	Chyathang		Damdang, Hulungma, Jesoso, Lasu Kharka, Simbakpa, Simchampa.
Gola	Lumwang Temwa	Thulo Charan Chetra, Gurase Dada, Lekh Chaur	Chandani, Gorjure
Guthi Gumba			Pejung Danda, Simpakap
Hatiya	Pang Kharka, Meningma, Phurbi Denga Charan Chhetra		Thangcham Charan Chhetra, Tudi Phurbi Denga, Pang Kharka, Suchung, Popti
Hema	Lekh Chaur, Bhanje Faste		Himshikhar, Mim Singh Kharka, Fokte Karka
Hongon	Hakchu, Genda	Jyakma, Aakchu Charan	Ting Samudayek Ban, Dhukmu, Kalajhar, Dabuk Charan, Yuruma Charan, Charpate
Jijinkha	Pakhawari Charan		Saleri Kharcha
Kapase			Gajure Nindagi Samudayek Ban, Talukharka, Tal Charan
Limbutar	Manga Charan Chhetra		Gorujure, Tal Kharka
Lingam	Limma, Darak	Pejung Danda	Jharakha, Singkapa
Lunsun		Nisang	Khani Danda
Namase	Luwangchen, Lurima Kharka, Chhokang, Siluwa, Changlama	Takchang	Himshikhar
Rapsa			
Rukma	Hakchu		Makpalung
Sembung	Gumba Charan, Bodakpa		Meningma, Thanchan
Sibrun	Chalama, Bhangbung, Domseka Charan	Salleri Kharka	Jor Khambe Samudaye Ban, Akhar Charan Chetra, Lekha Kharka, Himasikhar
Syaksila	Kechak Charan Chhetra, Bagsa		Longbang Tembang, Riding Charan, Thamsachama
Tunkhaling	Gore Jure Samudayek Ban		Ganure Nindagi

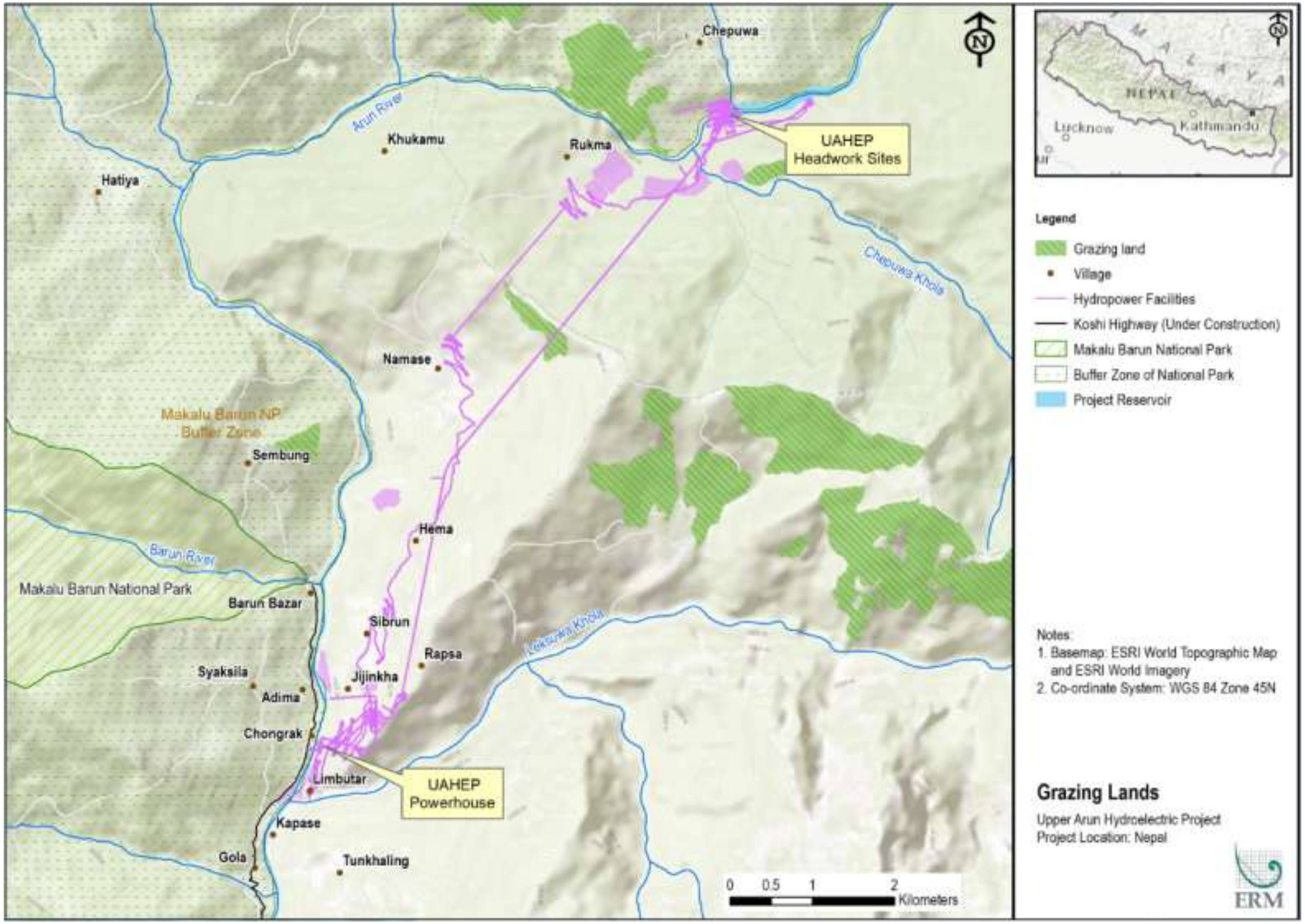
Source: ERM Socioeconomic Survey, 2019–2020

Figure 6.64 shows the location of government land and forest areas used for common grazing lands.[65] Prior to the establishment of Makalu Barun National Park (MBNP) and its Buffer Zone.[66] Grazing lands (locally known as *kharkas*) were under the Kipat (traditional tenure) system. However, as part of the establishment of the MBNP, a management plan was developed (the MBNP Management Plan) that recognized the importance of the MBNP ecosystem to conserving biological diversity and the livelihoods of local communities and, thus, sought to regulate the use of the rangeland within the MBNP for grazing purposes. In the mid to late 1990s the government established a Buffer Zone Community Forestry Program that ensures benefit-sharing mechanisms fulfil the dual purpose of meeting communities' forest product needs (including for fodder) while providing refuge for dispersing wildlife populations. The communities that live within the Buffer Zone, acting in accordance with the Community Forestry Program, play an important role in conserving wildlife and natural resources in the Buffer Zone.

[65] It was not possible to create a map showing the specific grazing grounds to which survey respondents referred, as survey responses indicated a variety of different informal/colloquial names for grazing grounds that do not necessarily align with the more formal names of the grazing grounds shown in ***Figure 6.64***.

[66] The Buffer Zone Regulations (1996) and Buffer Zone Guidelines (1999) provide the policy and legal framework for management of the Buffer Zone.

Figure 6.64: Map of Project DIA Showing National Park, Buffer Zone, and Areas Used as Common Grazing Lands



Ethnic Distribution of Land-Based Livelihoods

As mentioned above, the distribution of livelihoods among the population in the DIA tends to vary more based on geography and availability of certain types of land in particular villages, than it does by ethnicity. As shown in the ***Table 6.78***, most ethnicities earn more than 80% of their income from farm crops, supplementing it with livestock/poultry and, to lesser extents, the sale of herbs, firewood, and foraged products. The only two exceptions to this trend are the Kami (Bishowkarma) and Newars, both of whom rely less on farm crops (67.5% and 65.8% of annual income, respectively) and more on livestock/poultry (27.1% and 34.3%, respectively) than do other ethnicities. While Pradhan and Sherpa groups rely 100% on farm crops, it is important to understand that the number of households represented by these two ethnicities was very small (3 and 10 households, respectively) so these figures may not be representative of the broader population.

Table 6.78: Average Annual Income[67] from Land-Based Livelihoods, by Ethnicity

Ethnicity	Herbs	Farm Crops	Firewood & Foraged Products	Livestock & Poultry
Bhote	4.7%	85.0%	0.5%	9.8%
Kami (Bishowkarma)	0.0%	67.5%	0.0%	27.1%
Gurung	0.0%	81.1%	0.0%	18.9%
Newar	0.0%	65.8%	0.0%	34.2%
Pradhan	0.0%	100.0%	0.0%	0.0%
Rai	0.2%	90.7%	0.3%	8.7%
Sherpa	0.0%	100.0%	0.0%	0.0%
Tamang	1.1%	92.9%	0.2%	5.8%
Total	**3.3**%	**70.9%**	**0.4%**	**9.5%**

Source: ERM Socioeconomic Survey, 2019–2020

[67] All references to 'income' in this document refer to cash income – the socioeconomic census did not include questions on subsistence agriculture or the role that trade and barter practices play in sustaining surveyed households.

Community Use of Forests and Natural Resources

The life and livelihoods of communities in the DIA are linked to natural resources such as forests, rivers, and springs. The following sections address these linkages in more details.

Community Forests

Community forestry is a popular approach to mountain landscape restoration, forest management, biodiversity conservation, and support for rural livelihoods within the DIA. For example, small farmers practice subsistence farming and rely heavily on forests for grass and fodder to feed their livestock. They also collect leaf litter for use on their farms and firewood, which is the main source of energy for cooking and heating.[68] Herbs and other non-timber forest products (NTFPs) that can fetch a market price are primarily collected for sale, not for use by the collecting household.

The Forest Act of 2076 BS (2019) empowers local people through the establishment of a participatory decision-making process (organized through CFUGs) and clear guidelines for the distribution of benefits generated from community forest management. The CFUGs established under this legal framework are self-governing, empowered local institutions. In the project impact area there are eight such CFUGs (two of which are in the Buffer Zone) corresponding to a forest area of 2,526.4 ha of community forest with 693 user households. In Makalu-4, there exists the Mahavir Thansingh Thapla community forest, which spans 500 ha with 93 user households (***Table 6.79***). These community forests are home to a number of species used by local people, such as timber, fodder, fuelwood, medicinal plants, and wild vegetables, among others.

As ***Table 6.79*** indicates, the only community forest that will experience any significant impacts is Pari Parkha (because of its limited size).[69] There are only two villages that use community forest – Sibrun and Limbutar. Sibrun also has access to the much larger Him Shikhar community forest, so is not reliant on Pari Parkha, and the entire village of Limbutar is being physically relocated, so they will no longer use this community forest (see RAP). ***Figure 6.65*** shows a map locating community forests in the DIA.

[68] Additional information pertaining to forest resources is available in the UAHEP's Biodiversity Assessment and in the Biodiversity Management Plan.

[69] However, it should be noted that population in-migration and labor influx may, if not properly mitigated, lead to more significant impacts on community forests than what is indicated here. See Section 7.3.4 (Project-induced In-Migration and Population Influx) for a discussion.

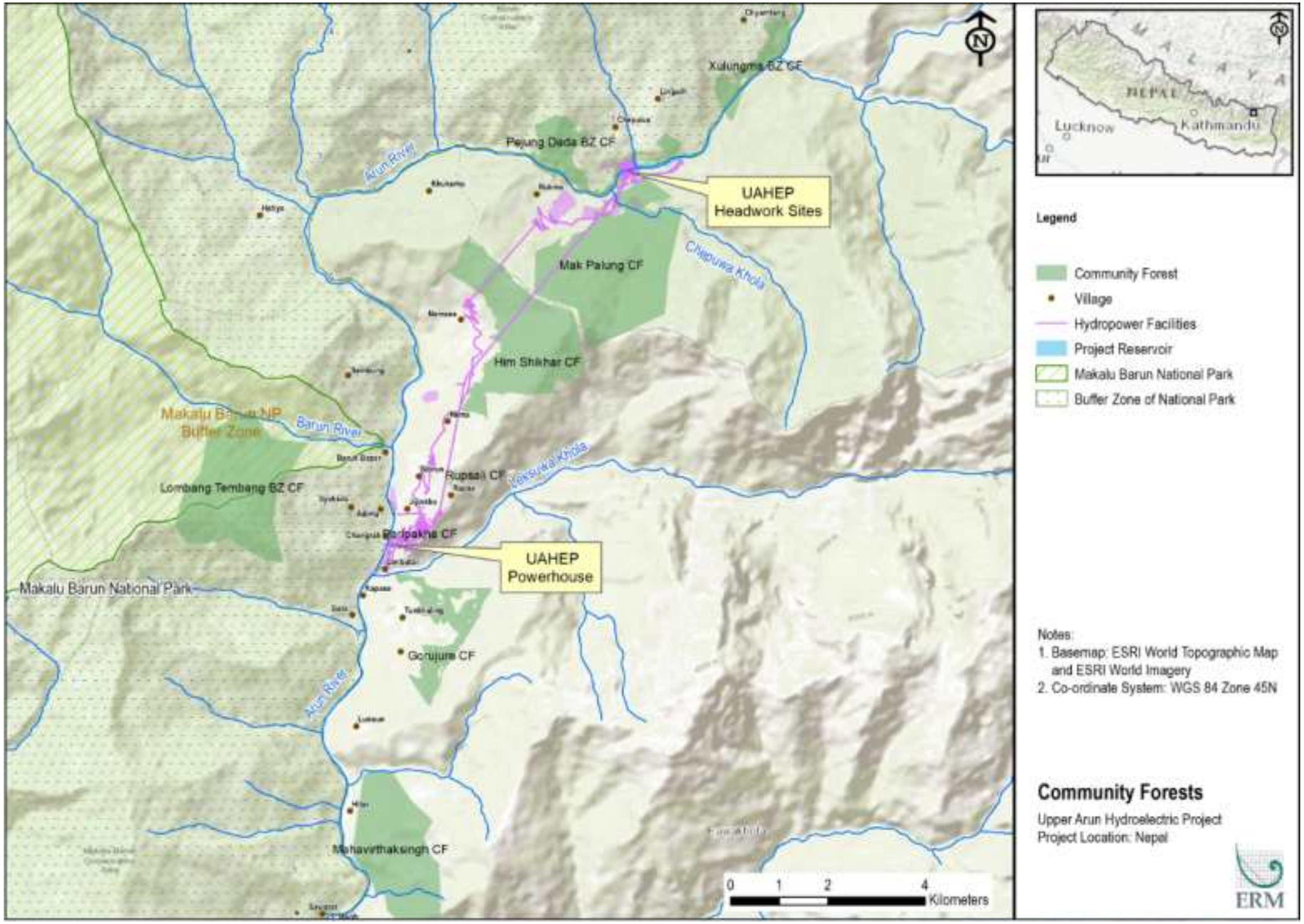
Table 6.79: Details of Community Forests and their Users in the Project DIA

Community Forest	Villages Using Community Forest	Number of Users	Forest Uses	NTFP Species	Location and No. of User HHs per Village	Community Forest Area (ha)	Community Forest Impacts (ha)	Community Forest Impacts (%)
Him Shikhar	Namase, Hema, Sibrun	157	Timber, fodder, fuelwood, NTFPs, medicinal plants, forage, grass	*Daphne sp., Arundinaria sp., Swerita sp.*	Bhotkhola-4, Namase (60), Hema (30), Sibrun (67)	481	0.1	~0
Mak Palung	Rukma	27	Fodder, timber, fuelwood, wild vegetables, forage, medicine	*Swerita* sp., *Paris* sp., *Astible* sp., *Urtica* sp., *Arundinaria* sp.,	Bhotkhola-2, Rukma	731	19.6	2.7
Rupsali	Rapsa	55	Fodder, fuelwood, NTFPs, forage	*Arundinaria sp., Swerita sp.*	Bhotkhola 4 & 5, Sirudanda (20) & Rapsa (35)	3.5	0	0
Pari Parkha	Sibrun, Limbutar	54	Fodder, timber, fuelwood, wild vegetables, forage, medicine	*Swerita* sp., *Paris* sp., *Astible* sp., *Urtica* sp., *Arundinaria* sp.	Bhotkhola-4, Sibrun	3.9	1.9	48.7
Gorujure	Tunkhaling, Kapase	120	Timber, fodder, fuelwood, NTFPs, forage	*Daphne sp, Arundinaria sp, Swerita sp*	Bhotkhola-5, Tungkhaling	312	0	0
Pejung Danda (BZ)	Chepuwa, Lingam, Gumba	145	Fodder, timber, fuelwood, wild vegetables,	*Cinamomum sp., Amomum sp., Urtica sp.,*	Bhotkhola-2 Chepuwa/Lingum/Gumba	495	14.4	2.9

Community Forest	Villages Using Community Forest	Number of Users	Forest Uses	NTFP Species	Location and No. of User HHs per Village	Community Forest Area (ha)	Community Forest Impacts (ha)	Community Forest Impacts (%)
			medicinal plants	*Dryopteris sp., Acorus sp., Aconogonum sp., Arundinaria sp., Swerita sp.*				
Mahavir Thansingh	Hitar, Obak	93	Timber, fodder, fuelwood, forage, grass, agriculture equipment, NTFPs and medicinal plants	*Daphne sp., Arundinaria sp., Swerita sp., Taxus baccata*	Makalu-4	500	0	0
Xulungma (BZ)	Chyamtan	~135	Fodder, timber, fuelwood, wild vegetables, forage, medicine	*Swerita sp., Paris sp., Astible sp., Urtica sp., Arundinaria sp.*	Bhotkhola-2, Chyamtan	90	0	0
					Total	**2,526.4**	**36**	

Source: ERM Socioeconomic Survey 2019–2020, FGDs and KIIs

Figure 6.65: Map of Community Forests and National Park



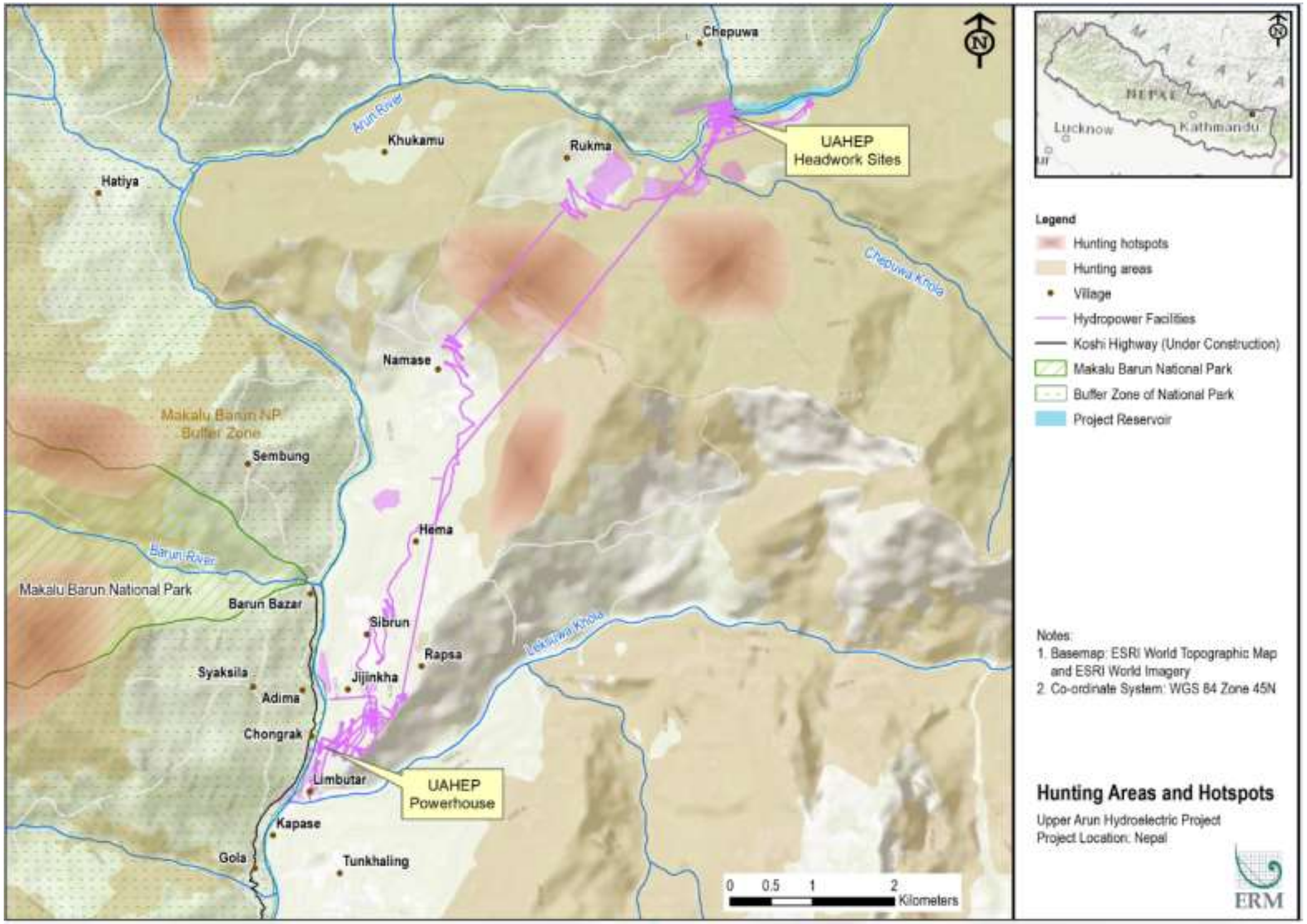
Hunting/Trapping and Collection of Forest Products

Regulated hunting was an important feature of traditional subsistence life of local communities until the government established the MBNP Conservation Area and community forests in 1991 and its Buffer Zone in 1999.[70] Hunting is restricted in the MBNP and community forest areas including Buffer Zone areas, and is controlled through regular patrolling efforts and check posts. In community KIIs, local communities indicated that, prior to the establishment of the MBNP and its Buffer Zone, they used to hunt in small groups with bow and arrow and locally made hunting equipment, as well as using pits and noose-traps. Their main target of hunting used to be deer, wild goats, and pigs, as well as birds such as kalij and danfe, and wild animals like dumsi, ghoral, thar, bhalu, and kasuri. FGD and KII participants also reported that some locals still hunt, although very occasionally and illegally, and also plant some crops in the forest areas. ***Figure 6.66*** identifies the hunting areas that the local communities used prior to the establishment of the MBNP and its Buffer Zone.

The Management Plan for the MBNP and its Buffer Zone identifies Kimathanka and Riddhak as important gateways for international trade in wildlife and plant parts. The Management Plan recognizes that the poaching of animals and pheasants and the illegal collection of NTFPs are important issues for the sustainable management of MBNP. Although poaching occurs within the MBNP, very few cases of poaching, however, have been reported/recorded. This is due primarily to a lack of resources to monitor and enforce anti-poaching measures.

[70] Management Plan for Makalu Barun National Park and Buffer Zone (2074 BS), page 16, section 5.3.1.2.2, provides proposed anti-poaching and intelligence gathering activities.

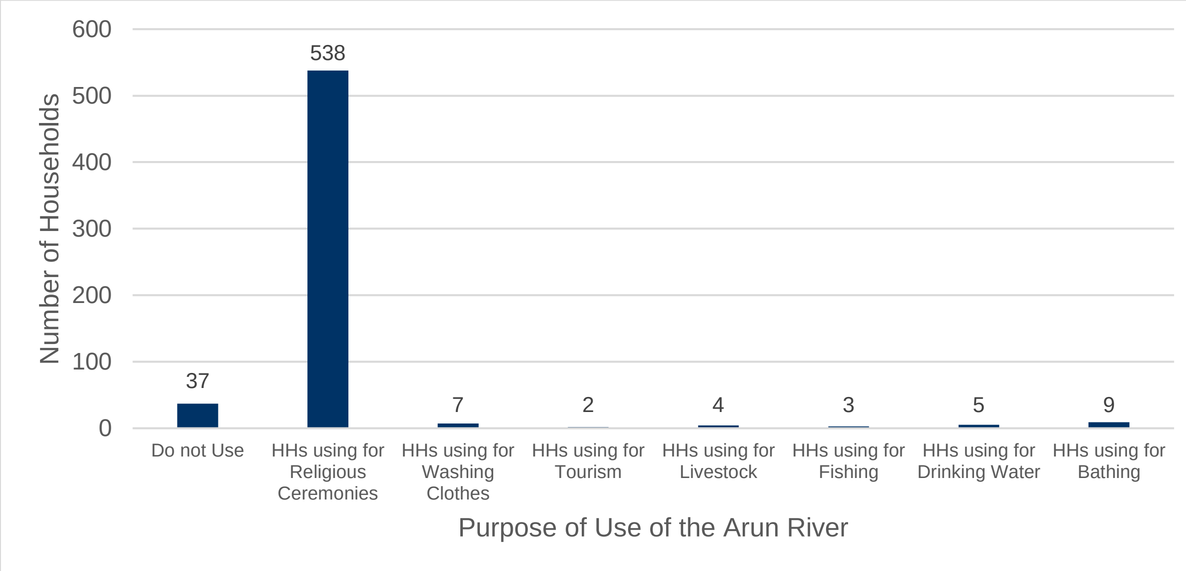
Figure 6.66: Map of Forest Areas used for Hunting Prior to Establishment of MBNP and Buffer Zone



Use of the Arun River and Springs

The Arun River consists of a deep gorge, the high ground above which is where most villages are located. This terrain limits the villagers' use of the Arun River as a source of water. Less than 2% of households use the river for fishing, drinking water, bathing, livestock, tourism, or washing clothes, but approximately 91% of households indicate they use the river for various religious purposes (***Figure 6.67***).

Figure 6.67: Purposes for which Households use the Arun River



Source: ERM Socioeconomic Survey, 2019–2020

The Arun basin in the DIA collects water from several perennial tributaries, including streams such as the Barun River, Ikhuwa Khola, and Leksuwa Khola.[71] Apart from these major tributaries, a number of smaller streams, both perennial and seasonal, discharge water to the Arun River. Some of these streams are used to supply drinking water, for irrigation, to operate *ghatta* (water mills), which are a popular device for grinding grains such as maize, millet, and wheat, and to operate lathes for turning prayer wheels and carving out wooden blocks to make small pots and cups. Information about the use of local springs is available in ***Table 6.80.*** For the location of these springs and additional information on their uses see ***Figure 6.17*** and ***Table 6.8***. Some streams are used to generate electricity through micro-hydroelectric plants, which supply power to one or multiple villages (see ***Figure 6.17*** for location of micro-hydroelectric plants. At present, most of the villages get their electricity supply from these micro-hydro plants for a fixed number of hours.[72]

Water from the Arun River in the DIA is not used for drinking water and irrigation purposes. Instead, households get their drinking water from streams and springs. The flow of some springs is channeled to farmland for irrigation purposes. Where water is tapped using pipes, the construction cost is borne by individual households or groups of households that use the water. ***Table 6.80*** provides a list of local springs which specific communities reported using during FGDs/KIIs, as well as the local communities' concerns about the likely impacts of the UAHEP upon them. ***Figure 6.6*** shows the locations of springs and *kholas* (streams). It is important to note that the table simply represents community concerns about the project impacts; a full discussion of assessed impacts is presented in Chapter 7.3.

[71] The socioeconomic survey did not collect information pertaining to the specific uses of these three streams.

[72] The following villages are connected to micro-hydro plants: Chepuwa, Lingam, Rukma, Namase, Sibrun, Hema, Sembung, and Rapsa. See Table 6.80 for further information about spring use.

Table 6.80: List of Local Springs and their Current Use

Name of Spring	Nearby Community /Users	Perennial/ Seasonal	Current Use	Community Concerns of UAHEP Impact
Khabo Khola located in Himshikhar Community Forest Block B	Namase	Perennial	Community managed micro hydro scheme with 8-kilowatt capacity, *ghatta* (water mill) and irrigation	May dry-up or change course due to construction of headrace tunnel and project access road
Mangpung Khola located below Namase village	Rapsa, Sibrun, Hema, and Sembung	Perennial	Community managed micro hydro power plant with 16-kilowatt capacity that provides electricity to Rapsa, Sibrun, Hema, and Sembung	May dry-up or change course due to construction of headrace tunnel and project access road
Fanglasexcha Khola	Namase	Seasonal	Irrigation	May dry-up or change course due to construction of headrace tunnel and project access road
Chudajembuk Khola located in Himshikhar Community Forest Block B	Namase	Perennial	Drinking water supply	May dry-up or change course due to construction of headrace tunnel
Yorim Khola	Namase	Seasonal	Unknown – community use	May dry-up or change course due to construction of headrace tunnel and project access road
Takchen Mul	Namase	Seasonal	Unknown – community use	May dry-up or change course due to construction of headrace tunnel and project access road
Lumajen Mul	Namase	Seasonal	Used for irrigation, bathing, washing	May dry-up or change course due to construction of headrace tunnel and project access road
Yaklem Khola	Namase	Seasonal	Unknown – community use	May dry-up or change course due to construction of headrace tunnel and project access road
Gurunsisa Khola	Namase	Seasonal	Irrigation	May dry-up or change course due to construction of headrace tunnel and project access road
Hesluks Khola	Namase	Perennial	Unknown – community use	May dry-up or change course due to construction of headrace tunnel and project access road
Manja Khola	Hema	Seasonal	Drinking water	May dry-up or change course due to construction of headrace tunnel and project access road
Hema Khola	Hema	Seasonal	Not used	May dry-up or change course due to construction of headrace tunnel and project access road
Angrukgaira Dhara	Sibrun	Seasonal	Drinking water	May dry-up or change course due to construction of headrace tunnel and project access road
Jijinkha Dhara	Jijinkha	Seasonal	Drinking water	May dry-up or change course due to construction of headrace tunnel and project access road

Source: ERM Socioeconomic Survey, 2019–2020

The Arun River has a number of native fish species such as asala (common snow-trout), tite (stone carp), chepte, and kapre (catfish);[73] however, fishing in the river is mainly done for recreation and personal consumption. Mr. Yosub Rai, a resident of Chongrak near the proposed powerhouse site, reported that about 15 individuals (13 Rai from Tungkhaling and 1 Kami from Syaksila, in addition to himself) occasionally fish in the Arun River and rely on fish as an occasional source of food. According to Yosub, fishing is usually done along the stretch of the Arun River from Chepuwa Phedi[74] to Gola Phedi (***Figure 6.69***).

[73] The scientific names of these fish are as follows: asala (common snow-trout) – *Schizothorax richardsonii*, tite (stone carp) – *Psilorhynchoides pseudecheneis*, chepte – scientific name pending, kabre – general name for several small catfish in the genus *Glyptothorax* and *Psedecheneis*.

[74] A place where people earlier crossed the river.

Figure 6.68: Springs Used by Local Communities and their Locations vis-à-vis Project Components

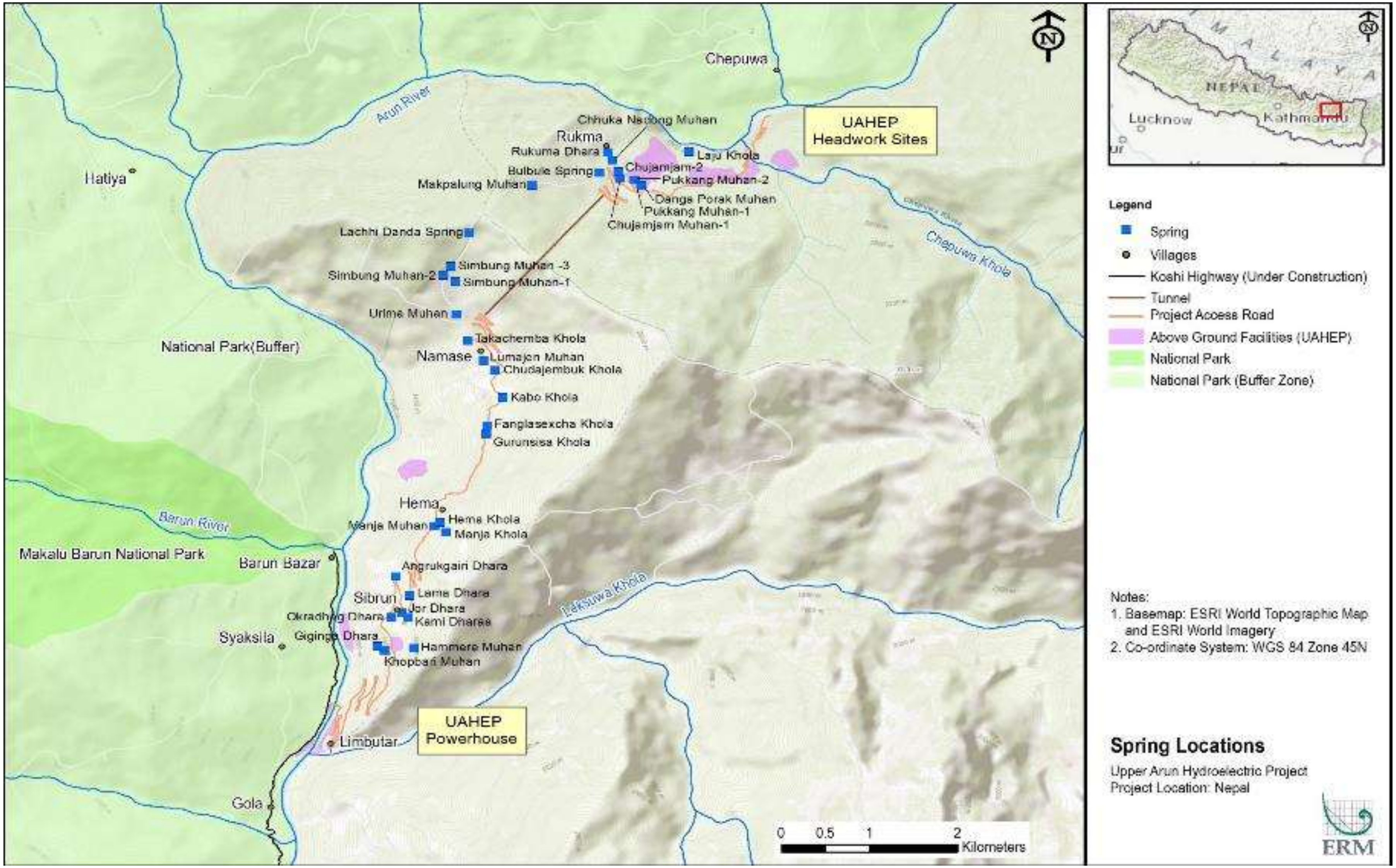
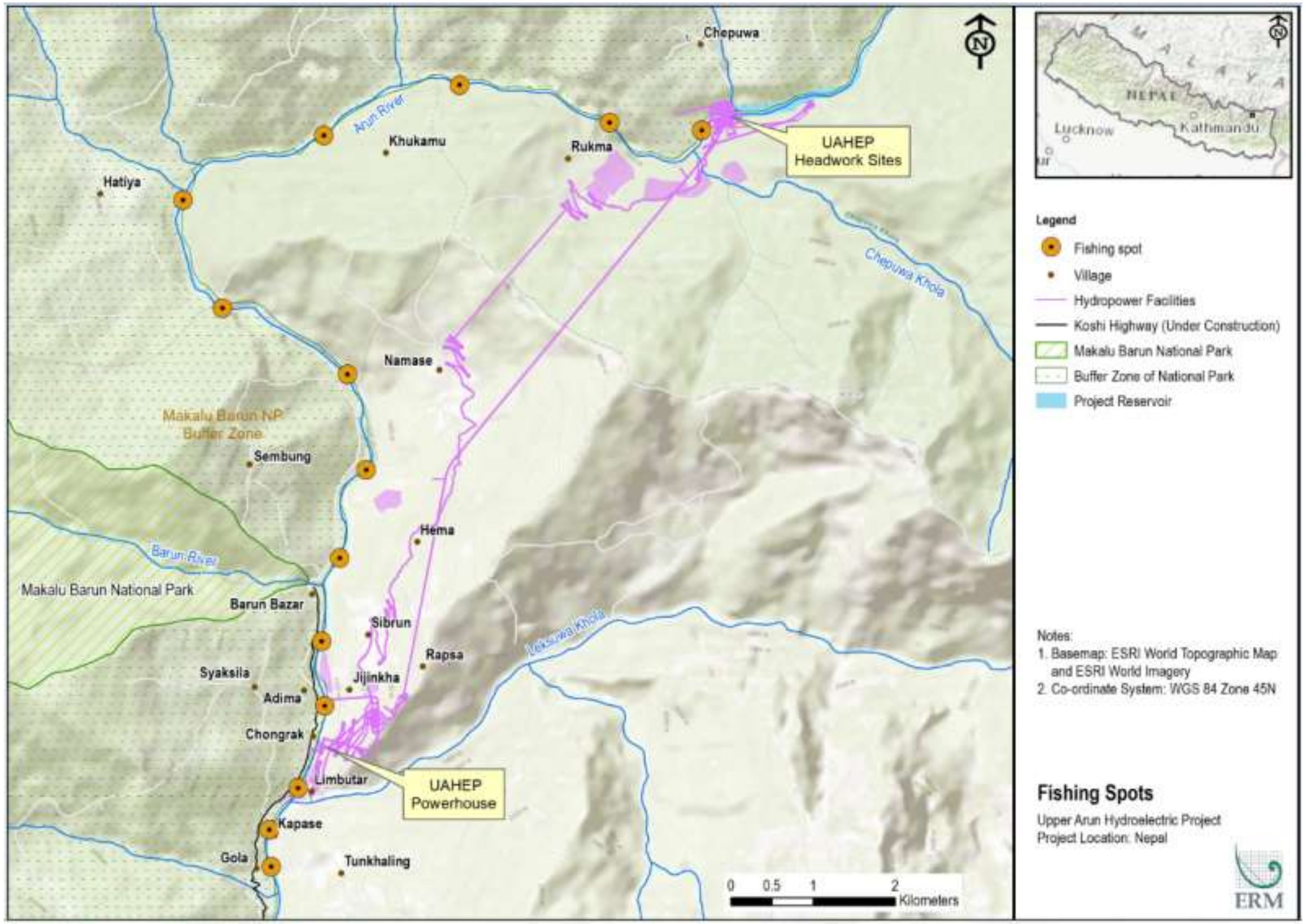


Figure 6.69: Fishing Spots along the Stretch of Chepuwa Phedi to Gola Phadi (Arun River)



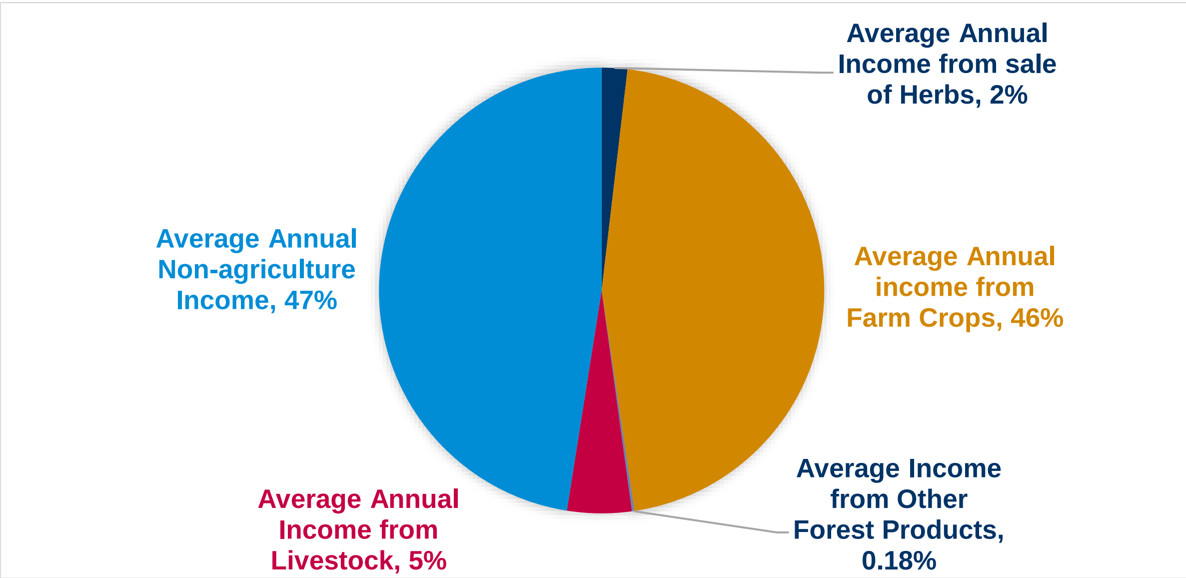
6.3.9 Household Income and Expenditure

Annual Income Levels

In terms of formal income, the economic conditions in the DIA are such that 19% of the population are living under Nepal's poverty line, while 60% are living under the internationally defined poverty line (however, this assessment of poverty is based purely on reported cash income and, therefore, does not consider subsistence agriculture or the role of exchange systems that impact on the standard of living).

The composition of occupations among the project-affected population/surveyed population is discussed in Section 6.3.6 above. The income streams for households, which correspond to these occupations, can be broadly divided into agricultural (including all related activities) and non-agricultural sources of income.[75] There are four major sources of agricultural income. They are: income from the sale of herbs; income from the sale of crops; income from the sale of other forest products, and; income from livestock. Non-agricultural income sources include long-term employment (service), short-term wage income, trade/business, self-employment, and remittances. An overview of the composition of household incomes from these sources is shown in ***Figure 6.70***. Farm income and non-agricultural income are almost equal in terms of their percentage contribution to household income. Income from livestock and the sale of herbs and forest products supplements household incomes.

Figure 6.70: Overall Composition of Average Household Income

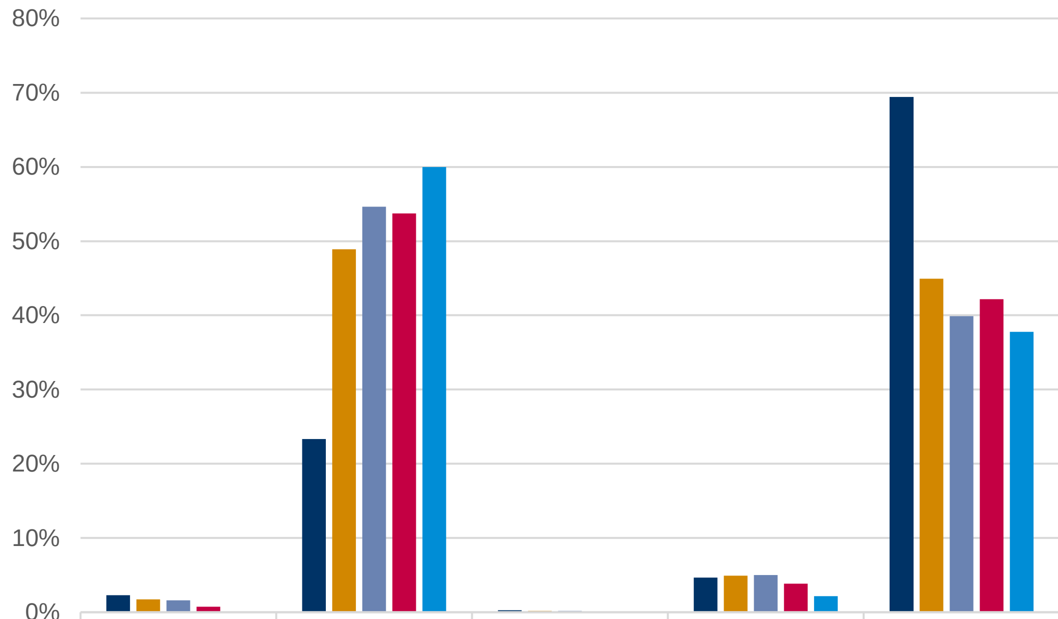


Source: ERM Socioeconomic Survey, 2019–2020

The variation in source of household income across different wards is shown in ***Figure 6.71***. The average annual income from selling herbs and other forest products does not vary much across different wards. Income from livestock is relatively equal in Bhotkhola-2, 3 and 4. A noticeable variation is seen in farm and non-farm income in Bhotkhola-2, in comparison to other wards. In Bhotkhola-2, income from farm crops is only 23% in comparison to other wards, which are in the 50–60% range. The non-farm income in Bhotkhola-2 is 69%, which is considerably higher in comparison to other wards, which are in the 40–45% range.

[75] It is important to note that the socioeconomic survey only collected information pertaining to cash income from agricultural (or non-agricultural) sources; the data is, therefore, limited in that it does not shed any light on the reliance of households on subsistence farming practices and/or exchange systems that are known to be prevalent in the area. Additional studies may be required to understand these practices.

Figure 6.71: Composition of Average Household Income from Agricultural and Non-Agricultural Sources, by Ward



	Average Annual Income from selling Herbs	Average Annual income from Farm Crops	Average Annual income from Other Forest Produce	Average Annual Income from Livestock	Average Annual Non-agriculture Income
Bhotkhola-2	2%	23%	0.3%	5%	69%
Bhotkhola-3	2%	49%	0.2%	5%	45%
Bhotkhola-4	2%	55%	0.2%	5%	40%
Bhotkhola-5	1%	54%	0.1%	4%	42%
Makalu-4	0%	60%	0.1%	2%	38%

Source: ERM Socioeconomic Survey, 2019–2020

Table 6.81 provides the average annual income of households from different income sources for each affected village. Lingam and Chyamtan in Bhotkhola-2 and Namase in Bhotkhola-4 report relatively high average annual income from selling herbs compared to other villages. Households from Hema earn a significant percentage of their income from farming; income from other sources is, therefore, relatively low. Average annual income from other forest products is higher in Rukma than other villages, while average annual income from livestock is higher in Gola, Chongrak, Barun Bazar, and Jijinkha. This may be because these villages are close to the Koshi Highway and have been receiving visitors over the past year. The non-agricultural income is highest in Gola, which is a market place where most of the households participate in trade/business. Households in Lingam and Chyamtan also have higher-than-average annual incomes from non-agricultural sources.

Table 6.81: Average Annual Household Income from Various Income Sources, by Village[76]

Rural Municipality	Ward No.	Village	Average Annual Income from Sale of Herbs		Average Annual Income from Farm Crops		Average Annual Income from Sale of Firewood, Basket, Honey, etc.		Average Income from Livestock		Average Non-Agriculture Income		Average Total Income from All Sources
			In NPR	In % of Total Income	In NPR	In % of Total Income	In NPR	In % of Total Income	In NPR	In % of Total Income	In NPR	In % of Total Income	
Bhotkhola	**Ward 2**	Chepuwa	8,564	2%	86,289	23%	642	0.2%	16,699	4%	266,628	70%	378,821
		Chyamtan	12,786	3%	79,016	17%	286	0.1%	17,860	4%	358,524	77%	468,472
		Guthi Gumba	4,735	1%	124,125	28%	-	0.0%	11,250	3%	299,000	68%	439,110
		Lingam	21,173	3%	164,094	22%	909	0.1%	25,091	3%	522,909	71%	734,176
		Rukuma	5,157	2%	97,679	36%	3,563	1.3%	25,899	9%	140,778	52%	273,076
	Ward 2 total		**9,187**	**2%**	**92,709**	**23%**	**1,044**	**0.3%**	**18,568**	**5%**	**275,988**	**69%**	**397,496**
	Ward 3	Hatiya	-	0%	173,893	57%	-	0.0%	14,255	5%	116,059	38%	304,208
		Hongon	8,761	3%	101,206	40%	902	0.4%	12,878	5%	129,976	51%	253,723
	Ward 3 total		**4,789**	**2%**	**134,603**	**49%**	**493**	**0.2%**	**13,502**	**5%**	**123,667**	**45%**	**277,055**
	Ward 4	Adima	-	0%	173,050	54%	300	0.1%	5,400	2%	144,400	45%	323,150
		Barun Bazar	-	0%	102,500	25%	-	0.0%	38,500	10%	262,500	65%	403,500
		Chongrak	-	0%	83,400	16%	-	0.0%	71,400	13%	379,000	71%	533,800
		Gola	14,167	1%	476,864	36%	875	0.1%	56,010	4%	774,500	59%	1,322,416
		Hema	6,175	1%	362,176	83%	1,420	0.3%	29,116	7%	35,280	8%	434,167
		Jijinkha	-	0%	145,900	40%	-	0.0%	49,000	13%	168,333	46%	363,233
		Limbutar	-	0%	142,000	69%	417	0.2%	8,633	4%	55,667	27%	206,717
		Namase	20,746	4%	374,906	65%	1,817	0.3%	26,356	5%	157,415	27%	581,241
		Sembung	-	0%	112,600	70%	-	0.0%	5,300	3%	43,000	27%	160,900
		Sibrun	2,819	1%	291,505	59%	555	0.1%	22,102	4%	178,877	36%	495,858

[76] As mentioned above, the socioeconomic survey only collected information pertaining to cash income from agricultural (or non-agricultural) sources; the data is, therefore, limited in that it does not shed any light on the reliance of households on subsistence farming practices and/or exchange systems. Given that these practices are known to be prevalent in the area, additional studies may be required to better understand these dynamics and their implications for RAP implementation.

Rural Municipality	Ward No.	Village	Average Annual Income from Sale of Herbs		Average Annual Income from Farm Crops		Average Annual Income from Sale of Firewood, Basket, Honey, etc.		Average Income from Livestock		Average Non-Agriculture Income		Average Total Income from All Sources
			In NPR	In % of Total Income	In NPR	In % of Total Income	In NPR	In % of Total Income	In NPR	In % of Total Income	In NPR	In % of Total Income	
		Syakshila	1,543	1%	100,997	36%	57	0.0%	10,689	4%	165,300	59%	278,586
	Ward 4 total		**8,574**	**2%**	**289,787**	**54%**	**889**	**0.2%**	**26,507**	**5%**	**211,651**	**39%**	**537,408**
	Ward 5	Kapase	-	0%	216,500	56%	250	0.1%	12,625	3%	160,625	41%	390,000
		Lunsun		0%	127,281	55%	-	0.0%	4,500	2%	99,866	43%	231,648
		Rapsa	-	0%	189,500	63%	-	0.0%	22,250	7%	91,000	30%	302,750
		Tunkhaling	6,384	2%	148,870	51%	412	0.1%	11,099	4%	122,814	42%	289,578
	Ward 5 total		**2,128**	**1%**	**156,347**	**53%**	**324**	**0.1%**	**11,156**	**4%**	**122,696**	**42%**	**292,650**
Bhotkhola total			**8,035**	**2%**	**199,882**	**46%**	**815**	**0.2%**	**20,581**	**5%**	**208,458**	**48%**	**437,771**
Makalu	**Ward 4**	Haitar		0%	165,417	80%	-	0.0%	5,333	3%	35,000	17%	205,750
		Obak		0%	108,705	54%	182	0.1%	4,145	2%	87,273	44%	200,305
	Ward 4 total			**0%**	**120,857**	**60%**	**143**	**0.1%**	**4,400**	**2%**	**76,071**	**38%**	**201,471**
Makalu total				0%	120,857	60%	143	0.1%	4,400	2%	76,071	38%	201,471
Grand total			**8,035**	**2%**	**197,885**	**46%**	**799**	**0.2%**	**20,199**	**5%**	**205,333**	**48%**	**432,251**

Source: ERM Socioeconomic Survey, 2019–2020

Table 6.82 provides the average annual income of the surveyed households for each ethnic group. The average annual household income of non-aadibasi/janajati ethnic groups is 328,438 NPR/year, while that of aadibasi/janajati groups is 419,407 NPR/year. Non-aadibasi/janajati groups are, therefore, have 22% lower average annual income than aadibasi/janajati groups in the DIA.[77]

The average annual income from selling herbs is highest among Bhote households, followed by Tamang households. Rai households also report a small income from selling herbs. In terms of average annual income from farming/agriculture, Gurung households have the highest average annual income, followed by Tamang households. The income from livestock is highest among Gurung households, followed by Kami and Newar households. The non-agricultural income is higher in Gurung households, followed by Bhote households. It is important to note that non-aadibasi/janajati groups do not have any income from selling herbs or from other forest products. This suggests that the traditional knowledge about herbs and other useful forest produce is limited to aadibasi/janajati communities.

[77] The most recent financial figures for Nepal (2018–2019) do not provide average annual income by household (only per capita figures are provided). The per capita income for 2018/2019 was NPR 117,455 – if one multiplies this by the average family size in the project area (6.1 people per household), the result is NPR 716,475/year (significantly above the average for households in the project area). If one assumes that household income is calculated based on an assumption about working adults (i.e., 2 adults per household) then the average household income at the national level would be 234,910 NPR/year (significantly below the average for households in the project DIA. Due to lack of information about the methodology of the Nepali Census, it is not possible to accurately compare the average individual income level at the national level with the average household income level within the project DIA (Census source: Government of Nepal 2019).

Table 6.82: Average Annual Household Income of Different Ethnic Groups

Ethnic Group Category	Caste/Ethnic Name	Average Annual Income from Selling Herbs (in NPR)	% Income from Selling Herbs	Average Annual Income from Farm Crops (in NPR)	% of Annual Average Income from Farm Crops (in NPR)	Average Annual Income from Other Forest Products (in NPR)	% of Annual Average Income from Other Forst Products	Average Annual Income from Livestock (in NPR)	% of Average Annual Income from Livestock (in NPR)	Average Annual Non-Agriculture Income (in NPR)	% of Average Annual Non-Agriculture Income (in NPR)	Average Total Income from All Sources (in NPR)
Non-AJ	Kami (Bishowkarma)		0%	106,938	33%		0%	42,875	13%	178,625	54%	328,438
Non-AJ total			0%	**106,938**	33%		0%	**42,875**	13%	**178,625**	54%	**328,438**
AJ	Bhote	9,628	2%	185,909	44%	942	0%	19,449	5%	219,850	53%	418,646
	Gurung		0%	271,762	42%		0%	54,880	8%	358,000	55%	648,407
	Newar		0%	74,352	39%		0%	38,600	20%	77,000	41%	189,952
	Pradhan		0%	75,000	17%		0%		0%	360,000	83%	435,000
	Rai	1,064	0%	151,992	46%	578	0%	14,580	4%	162,903	49%	330,407
	Sherpa		0%	40,500	21%		0%		0%	150,000	79%	190,500
	Tamang	4,814	1%	344,487	66%	600	0%	21,702	4%	151,508	29%	522,518
AJ total		**8,162**	2%	**199,217**	47%	**810**	0%	**19,889**	5%	**205,698**	49%	**419,407**
Grand total		**8,035**	2%	**197,885**	47%	**799**	0%	**20,199**	5%	**205,333**	49%	**418,180**

Source: ERM Socioeconomic Survey, 2019–2020

Table 6.83 compares the average annual household incomes of male-headed households to those of female-headed households. There were no female-headed households among non-aadibasi/janajati communities. Of the 580 aadibasi/janajati households surveyed, 72 were female-headed households. A higher percentage of households among Bhote were headed by women.[78] The comparison of average annual income of Bhote male-headed and female-headed households shows 23% higher income in female-headed households. Participants in FDGs and KIIs believed this was because Bhote women play a more empowered economic role in the household than do women of other ethnic groups and, therefore, manage the household finances better than men.[79] Among other ethnic communities, female-headed households reported a lower average annual income than do male-headed households. Among Gurung households, the income of female-headed households is 70% less than male-headed households, while for Rai households it is 60% less (note: small sample sizes for these groups suggest these figures may not be representative). Among Tamang households, the difference is comparatively smaller (26%).

Table 6.83: Average Household Annual Income of Female-Headed Households and Male-Headed Households, by Ethnic Group

Ethnic Group Name	Number of HHs Surveyed	Number of Female-Headed HHs	% of Female-Headed HHs	Average Annual HH Income (Male-Headed HHs) in NPR	Average Annual HH Income (Female-Headed HHs) in NPR	% Difference in Income of Female Headed Household Vs Male Headed Household
Bhote	406	60	15%	405,092	496,810	+23%
Gurung	15	1	7%	680,150	204,000	-70%
Rai	90	7	1%	346,489	139,714	-60%
Tamang	65	4	6%	530,851	395,438	-26%
Total	**580**	**72**	**13%**	**416,954**	**452,155**	**+8%**

Source: ERM Socioeconomic Survey, 2019–2020

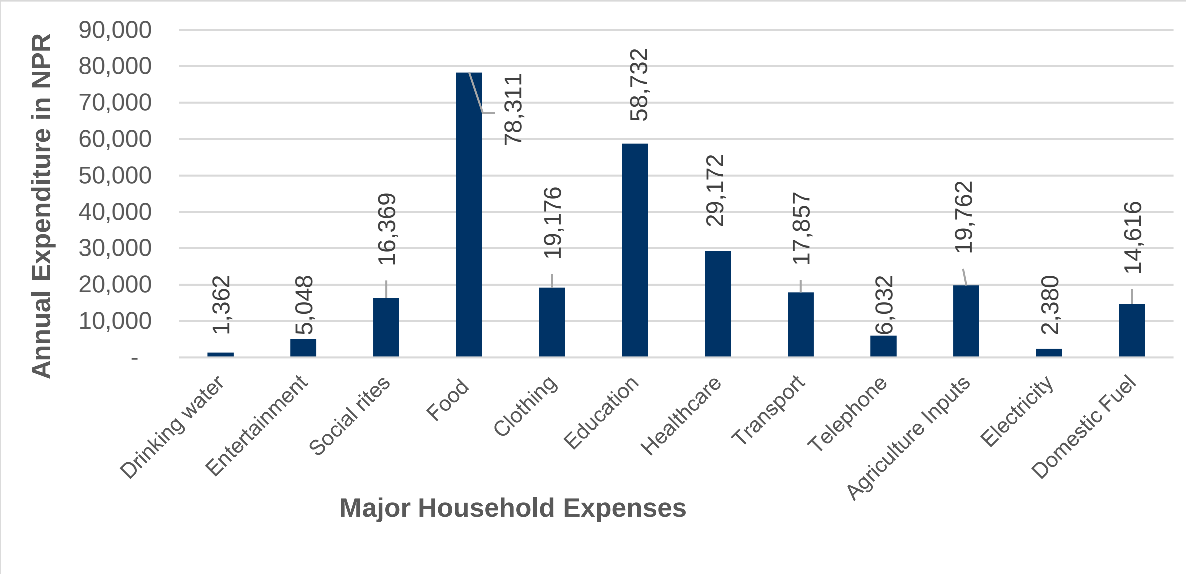
Annual Household Expenditure

ERM asked the surveyed households to share information on approximate expenses under different categories for the last year based on their memory. It was difficult for aadibasi/janajati households to recall expenses and report them with accuracy, as many of them are not fully integrated into a monetary economy. However, the information shared is useful to establish the indicative relative significance of different expenses. As shown in ***Figure 6.72*** the highest household expense is food, followed by education and health care. Households also reported spending an average of 19,762 NPR per year on agricultural inputs, mostly for cardamom farming. Monthly expenses related to transport averaged 17,857 NPR, while expenses for drinking water and electricity were relatively low. The low electricity expenditures may be due to low usage (due to poor availability), rather than low rates. The expenses related to clothing, social events and ceremonies/rites were also important expense categories.

[78] Households self-identified as female-headed; ERM did not specify any particular criteria to determine what did and did not constitute a woman being the head of the household.

[79] Bhote women are perceived by community members as being more empowered, as they often migrate with their husbands and have more financial responsibility within the household.

Figure 6.72: Average Annual Household Expenses



Source: ERM Socioeconomic Survey, 2019–2020

Table 6.84 offers a comparison of reported annual incomes compared to annual expenditures. These income figures are estimates by the households – many of which had a hard time estimating such things, due to reliance on non-cash based economies – and, therefore, are only indicative of broad income trends between villages. Generally speaking, those villages with the highest levels of income sufficiency (defined as the extent to which your annual income exceeds your annual expenditure) were Lingham (45% report income exceeding expenditures by >500,000 NPR), Chongrak (40%), Gola (33%), and Namase (30%). Those reporting the highest levels of income *deficiency* (annual income < annual expenditure) were Jijinkha (17% reported expenditure exceeding income by >500,000 NPR), Gola (8%), and Rukma (4%). In total, 84% of surveyed households reported income sufficiency, while only 16 reported income deficiency.

Table 6.84: Income Sufficiency: Annual Expenditure versus Income, by Village

Rural Municipality	Ward No.	Village	Income Deficient Households (in NPR)						Income Sufficient Households					
			< -500,000	-200,000 to -500,000	-100,000 to -200,000	-30,000 to -100,000	-10,000 to -30,000	0 to -10,000	0 to 10,000	10,000 to 30,000	30,000 to 100,000	100,000 to 200,000	200,000 to 500,000	>500,000
Bhotkhola	**Ward 2**	Chepuwa	0%	4%	6%	4%	4%	2%	1%	11%	28%	16%	17%	8%
		Chyamtan	0%	0%	0%	5%	5%	0%	0%	14%	24%	10%	33%	10%
		Guthi Gumba	0%	13%	0%	0%	0%	0%	0%	0%	0%	63%	13%	13%
		Lingam	0%	0%	0%	0%	0%	0%	0%	0%	9%	18%	27%	45%
		Rukuma	4%	0%	0%	4%	0%	7%	4%	11%	33%	19%	19%	0%
	Ward 2 total		**1%**	**3%**	**3%**	**3%**	**3%**	**2%**	**1%**	**10%**	**26%**	**18%**	**20%**	**9%**
			16%						**84%**					
	Ward 3	Hatiya	0%	0%	0%	9%	3%	3%	0%	3%	26%	24%	21%	12%
		Hongon	2%	2%	0%	7%	2%	0%	0%	15%	24%	17%	22%	7%
	Ward 3 total		**1%**	**1%**	**0%**	**8%**	**3%**	**1%**	**0%**	**9%**	**25%**	**20%**	**21%**	**9%**
			15%						**85%**					
	Ward 4	Adima	0%	0%	20%	0%	0%	0%	0%	20%	20%	0%	20%	20%
		Barun Bazar	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	83%	0%
		Chongrak	0%	0%	0%	0%	0%	0%	0%	0%	0%	20%	40%	40%
		Gola	8%	13%	0%	0%	4%	0%	0%	0%	8%	8%	25%	33%
		Hema	0%	0%	0%	12%	0%	4%	0%	0%	20%	24%	16%	24%
		Jijinkha	17%	17%	17%	0%	0%	17%	0%	0%	17%	0%	0%	17%
		Limbutar	0%	0%	17%	0%	0%	0%	17%	0%	50%	0%	0%	17%
		Namase	0%	0%	1%	4%	0%	1%	6%	1%	13%	21%	23%	30%
		Sembung	0%	20%	0%	20%	0%	0%	0%	0%	40%	20%	0%	0%
		Sibrun	3%	0%	3%	4%	0%	0%	1%	4%	15%	14%	40%	16%
		Syakshila	0%	6%	6%	9%	0%	0%	6%	11%	23%	9%	26%	6%
	Ward 4 total		**2%**	**3%**	**3%**	**5%**	**0%**	**1%**	**3%**	**3%**	**16%**	**15%**	**28%**	**21%**
			14%						**86%**					
	Ward 5	Kapase	0%	25%	13%	0%	0%	0%	0%	0%	13%	25%	13%	13%
		Lunsun	0%	13%	0%	0%	0%	0%	0%	25%	50%	0%	13%	0%
		Rapsa	0%	0%	0%	0%	0%	0%	0%	0%	50%	25%	25%	0%
		Tunkhaling	2%	6%	8%	8%	0%	0%	2%	0%	27%	29%	10%	8%
	Ward 5 total		**1%**	**8%**	**7%**	**6%**	**0%**	**0%**	**1%**	**3%**	**30%**	**25%**	**11%**	**7%**
			23%						**77%**					
Bhotkhola total			**1%**	**3%**	**3%**	**5%**	**1%**	**1%**	**2%**	**6%**	**22%**	**18%**	**22%**	**14%**
			16%						**84%**					

Rural Municipality	Ward No.	Village	Income Deficient Households (in NPR)						Income Sufficient Households					
			< -500,000	-200,000 to -500,000	-100,000 to -200,000	-30,000 to -100,000	-10,000 to -30,000	0 to -10,000	0 to 10,000	10,000 to 30,000	30,000 to 100,000	100,000 to 200,000	200,000 to 500,000	>500,000
Makalu	**Ward 4**	Haitar	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
		Obak	0%	0%	0%	9%	0%	9%	0%	9%	36%	18%	18%	0%
	Ward 4 total		**0%**	**0%**	**0%**	**7%**	**0%**	**7%**	**0%**	**7%**	**50%**	**14%**	**14%**	**0%**
			14%						**86%**					
Makalu total			**0%**	**0%**	**0%**	**7%**	**0%**	**7%**	**0%**	**7%**	**50%**	**14%**	**14%**	**0%**
Grand total			**1%**	**3%**	**3%**	**5%**	**1%**	**2%**	**2%**	**6%**	**22%**	**18%**	**22%**	**14%**
Grand total			**16%**						**84%**					

Indebtedness of Households and Access to Finance

Of the total 593 households surveyed, 371 households (63%) had not received any loans in the past year. The details of the 222 households that did receive a loan are provided in ***Table 6.85***. The loan amounts ranged from 800 NPR to 6,000,000 NPR, with the average loan amount being 209,958 NPR. The average loan amounts for households in Chongrak, Gola, and Sibrun are above this average. The higher loan amounts are related to businesses and housing construction. The villages where households are engaged in trade and business, like Gola, Chongrak, and Sibrun, therefore, show higher average household loans.

Table 6.85: Loan Profile for Households

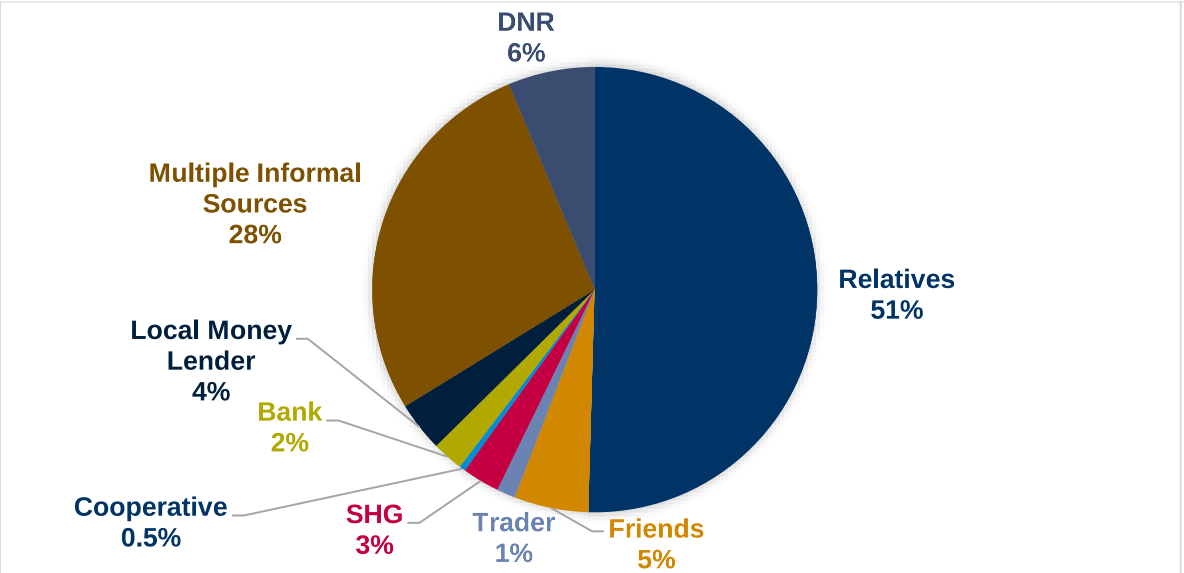
Rural Municipality	Ward No.	Village	Number of HHs Taken Loan	Average Amount of Loan in NPR	Min Amount of Loan in NPR	Max Amount of Loan in NPR
Bhotkhola	**Ward 2**	Chepuwa	35	159,914	10,000	600,000
		Chyamtan	4	46,500	6,000	100,000
		Guthi Gumba	3	233,333	150,000	300,000
		Rukma	9	63,333	20,000	100,000
	Ward 2 total		**51**	**138,294**	**6,000**	**600,000**
	Ward 3	Hatiya	8	91,500	10,000	400,000
		Hongon	10	126,300	6,000	500,000
	Ward 3 total		**18**	**110,833**	**6,000**	**500,000**
	Ward 4	Adima	2	110,000	20,000	200,000
		Barun Bazar	1	40,000	40,000	40,000
		Chongrak	1	1,000,000	1,000,000	1,000,000
		Gola	12	453,167	18,000	1,000,000
		Hema	6	91,667	50,000	200,000
		Jijinkha	5	240,000	100,000	300,000
		Limbutar	3	158,333	25,000	400,000
		Namase	27	218,111	15,000	1,300,000
		Sembung	2	130,000	60,000	200,000
		Sibrun	36	405,278	10,000	6,000,000
		Syaksila	14	99,857	12,000	400,000
	Ward 4 total		**109**	**284,954**	**10,000**	**6,000,000**
	Ward 5	Kapase	5	202,400	12,000	400,000
		Lunsun	4	82,500	30,000	200,000
		Rapsa	2	65,000	50,000	80,000
		Tunkhaling	26	163,232	800	500,000
	Ward 5 total		**37**	**154,244**	**800**	**500,000**

Rural Municipality	Ward No.	Village	Number of HHs Taken Loan	Average Amount of Loan in NPR	Min Amount of Loan in NPR	Max Amount of Loan in NPR
Bhotkhola total			**215**	**213,368**	**800**	**6,000,000**
Makalu	**Ward 4**	Haitar	1	100,000	100,000	100,000
		Obak	6	86,000	50,000	150,000
	Ward 4 total		**7**	**88,333**	**50,000**	**150,000**
Makalu total			**7**	**88,333**	**50,000**	**150,000**
Grand total			**222**	**209,958**	**800**	**6,000,000**

Source: ERM Socioeconomic Survey, 2019–2020

The interest rate on the loans reported by surveyed households ran from 12% to 36% per annum, with most households paying 24% interest per annum. Of the 222 households that received a loan, only 12 households (5%) reported to have pawned or given some asset as collateral. Thus, most of these loans are unsecured. As shown in ***Figure 6.73***, 51% of these loans are from close relatives/kin, while only 2% are from formal loan sources. The local sources of loans other than one's kin include traders, moneylenders, friends, and self-help groups (SHGs). Many of the households reported to have taken loans from multiple sources.

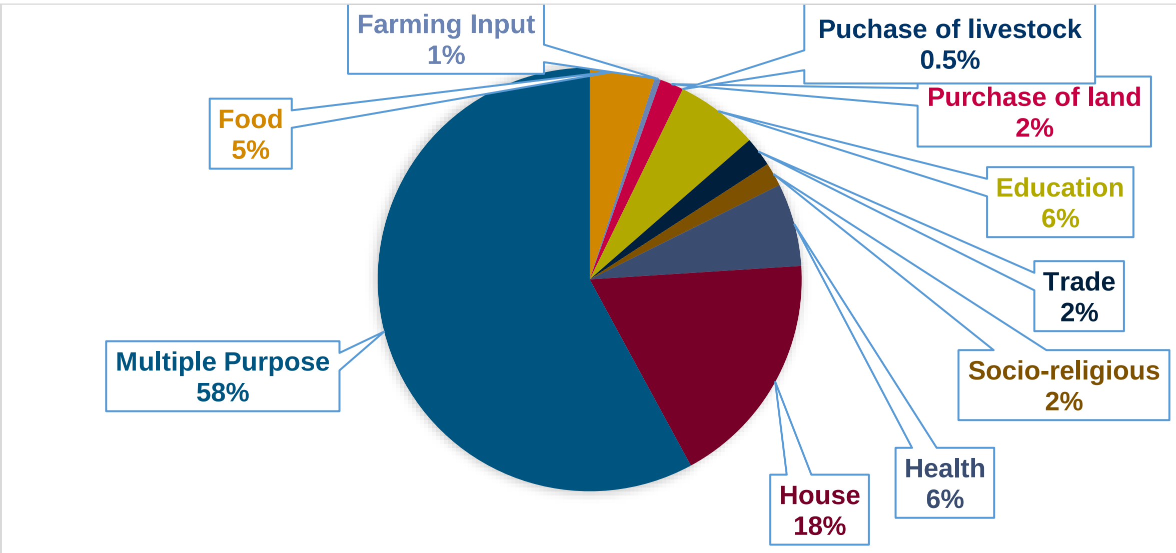
Figure 6.73: Sources of Loans



Source: ERM Socioeconomic Survey, 2019–2020
Note: DNR = did not respond

Many (58%) of the 222 households that took loans also reported to have taken the loan for multiple purposes. Construction of housing (18%), health care (6%), education (6%), and food (5%) are some of the important reasons that households cited for taking a loan (see ***Figure 6.74***).

Figure 6.74: Household Reasons for Taking Loans



Source: ERM Socioeconomic Survey, 2019–2020

6.3.10 Dietary Habits and Food Security

Dietary habits in the DIA depend on a variety of factors, including the location of the household, its level of wealth, and the age of its inhabitants. FGDs and KIIs revealed that households that live in mountainous areas tend to eat *dhido* (millet or barley cooked dough), potato curry, *momos* (dumplings), yak, goat or sheep meat, milk, *thukpa* (a soup made of flour and vegetables), and locally-made alcohol (millet/maize/juice) for their regular diet. In hilly areas – which characterize most of the UAHEP – people eat rice, wheat, maize, millet, *uwa*, buckwheat, lentils, and more green vegetables than meat.

Children tend to eat dal bhat (rice, lentil, and vegetables) at home, but take money to school to buy junk food for snacks. Youths – especially boys and men – tend to spend more time out of the house and therefore eat more junk food, such as instant noodles, chips, biscuits, soft drinks (Coke, Fanta), and Red Bull or other energy drinks. However, when at home, they eat roasted maize, soybean, and *thukpa*, and drink locally made beer (*jaand*). Those who tend to stay close to the homestead – including adults engaged in agricultural work and other home-based businesses and those over 60 years of age – tend to eat more locally produced soft food including yams (*ban tarul*, *ghar tarul*, and *simal tarul*) and roots like sweet potato, potato, and *thukpa*. They also drink locally made beer (jaand).

Most of the households in the DIA are dependent on subsistence farming and they grow whatever they need for the family to consume, as per their culture. They cultivate wheat, barley potato, mustard (oil seed), sweet potato, yam (varieties of roots), seasonal green vegetables, fruit (e.g., oranges, bananas) in winter. In summer they grow paddy, maize, soybean, millet, buckwheat, legumes (e.g., peas, beans, lentils), seasonal green vegetables, and fruit (e.g. plums, peaches, and bananas). However, with the advent of large-scale cardamom cultivation, many households grow grains and other food for direct consumption on a small parcel of their land. As this food is often insufficient to feed the family, these households use the money from selling cardamon to purchase food from local markets. Also, the increased availability of junk food in the area means that households often sell their locally produced agriculture such as soybean, buckwheat and millet, onion, garlic, fruits, and vegetables, and purchase instant noodles and *thukpa* for consumption. Households with higher levels of income add more meat, fish, and egg to their diets.

Most households in the DIA also collect food from community forests, including herbs (e.g., *yarshagumba* and *titepati yarshagumba*, *panch aunle*, *silajit*) and wild bee honey (when and where available, mostly in the winter). In the summer, households collect wild green vegetables (*niuro*), bamboo shoot, asparagus, mushroom, walnuts, *katus*, and herbs. ***Table 6.86*** shows the primary foods grown and collected by households in winter and summer seasons.

Table 6.86: Food Grown and Collected in the Project DIA

Production Area	Food in Winter	Food in Summer
Agricultural farm land	Wheat, potato, sweet potato, yam (varieties of roots), seasonal green vegetables, fruit (e.g., oranges, bananas), barley, honey)	Maize, soybean, millet, legumes (peas, beans, lentils (*mas* and *mashyam*), buckwheat, seasonal green vegetables, fruit (e.g., plums, mangos)
Community forest	Nutritious herbs, wild bee honey, yarshagumba and titepati yarshagumba, which are available in the lower belt of this rural municipality	Green vegetables (*niuro* and others), bamboo shoot, asparagus, mushroom, walnuts, *katus*, and herbs

Source: ERM Socioeconomic Survey, 2019–2020, FGDs & KIIs

Food security is a significant concern in the DIA. There were two components of the socioeconomic survey that offer insight into this matter. The first is the number of households that had to take out loans to pay for food. While only 11 (5%) of the 222 households[80] that took loans in the last year cited doing so to pay for food (recall ***Table 6.87***), this does not include loans for food that were folded into "multiple purpose" loans, which constituted 58% of all loans taken. Therefore, the number of loans taken at least in part to pay for food may be significantly higher.

Another indicator of food security is households' self-assessment of the extent to which their income suffices to cover their basic needs. As ***Table 6.87*** shows, a relatively high percentage of households in the following villages stated that they "struggled for food year-round" Lunsun (75%), Limbutar (67%), Rukma (56%), Hema (52%), Rapsa (50%), Syaksila (46%), Adima (40%), and Sembung (40%). This suggests low levels of food security.

Table 6.87: Self-Assessment of Sufficiency of Income to Meet Basic Needs, by Village

Rural Municipality	Ward No.	Village	Sufficient to Meet Needs and Save	Sufficient to Afford Anything Family Wants	Sufficient to Meet Needs, but Not to Save	Only Sufficient to Meet Minimum Needs for Food and Clothing	Struggle for Food Year-Round
Bhotkhola	**Ward 2**	Chepuwa	2%	40%	27%	6%	26%
		Chyamtan	0%	62%	10%	5%	19%
		Guthi Gumba	0%	63%	13%	25%	0%
		Lingam	0%	73%	18%	9%	0%
		Rukma	0%	26%	11%	4%	56%
	Ward 2		**1%**	**44%**	**21%**	**6%**	**27%**
	Ward 3	Hatiya	0%	47%	12%	27%	15%
		Hongon	0%	46%	24%	10%	20%
	Ward 3		**0%**	**47%**	**19%**	**17%**	**17%**
	Ward 4	Adima	0%	20%	20%	20%	40%
		Barun Bazar	0%	100%	0%	0%	0%
		Chongrak	0%	60%	20%	0%	20%
		Gola	4%	71%	0%	4%	21%

[80] The ethnic breakdown of households taking loans to pay for food is as follows: Tamang (four households); Bhote, Kami (Bishowkarma), Raj (two households each); Newar (one household).

Rural Municipality	Ward No.	Village	Sufficient to Meet Needs and Save	Sufficient to Afford Anything Family Wants	Sufficient to Meet Needs, but Not to Save	Only Sufficient to Meet Minimum Needs for Food and Clothing	Struggle for Food Year-Round
		Hema	0%	36%	8%	4%	52%
		Jijinkha	0%	33%	0%	0%	67%
		Limbutar	0%	17%	17%	0%	67%
		Namase	1%	49%	20%	21%	7%
		Sembung	0%	40%	20%	0%	40%
		Sibrun	0%	51%	6%	11%	32%
		Syaksila	0%	34%	9%	11%	46%
	Ward 4		**1%**	**48%**	**10%**	**12%**	**29%**
	Ward 5	Kapase	0%	50%	0%	25%	25%
		Lunsun	0%	25%	0%	0%	75%
		Rapsa	0%	0%	0%	50%	50%
		Tunkhaling	2%	22%	26%	20%	31%
	Ward 5		**1%**	**24%**	**18%**	**20%**	**37%**
Bhotkhola total			**1%**	**44%**	**16%**	**12%**	**28%**
Makalu	Ward 4	Haitar	0%	0%	33%	33%	33%
		Obak	0%	18%	9%	36%	36%
	Ward 4		**0%**	**14%**	**14%**	**36%**	**36%**
Makalu total			**0%**	**14%**	**14%**	**36%**	**36%**
Grand total			**1%**	**43%**	**16%**	**12%**	**28%**

As ***Table 6.88*** shows, there are marked differences between ethnic groups in terms of their perceptions of their food security (represented by the concept of “income sufficiency”). While on average 28.3% of households stated that they struggled to put food on the table year-round, this number was significantly higher for Kami (Bishowkarma), 75% of which expressed struggling to put food on the table. Other groups that expressed high rates of struggle to put food on the table year-round were Sherpa (100%) and Newar (60%); however, as stated previously the sample size for Sherpa is fairly small (10 households), while that of Newar is only slightly larger (27 households).

Table 6.88: Self-Assessment of Sufficiency of Income to Meet Basic Needs, by Ethnicity

	Sufficient to Afford Anything Family Wants	Sufficient to Meet Needs and Save	Sufficient to Meet Needs, but Not to Save	Only Sufficient to Meet Minimum Needs for Food and Clothing	Struggle for Food Year-Round
Bhote	1%	47%	17%	12%	22%
Kami (Bishowkarma)	0%	25%	0%	0%	75%
Gurung	0%	60%	7%	13%	20%
Newar	0%	0%	40%	0%	60%
Pradhan	0%	100%	0%	0%	0%
Rai	2%	26%	17%	17%	39%
Sherpa	0%	0%	0%	0%	100%
Tamang	0%	42%	6%	14%	37%
Total	**1%**	**43%**	**15%**	**12%**	**28%**

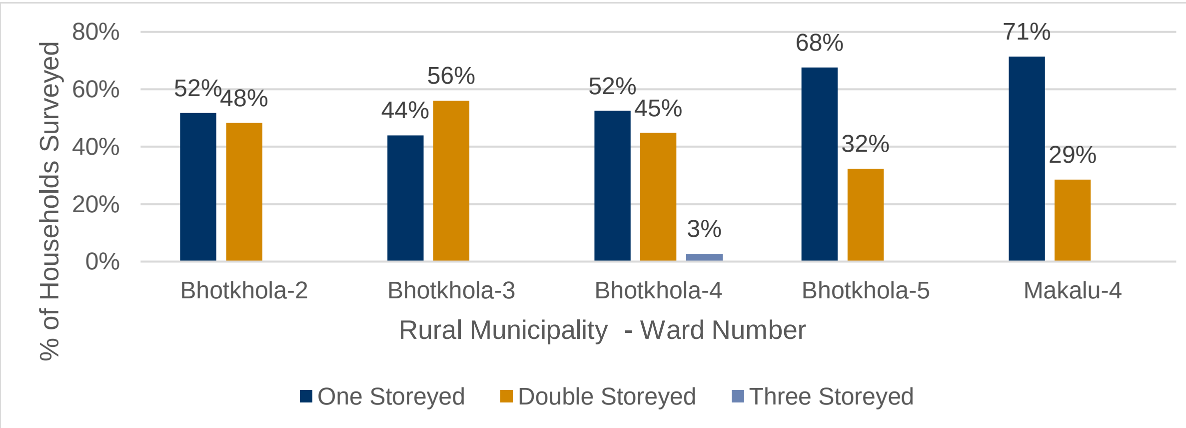
6.3.11 Living Conditions

The living conditions of households can be assessed through a range of parameters such as housing condition, supply of drinking water, access to sanitation/toilet, access to electricity, source of domestic fuel, and waste management. These are described in turn below.

Housing Conditions

Physical living conditions (i.e., housing) are described in term of materials used for the construction of the floor, walls, and roof. Wood and stone are common materials for flooring in the DIA. Houses are typically either single or double story. Of the 593 houses surveyed, 317 houses (53.5%) were single story and 269 houses (45.5%) double story (see ***Figure 7.75***). Only seven houses (1%) were triple-story. The percentage of single-story houses in Bhotkhola-3 is lower than double-story houses. In Bhotkhola-5 and Makalu-4, approximately 70% of the households are single-story.

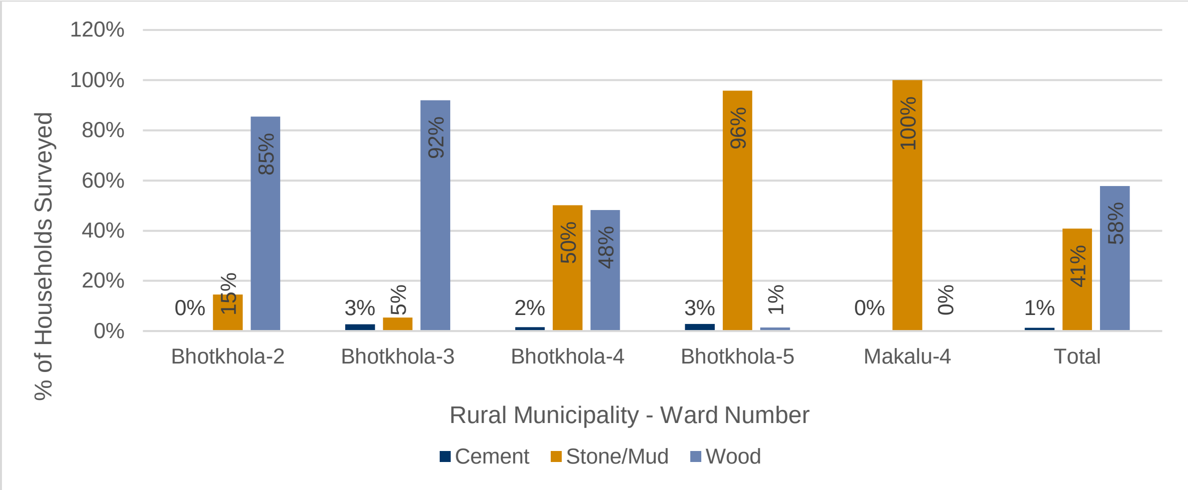
Figure 6.75: Number of Stories in Residential Structures



Source: ERM Socioeconomic Survey, 2019–2020

The floors of the residential houses in the DIA are made either of stone/mud or wood. Of the total households surveyed, 58% of houses had wood as their floor material and 41% had stone/mud (see ***Figure 6.76***). Only 1% of the houses reported having cement floors. The use of wood as floor material is more common in Bhotkhola-2 and Bhotkhola-3, compared to other areas. In Bhotkhola-4, the use of wood and stone/mud as floor material is relatively equivalent.

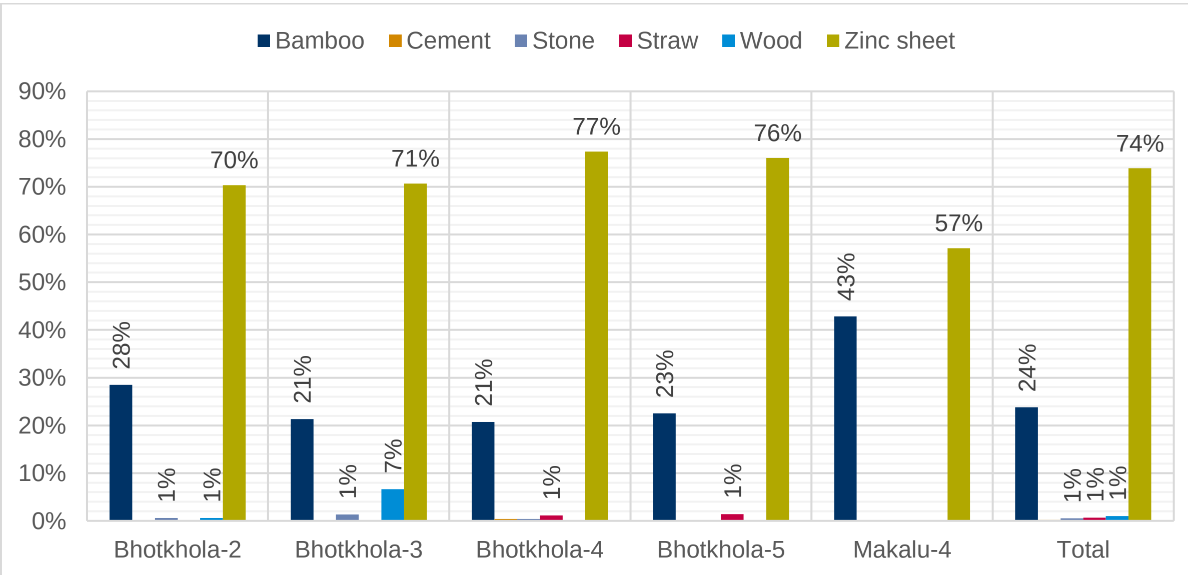
Figure 6.76: Floor Material used in Residential Structures



Source: ERM Socioeconomic Survey, 2019–2020

The exterior walls of houses are mostly made of stones, with the gaps filled with mud and then cemented from the outside. In some houses, the walls are also made from wooden planks. Of the total households surveyed, 86% had walls made of stones and 8% had walls made of wood (see ***Figure 6.77***). The use of bamboo was reported in 3% of houses and zinc-coated steel sheeting in the remaining 2%. Although there is some variation across different wards, stone/mud emerges as the most prevalent material for walls. Comparatively, the use of wood is more common in Bhotkhola-5 (11%), Bhotkhola-2 (9%), and Bhotkhola-4 (9%). The use of zinc-coated steel sheets is more prevalent in Bhotkhola-5 and Makalu-4 areas.

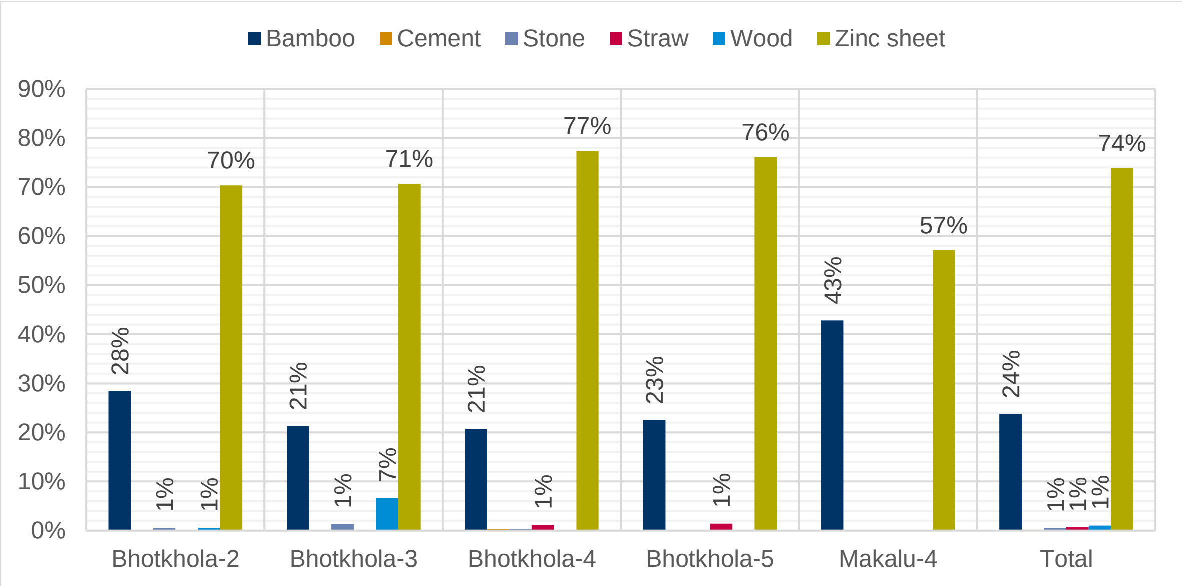
Figure 6.77: Wall Material used in Residential Structures



Source: ERM Socioeconomic Survey, 2019–2020

Roofs in the DIA are primarily zinc-coated steel panels (ranging from 57% of households that have this type of roofing in Makalu-4 to 77% in Bhotkhola-4), followed by bamboo (ranging from 21% in Bhotkhola-3 and Bhotkhola-4 to 43% in Makalu-4) (see ***Figure 6.78***).

Figure 6.78: Roof Material Used in Residential Structures



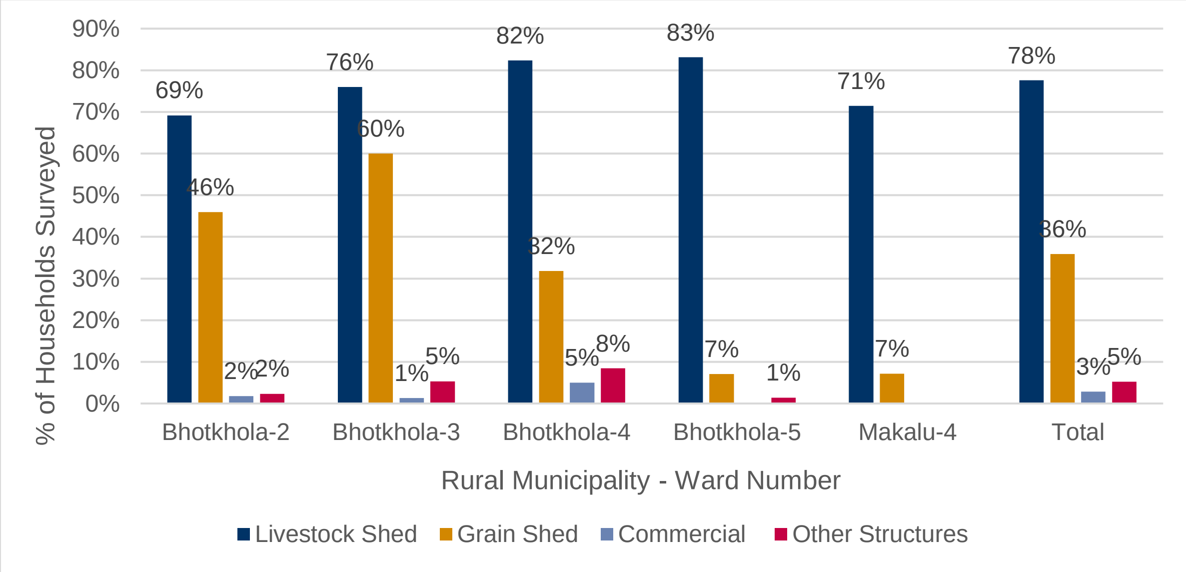
A typical house is comprised of a main building used for living and has ancillary structures such as animal shed, grain/wood storage, and toilet. As shown in ***Figure 6.79***, 78% of the households surveyed had a livestock shed. Comparatively, a lower percentage of houses in Bhotkhola-2 had livestock sheds. The percentage of houses with a livestock shed was higher in Bhotkhola-4 and Bhotkhola-5.[81]

Approximately 36% of the total households surveyed had a separate storage shed where agricultural products and byproducts are stored until they are consumed or used. In Bhotkhola-3, 60% of households had a grain shed, as did 46% of the households in Bhotkhola-2. In Bhotkhola-5 and Makalu-4, the percentage of households with separate grain storage was small.

Some of the households use part of their house for running shops, while others have a separate structure. Of the 593 households surveyed, 17 households (3%) had a separate commercial shed. The villages in Bhotkhola-4 are along the track connecting Rukma and Chepuwa, which is used by commuters. Therefore, the percentage of households with a separate commercial shed/structure was slightly higher in Bhotkhola-4.

[81] An examination of livestock ownership versus livestock shed ownership revealed no relevant trends. The vast majority of households with livestock also had livestock sheds, and eight households had livestock sheds despite not owning livestock. There were no ethnic nor geospatial trends with respect to the distribution of households with/without livestock sheds that would warrant an alteration of the impact assessment, vulnerability assessment, or mitigation measures/management plans.

Figure 6.79: Residential House – Auxiliary Structures

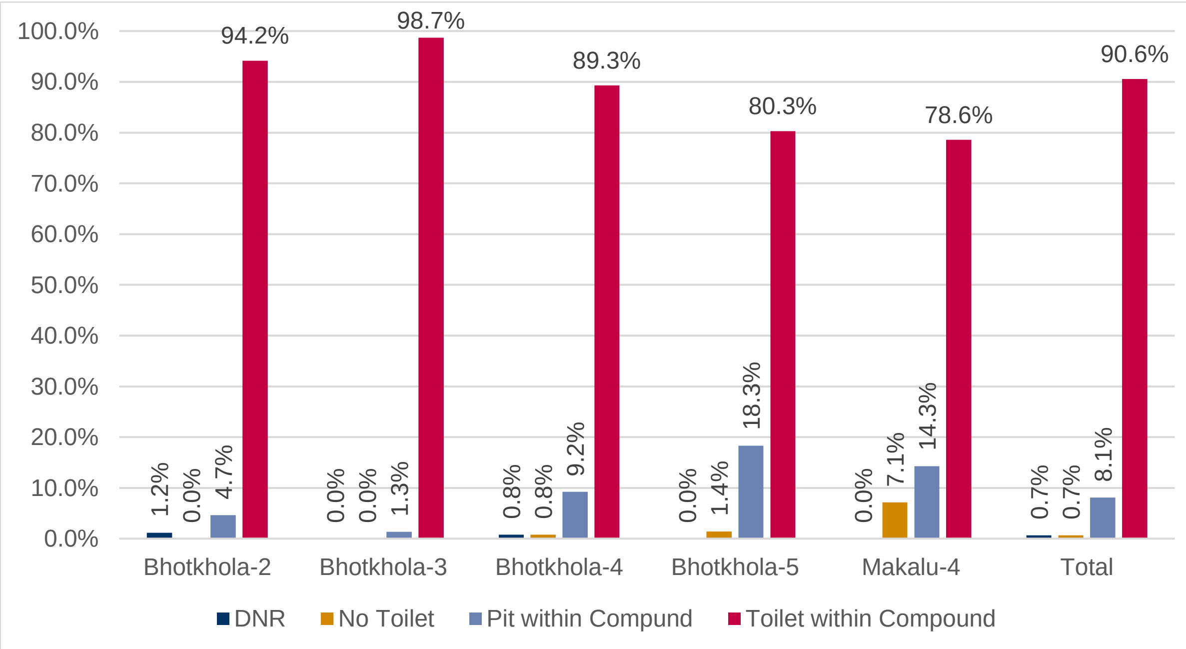


Source: ERM Socioeconomic Survey, 2019–2020

Sanitation and Waste Management

According to the National Sanitation and Hygiene Coordination Committee, 99.3% of Nepal had access to a toilet in 2019, an exponential increase compared to 2010, where barely 46% of Nepal had such access (Lal 2019). Of the 593 households surveyed, only four households reported not having a toilet (an additional four households did not reply to this question) (see ***Figure 6.80***). Thus, apart from these eight households, the remaining 585 houses (98.7%) have toilets. Of these, 8% households use a basic pit latrine. The number of houses using pit latrines is higher in Bhotkhola-5 and Makalu-4 than in other area. The most common form of toilet is a pour-flushed, connected to a septic tank.

Figure 6.80: Household Access to and Types of Toilets

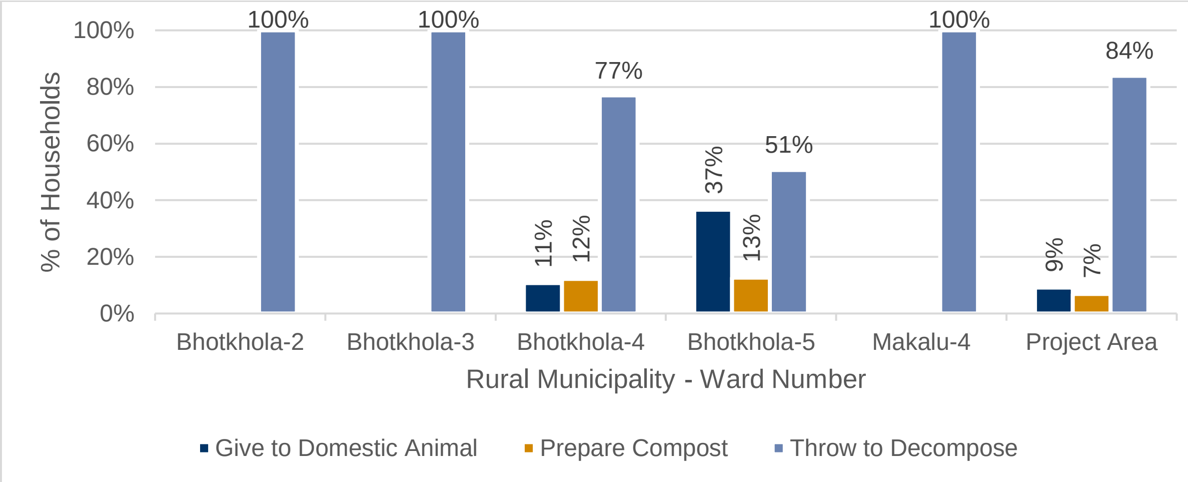


Source: ERM Socioeconomic Survey, 2019–2020

Note: DNR = did not respond

Systematic waste management was not present in the project-affected villages. Organic waste generated from the households includes food waste and livestock/crop waste. Inorganic waste generated from households consists of all wrappers (packaging materials), clothes, paper, and broken or discarded household items of metal or plastic. The socioeconomic survey asked respondents in each surveyed household how they usually dispose of organic, inorganic, and electronic waste. Electronic waste is simply discarded. Disposal methods for organic and inorganic waste are provided in ***Figures 6.81*** and ***6.82***.

Figure 6.81: Household Methods of Organic Waste Disposal

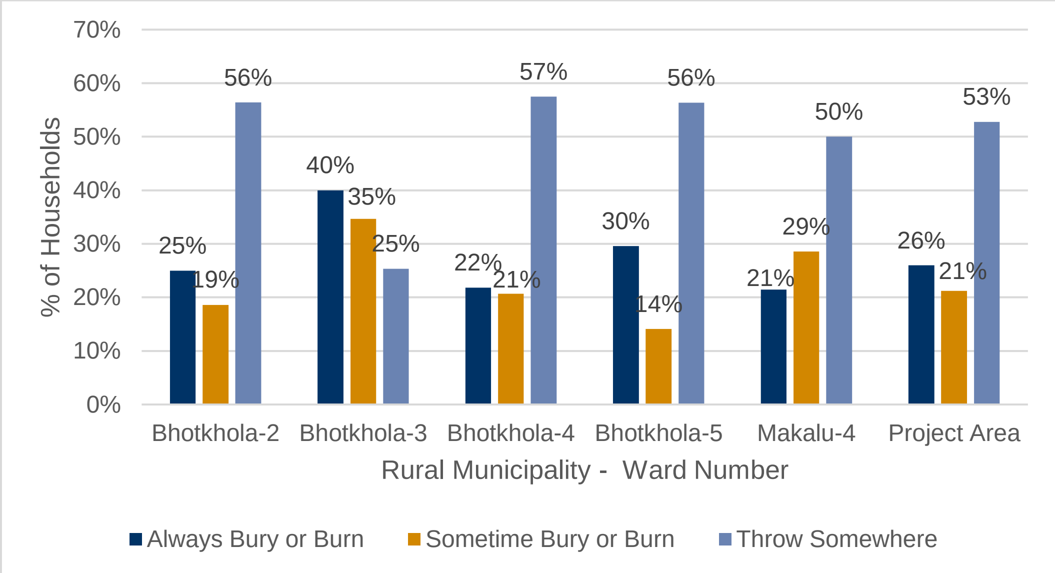


Source: ERM Socioeconomic Survey, 2019–2020

As shown above, 84% of the households surveyed reported throwing organic waste into their household compound daily, where it decays naturally. Seven percent (7%) of households said that they throw it in a fixed pit within the compound to turn it into compost and use it in the kitchen garden. The remaining 9% of households give the organic waste to domestic livestock. Throwing organic waste away for natural decomposition is the only practice for all households from Bhotkhola-2, 3, and Makalu-4. The use of organic waste to feed domestic livestock is highest in Bhotkhola-5.

As shown in ***Figure 6.82***, inorganic waste generated from the households typically ends up as litter around the settlement, as 53% of households reported throwing it away indiscriminately. Only 26% of households reported always burning or burying inorganic waste within their compound. The remaining 21% of households reported occasionally burning or burying inorganic waste. As mentioned above, the rural municipalities do not have a waste collection system; waste disposal is solely the responsibility of the household. The practice of waste disposal, therefore, depends on the awareness of the household.

Figure 6.82: Household Methods of Inorganic Waste Disposal



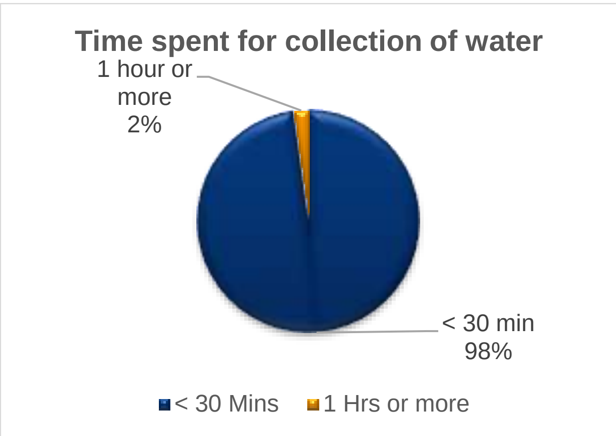
Source: ERM Socioeconomic Survey, 2019–2020

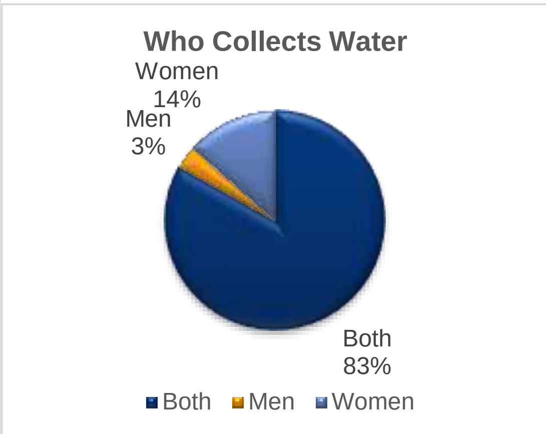
Supply of Drinking Water

Households mainly source drinking water from perennial springs. Each village or settlement has a perennial spring on which a bund (containment structure) is constructed to create a small pond/pool. The water is brought from this pond/pool through pipes closer to the settlement. A cluster of households collect water from this point using pots. Households are allowed to use pipes to take water to their houses, and the cost of the pipes to connect an individual household is borne by the household itself.

The water from these springs is used for drinking as well as other household uses. In monsoon months, some households boil the water to make it appropriate for drinking. Access to water is assessed by the time taken to fetch water. As shown in ***Figure 6.83***, 98% of the households surveyed spend less than 30 minutes each day fetching water for the household. Approximately 83% of households stated that both men and women fetch water for the household, as per their mutual understanding. Only 14% of households reported that only women fetch the water for the household.

Figure 6.83: Time Spent Collecting Water and Responsibility for Water Collecting



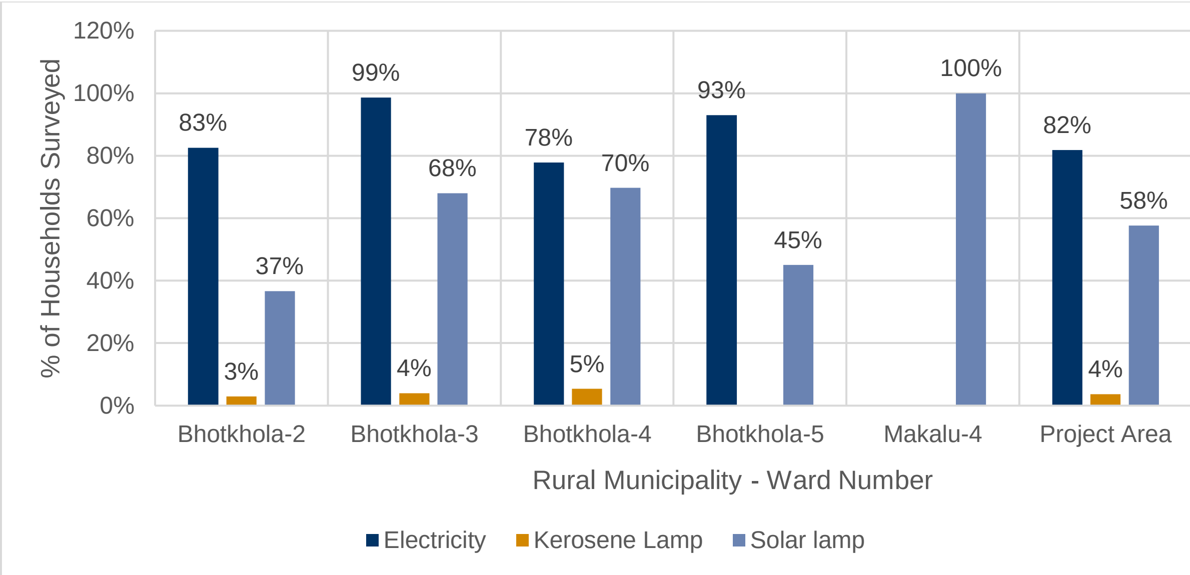


Source: ERM Socioeconomic Survey, 2019–2020

Access to Energy

Household energy requirements are driven by lighting and cooking fuel needs. As shown in ***Figure 6.84***, demand for lighting-related energy is met through three major sources: electricity, solar lamps or traditional lamps (*divalo*, which uses kerosene or a range of oils). The survey found that 82% of households use electricity for lighting their house. The electricity is supplied through micro-hydro projects and has fixed hours of supply. As electricity supply is not ensured all times of the day, households supplement with alternative energy sources for lighting. Fifty-eight percent (58%) of the households also use solar energy stored through batteries for lighting. Only 4% of the households reported still using traditional lamps for lighting.

Figure 6.84: Energy Source used by Households for Lighting



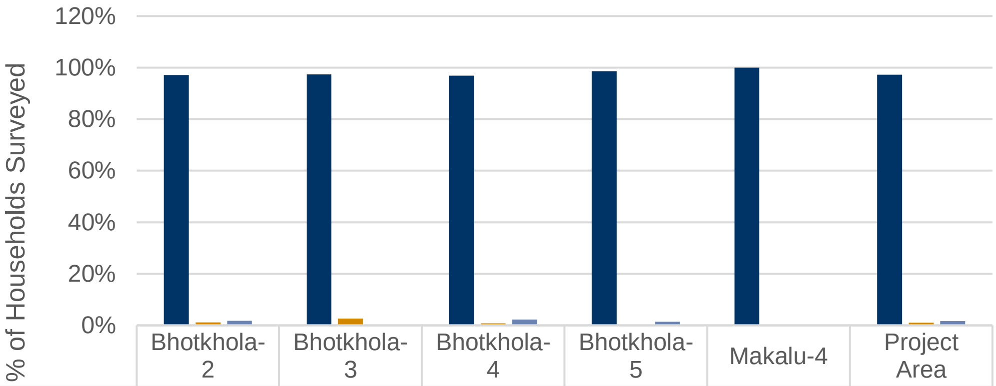
Source: ERM Socioeconomic Survey, 2019–2020

There is variation in the different wards on the use of electricity as the source of lighting. In Bhotkhola-3 and Bhotkhola-5, a higher percentage of households reported using electricity for lighting. The use of electricity was lowest in Ward 4. All households surveyed in Makalu-4 reported using solar lamps for lighting, while 70% of the households in Bhotkhola-4 and 68% of households in Bhotkhola-3 reported using solar lamps.

As shown in ***Figure 6.85***, firewood is the most commonly used cooking fuel with 97% of the households surveyed stating that they entirely depend on firewood for their cooking needs.[82] Only 2% of households said they use liquefied petroleum gas (LPG) cylinders as their primary source of cooking fuel, while 1% of households reported using a combination of firewood and LPG cylinders. Households running commercial shops and home-stay arrangements are typically those that use LPG cylinders.

[82] Clean cooking stove and/or use of biofuel from large livestock are potential areas for project intervention.

Figure 6.85: Source of Household Cooking Fuel



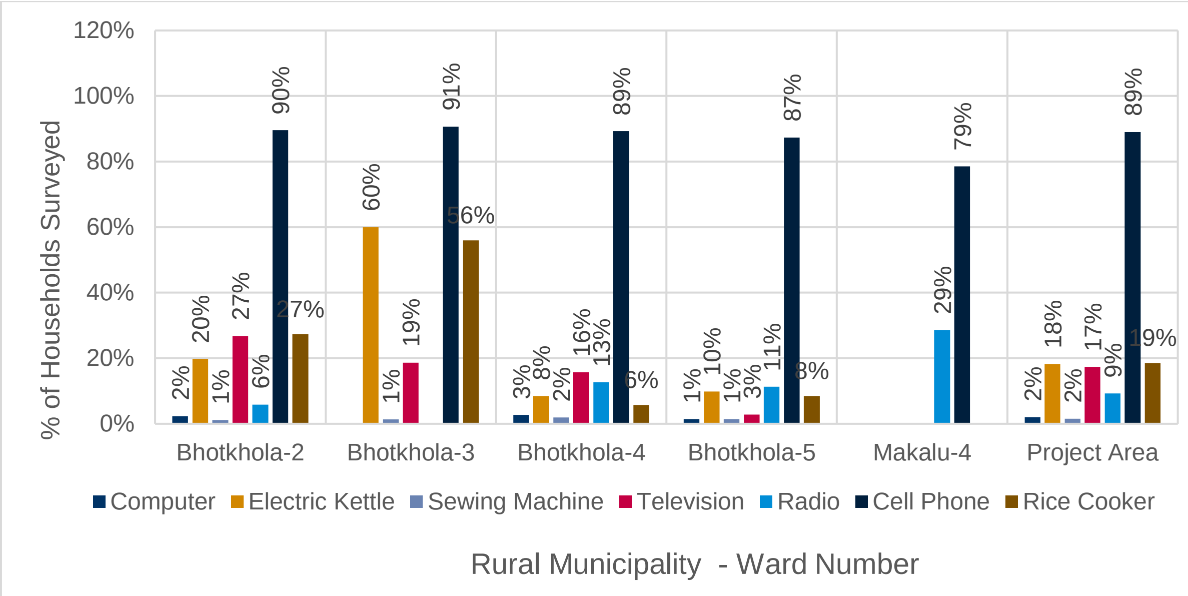
	Bhotkhola-2	Bhotkhola-3	Bhotkhola-4	Bhotkhola-5	Makalu-4	Project Area
Firewood	97%	97%	97%	99%	100%	97%
Firewood + LPG	1%	3%	1%	0%	0%	1%
LPG	2%	0%	2%	1%	0%	2%

Source: ERM Socioeconomic Survey, 2019–2020

Use of Electronics and Electrical Items

The use of modern electrical and electronic household goods is an indication of the living conditions of the household. ERM asked surveyed households about use of common household items such as an electric kettle, radio, television, computer, mobile phone, rice cooker and sewing machine. Survey results revealed that 89% of household use mobile phones and 58% of households have solar panels for lighting (see ***Figure 6.86***). Televisions were found in 17% of households and radios in 9% of households. Electrical equipment such as electric kettles and rice cookers are used by 18% and 19% of the surveyed households, respectively. Only 2% of households reported having a computer. There was only minor variation in use of mobile phones in different wards of Bhotkhola, although the use of mobile phones in Makalu-4 is marginally lower than the other wards. Use of electric kettles and rice cookers was higher in Bhotkhola-3. The possession of television sets was marginally higher in Bhotkhola-2 and 3, in comparison to Bhotkhola-4 and 5.

Figure 6.86: Possession and Use of Modern Electrical and Electronic Equipment



Source: ERM Socioeconomic Survey, 2019–2020

6.3.12 Community Health and Wellbeing

Community health and wellbeing within the DIA depends on health determinants, which includes quality of life parameters, sociocultural behaviors, and exposure to occupational risks and hazards. ERM collected information on these health determinants during the socioeconomic survey and FGDs/KIIs with the project-affected communities. ERM collected information on disease prevalence from the Health Information Management System (HMIS) of the District Hospital at Khandbari.[83] The community health baseline provides the following information in sub-sections below:

- Health-seeking behavior
- Occupational health risks of local community
- Mental health and other psychiatric disorders
- Communicable and infectious diseases
- Non-communicable diseases
- Maternal and child health

Healthcare Seeking Behavior and Consumption of Intoxicants

The traditional healing system in Nepal has a strong cultural and religious background. It manifests in different ways depending on the ethnic or tribal group and their ritual or ceremonial practices. In Nepal, traditional healers believe that not only germs, but also certain spiritual factors, can cause disease (Raut *et al.* 2018). Faith healers or shamans treat diseases with prayer and faith in God; hence, their treatments are not part of the official health care system. In Nepal, faith healers are known as *dhami-jhakri* and *gosai achhat*. *Ban jhakaris* (a type of *dhami-jhakari*) exorcise evil spirits from the bodies of sick people. A Kirati shaman is called a *mangpa* or a *bijuwa* (in the eastern part of the country). They are also commonly referred to as *phukne manchhe* in Nepali language. *Pandits, lamas, pujaris,* and *gubhajus* are the priests of different ethnic and religious groups in Nepal. *Pandits* and *pujaris* are the Hindu priests, *gubhaju* are the priest of Buddhist Newars, and *lamas* are the priests at Buddhist

[83] ERM did not collect health information equivalent to that available from the HMIS during the socioeconomic survey. Therefore, it was not possible to do DIA-level comparisons beyond these datapoints.

monasteries. They all diagnose and cure illness through prayers and rituals. *Jyotshi* are the astrologers; they read horoscopes, palms and foreheads of patients (Raut and Khanal 2011).

Consultations (FGDs and KIIs) with traditional healers indicate that the community is highly religious and prefers to seek treatment from traditional healers before visiting a health post or any other health service center. Women also seek treatment from traditional healers when encountering serious problems with pregnancy or childbirth. Consultations held with a female traditional healer (*dhamini*) from Hatiya and Shykshila revealed that she usually prays to the god twice in a month (during *aunshi* [new moon] and *purnima* [full moon]). The number of people visiting traditional healers is the highest during these times, and people approach healers with ailments such as fever, headache, backache, chest pain, or abdominal pain. The healers perform *chinta basne* (investigation of sickness) and begin treatment. The healers provide rice and water and use *titepati* (herb) to touch/brush the patient's head to wipe out the disease.

If traditional healing does not rectify the health issue, households reported seeking formal treatment in Chaymtang, Gola Health Post, or the Community Health Unit in Chepuwa, Namase, or Sibrun villages. Elderly people who are unable to visit health service centers use herbal medicines for their health problems. In the case of severe health problems, they go to the district hospital in Khandbari. Pregnant women typically visit a community health unit or health post for antenatal care (ANC) and most of the women go to a health post for delivery. However, there are insufficient qualified health care workers in the health posts and community health units. Under the Rastrapati Mahila Utthan Karyakram/Fund (2016 [2073 BS]), the GoN provides air transportation to a hospital free of cost for pregnant women in remote villages. In severe risk pregnancies, patients are transferred to larger hospitals using a chartered helicopter with government support or at their personal cost.[84]

Alcohol consumption is common for both men and women in the communities in the project DIA. As per local cultural practice, alcohol is consumed at all events including rituals related to birth and death. Under the influence of alcohol, there have been various incidents of conflict and violence with family friends and relatives (as reported in FGDs and KIIs). At times, such conflicts can also lead to injuries, divorce, irritation, and distress in the family. The male members of the community tend to drink more alcohol and smoke more tobacco than do females members, as they see this as a stress reducer. Mental health and substance abuse are addressed in the Sustainable Development Goals (SDG), particularly SDG targets 3.4 and 3.5.

Gender Based Violence

In Nepal, social, economic, and religious factors, combined with traditionally defined roles and responsibilities between Nepali men and women, have led to an institutional system that treats women inequitably (UNFPA 2008). Child/early marriage, forced marriage, polygamy, dowry, and *chhaupadi* (the requirement that women and girls stay out of the house during menstruation) issues exist in Nepal. The trafficking of women and girls is also a major problem, and it is estimated that 5,000 to 10,000 Nepali women are trafficked annually to India alone. Many women and girls are lured with the promise of foreign employment (e.g., Malaysia, Dubai, Indonesia, Japan, Korea), only to be trafficked upon their arrival. The trafficking cases registered with Nepal Police increased from 185 in 2014 to 305 in 2018 (National Human Rights Commission 2018). The FGDs and KIIs revealed that traditional patriarchal thinking and behavior towards women and girls is very strong and domestic gender-based violence (GBV) is hampering development and the empowerment of women and girls.

To help combat this, the Government of Nepal has formed a Nigarani Samuha (Watch Group) at the rural municipality level to combat GBV), to run various other programs aimed at the elimination of GBV and violence against women (VAW), and to offer rehabilitation support to women and girls vulnerable to human trafficking. The rural municipality also implements agriculture development, health, education, and economic development programs (i.e., income generating activities) that focus on women.

[84] Gender Assessment, Feb 2020 UAHEP

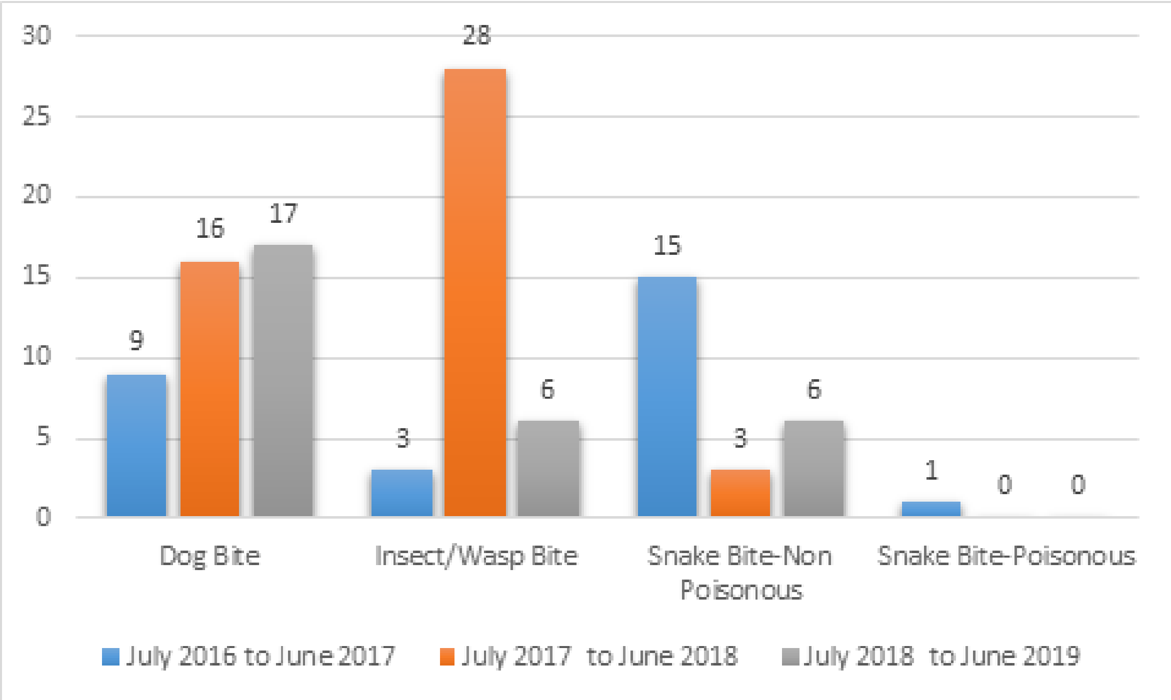
However, the rural municipality office faces problem in running these programs effectively, due to lack of adequate financial support and staff required for their implementation.

Recently, the Bhotkhola Rural Municipality has completed planning and budgeting for program implementation. In general, women participate in the agriculture development program through small farmers' group and in the community health program through Aama Samuha. The women/mothers groups in the local villages focus on maternal and child health and, generally, do not address GBV issues. There is no Women Children Development Unit (WCDU) in Bhotkhola Rural Municipality. This Unit usually works to mobilize and empower women to combat GBV. The Women and Children Services Center of the District Police and the One-stop Crisis Management Center in the District Public Health Office provide GBV services in Khandbari.

Occupational Health Risks – Accidents and Injuries

As mentioned above, agriculture and livestock keeping are the main occupational activities in the DIA; each of which carries with it its own occupational health risks (OHRs). During FGDs and KIIs, the local community reported bites from dogs, insects, and snakes as common health hazards associated with agricultural activities. The occurrence of these incidents in Bhotkhola is provided in ***Figure 6.87***.

Figure 6.87: Occupational Health Risks and Injuries in Bhotkhola, 2016–2019

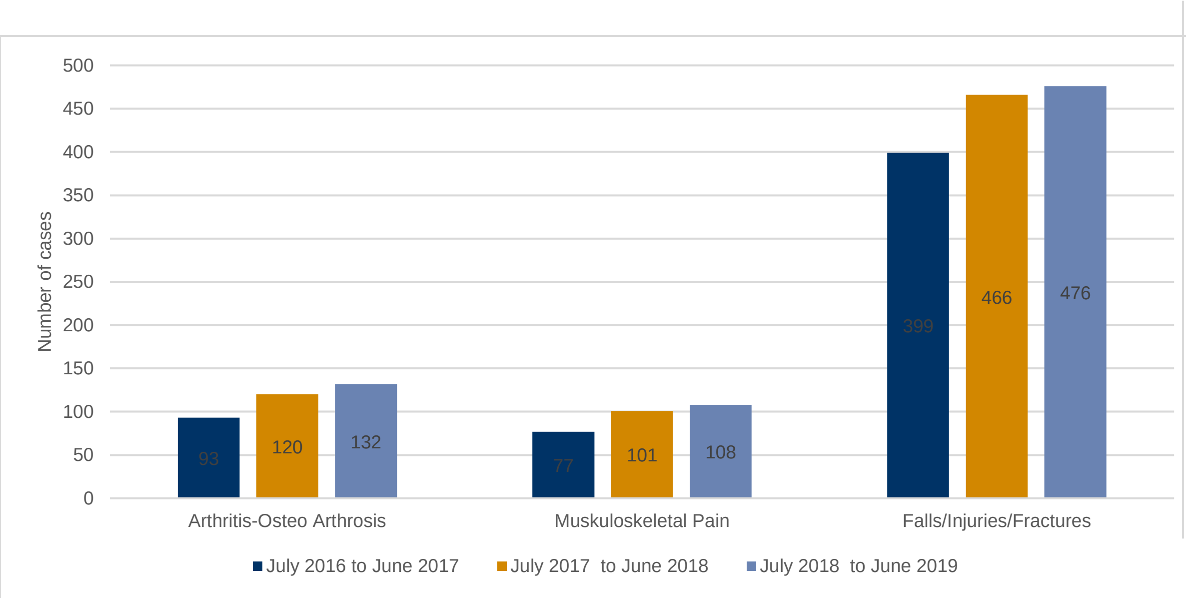


Source: OPD data, Health Department, Bhotkhola Rural Municipality

Community members work on their farmland, which is mostly located on steep slopes; therefore, accidents and injuries are common. As shown in ***Figure 6.88***, out of approximately 2,000 orthopedic cases reported in the past three years (2016–2019), the highest percentage (66%) were caused by falls/injuries/fractures.[85] The trend is similar to the district data available in the outpatient department (OPD) data referenced above.

[85] While one might argue that a fall is a cause of injury, of which a fracture constitutes a particular type of injury, the OPD data itself grouped these three together, thus, they are represented in the same way here.

Figure 6.88: Occupational Health Risks – Accidents and Injuries



Source: OPD data, Health Department, Bhotkhola Rural Municipality

Mental and Psychiatric Health

Nepal suffers from inefficiencies and deficiencies in mental health services, including limited diagnostic capacity and limited availability of treatment and human resources to address mental health issues. Nepal has the seventh highest suicide rate in the world – mostly among girls and woman of reproductive age (Cousins 2016).

According to data collected by the Bhotkhola Rural Municipality Health Department,[86] there were only 33 psychiatric patients from Bhotkhola between 2016 and 2019, with lower numbers being reported each of the three years (***Table 6.89***). While this may suggest that the mental and psychiatric health of the communities in the DIA is not a major health concern, it is important to consider the possibility that stigma surrounding mental health, as well as the aforementioned lack of diagnostic capacity, has resulted in some cases of mental health not being recognized/admitted to during the socioeconomic survey, FGDs, and/or KIIs.

[86] According to OPD data, Health Department, Bhotkhola Rural Municipality.

Table 6.89: Mental and Psychiatric Cases in Bhotkhola, 2016–2019[87]

Disease Name	Number of Reported Cases		
	July 2016 to June 2017	July 2017 to June 2018	July 2018 to June 2019
Addiction	9 (45%)	3 (30%)	
Dementia		1 (1.00%)	
Depression	3 (0.01%)	4 (40%)	1 (33.3%)
Epilepsy		1 (10%)	1 (33.3%)
Mental disorder	7 (15%)		
Mental retardation		1 (10%)	
Other anxiety	1 (5.00%)		1 (33.3%)
Grand total	**20**	**10**	**3**

Note: Addiction includes chronic alcoholism, dipsomania, and drug use

Source: OPD data, Health Department, Bhotkhola Rural Municipality

Communicable or Infectious Diseases

According to the Health Department of Bhotkhola Rural Municipality, approximately 7,000 cases of communicable diseases were reported during the period 2016–2019 from Bhotkhola. Water/food borne disease cases were the highest (43%), followed by other communicable diseases such as acute respiratory infection (ARI), lower respiratory tract infection (LRTI), upper respiratory tract infection (URTI), and viral influenza. No cases of vector borne diseases were reported between 2016 and 2019.

As evident from ***Figure 6.89***, the number of ear, nose, and throat (ENT) cases in Bhotkhola steadily increased between 2016 and 2019,[88] while other communicable diseases and sexually transmitted diseases (STDs) remained fairly stable. Skin diseases increased rapidly over the same time period, whereas water/food borne diseases, which represent a large percentage of the total diseases, show a steady decrease.

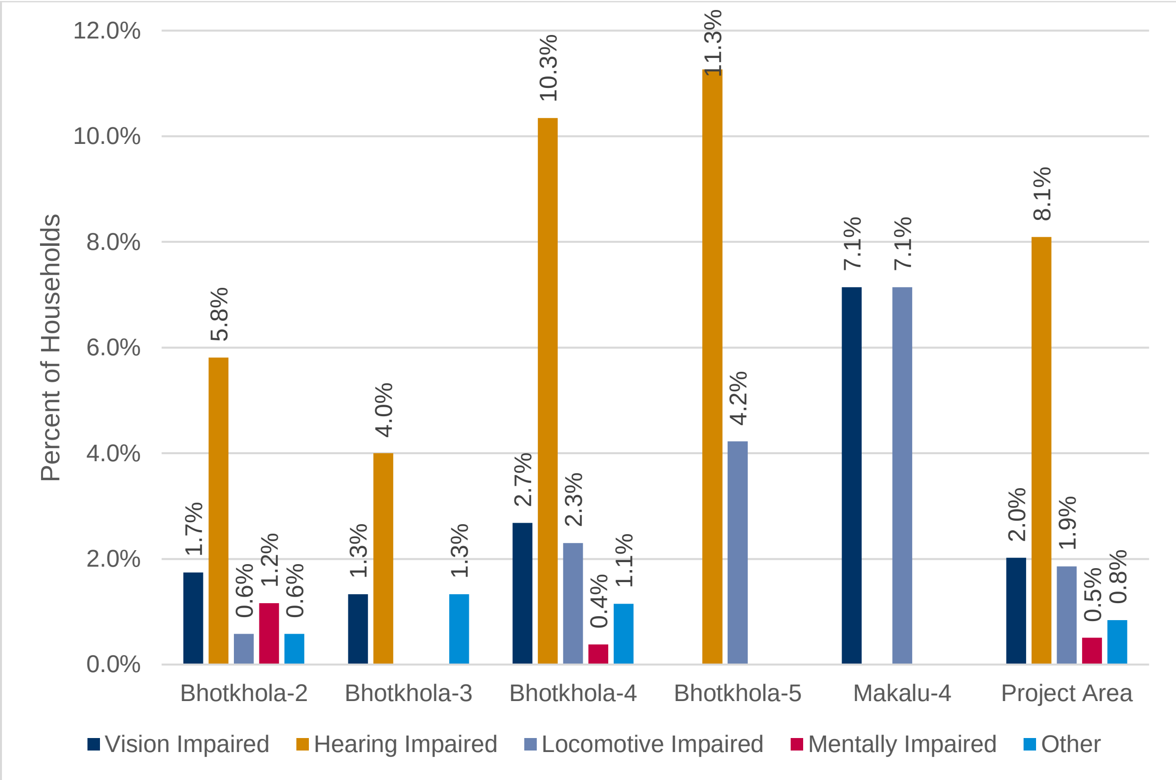
These trends are in line with the national and district level trend of a decline in communicable/infectious diseases. As per the Nepal Burden of Disease Report 2017 (Nepal Health Research Council *et al.* 2019) and Annual Health Report 2017/18 (Department of Health Services 2019), there has been an overall decline in communicable diseases in Nepal in recent decades. The current disease pattern is vastly different from the trend that existed during the 1990s (***Figure 6.89***). Communicable diseases were the leading causes of mortality and morbidity in Nepal until 2000. The declining burden of communicable diseases may be attributable in part to disease-specific priority health interventions such as the Malaria Control Program. As per the Burden of Disease Report, the mortality rate for communicable, maternal, neonatal, and nutritional (CMNN) diseases dropped sharply from 698.2 to 150.9 deaths per 100,000 people between 1990 and 2017. Diarrheal diseases, LRTIs, and drug-susceptible tuberculosis (TB) were the top three ranked communicable diseases in 1990 and 2017.[89]

[87] We recognize that this table represents a mix of mental health and disability categories; however, this is how the Health Department reports the statistics, and so it has been replicated here.

[88] While this may have to do with the prevalence of smoking in the area, a health expert would be required to offer definitive analysis.

[89] The socioeconomic study did not collect data concerning drug-resistant TB and no such information was available at the municipal or ward level.

Figure 6.89: Communicable Diseases in Bhotkhola, 2016–2019



Source: OPD data, Health Department, Bhotkhola Rural Municipality

As shown in ***Table 6.90***, approximately 2,154 cases of “other communicable diseases” (which includes respiratory infections, bronchitis, and viral influenza) were reported in Bhotkhola between 2016 and 2019. Of this, cases of URTI constituted 34% and LRTI made up 33% of all reported communicable diseases. Viral influenza cases comprised 21% and bronchitis 8%.

Table 6.90: Other Communicable Diseases in Bhotkhola, 2016–2019[90]

Disease Name	Number of Cases			
	2016/17	2017/18	2018/19	Total (%)
LRTI	199	281	235	33%
Bronchitis (acute & chronic)	27	46	96	8%
Leprosy	0	0	0	0%
Meningitis	0	0	0	0%
Pneumonia	36	27	20	4%
Severe pneumonia	3	0	1	0%
URTI	207	269	256	34%
Viral influenza	248	88	115	21%
Grand total	**720**	**711**	**723**	**2,154**

Source: OPD data, Health Department, Bhotkhola Rural Municipality

[90] Note: given that these statistics cover the time frame of 2016-2019, they clearly do not reflect the impact of COVID on community health.

In Bhotkhola, a total of 87 immunizable diseases were reported between 2016 and 2019. However, out of the total reported cases, 66% were cases of mumps, which spiked in 2017/18. This was followed by few cases of chicken pox (23%) and TB (less than 10%).

No cases of vector born disease[91] such as acute encephalitis-like syndrome (AES), clinical malaria, dengue fever, kala-azar/leishmaniasis were reported between 2016 and 2019 in Bhotkhola. Even at the district level, only three cases of malaria and dengue were reported in 2018/19.

A total of 3,215 cases of water-borne diseases were reported between 2016 and 2019. Of the total reported cases, cases of intestinal worms were highest (31%), followed by diarrhea (30% of the total reported in last three years), and acute gastroenteritis (AGE) (21%). However, the cases of AGE increased between 2017/18 and 2018/19 while cases of diarrhea show a decline by almost 50% over the same time.

Approximately 1,600 cases of ENT and skin diseases were reported between 2016 and 2019. Of the total reported cases, conjunctivitis, impetigo, and scabies were the most prominent.

A total of 246 STDs were reported in Bhotkhola between 2016 and 2019. Of this, approximately 87% were cases of urinary tract infection (UTI), followed by lower abdominal pain syndrome (LAPS). The cases of UTI were highest in 2017/2018 and have decreased since then. No cases of human immunodeficiency virus (HIV) infection, inguinal bubo syndrome, or respiratory tract infections were reported between 2016 and 2019. A review of the latest epidemiological data indicates that the epidemic transmission of HIV has halted in Nepal (Department of Health Services 2019).

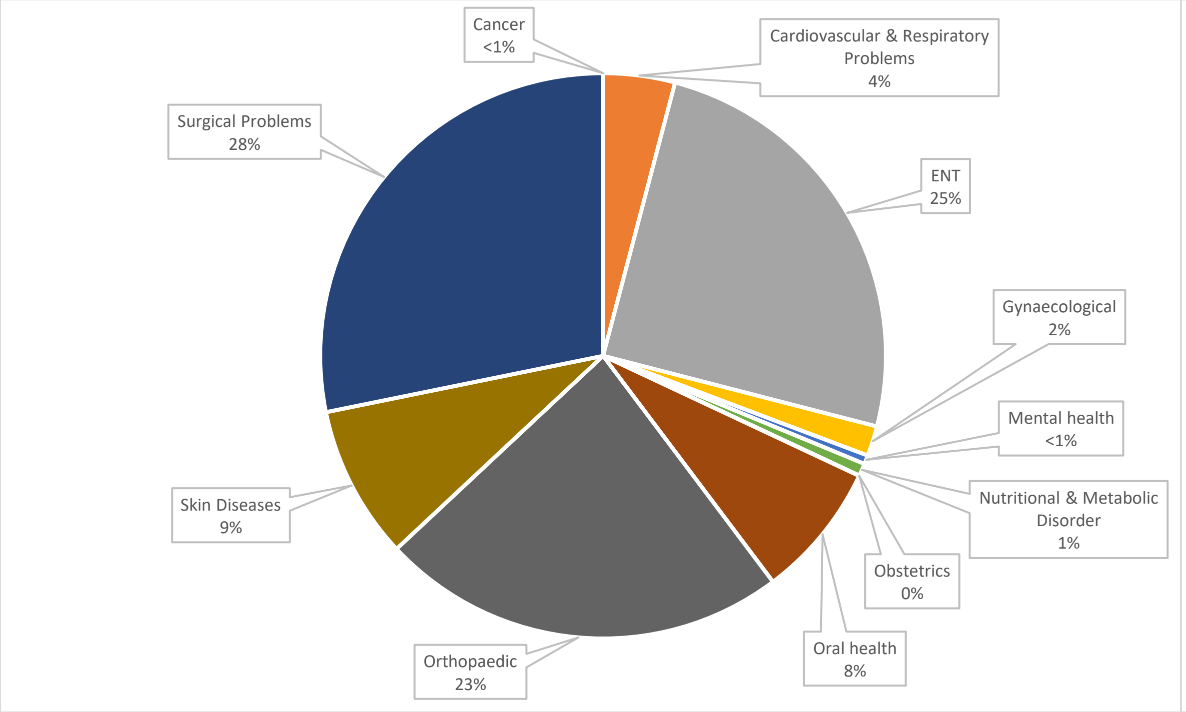
The health workers and health department ERM consulted with also reported LAPS cases and vaginal discharge syndrome (VDS) as common diseases among women. Health workers also suggested that the government should provide medicine, equipment, and human resources for the treatment of such cases in local health posts.

Non-Communicable Diseases

Non-communicable diseases (NCDs) are a significant and growing burden on the health of individuals and populations worldwide. Behavioral factors such as tobacco use, alcohol consumption, physical inactivity, and unhealthy diet are driving the epidemic of NCDs, which are further influenced by social, economic and environmental determinants (Joshi *et al.* 2017). Deaths due to NCDs have increased from 60% of all deaths in 2014 to 66% in 2018 (WHO 2018). ***Figure 6.90*** shows the composition of NCDs in Bhotkhola between 2016 and 2019.

[91] Vector-borne diseases are illnesses that are transmitted by vectors, which include mosquitoes, ticks, and fleas. These vectors can carry infective pathogens such as viruses, bacteria, and protozoa, which can be transferred from one host (carrier) to another.

Figure 6.90: Non-Communicable Diseases in Bhotkhola, 2016–2019



Source: OPD data, Health Department, Bhotkhola Rural Municipality

Not a single case of cancer was reported in Bhotkhola between 2016 and 2019; however, a total of 356 cases of cardiovascular and respiratory diseases were reported during the same time period (***Table 6.91***). Of this, more than 70% were cases of bronchitis and chronic obstructive pulmonary disease (COPD). The cases of bronchitis declined between 2017/18 and 2018/19, while cases of COPD and hypertension increased. Similar trends have been reported at the district level in 2018/19.

As per the Nepal Burden of Disease Report 2017 (Nepal Health Research Council *et al.* 2019), cardiovascular disease and COPD are the biggest contributors to early deaths among adults aged 30 and above. The prevalence of hypertension – one form of cardiovascular disease – increases with age among both women and men; however, the prevalence increases substantially after age 60 among women and after age 55 among men. Rates of hypertension are higher among tobacco users than among those who do not use tobacco (Ministry of Health, Nepal *et al*. 2016).

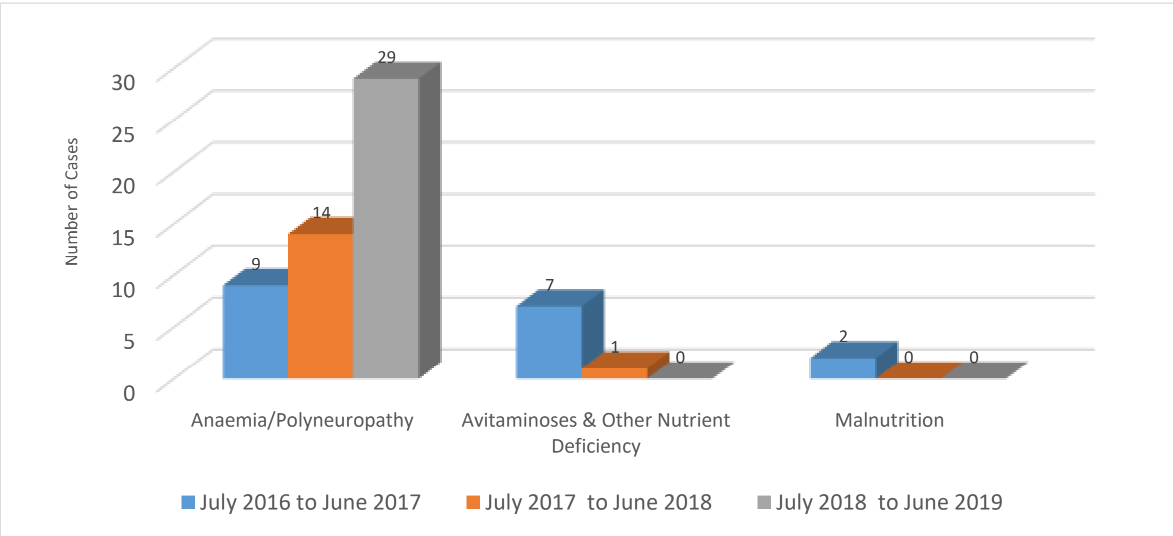
Table 6.91: Cardiovascular and Respiratory Illnesses in Bhotkhola, 2016–2019

Disease	Number of Cases (% of Total)		
	July 2016 to June 2017	July 2017 to June 2018	July 2018 to June 2019
Acute rheumatic fever	13 (11.61%	4 (3.15 %)	1 (0.85 %)
Bronchial asthma	45 (40.18%)	57 (44.88%)	30 (25.64%)
Cardiac failure	0 (0.00%)	0(0.00%)	1 (0.85%)
Congestive heart failure	0 (0.00%)	0 (0.00%)	0 (0.00%)
COPD	26 (23.21%)	46(36.22%)	51 (43.59%)
Hypertension	27 (24.11%	20 (15.75%)	33 (28.21%)
Ischemic heart disease	0 (0.00%)	0 (0.00%)	0 (0.00%)
Other cardiovascular problems	1 (0.89%	0 (0.00%)	1 (0.85%)
Rheumatic heart disease	0 (0.00%)	0 (0.00%)	0 (0.00%)
Grand total	**112**	**127**	**117**

Source: OPD data, Health Department, Bhotkhola Rural Municipality

A total of 62 cases of nutrition and metabolic diseases (anemia, malnutrition) were reported in Bhotkhola between 2016 and 2019 (see ***Figure 6.91***). This constitutes only 1% of total NCDs in the area.[92] Of these 62 cases, 84% were anemia. The cases of nutrition and metabolic diseases have almost doubled from 2017/18 to 2018/19. Although gender disaggregated statistics are not available, the aforementioned health reports cite anemia is a major concern among women, which leads to increased maternal morbidity and mortality and poor birth outcomes, as well as reductions in work productivity.[93] Although there have been no reported cases of malnutrition in Bhotkhola in the last two years, the increase in anemia cases constitutes an important health concern.

Figure 6.91: Nutritional and Metabolic Diseases in Bhotkhola, 2016–2019



Source: OPD data, Health Department, Bhotkhola Rural Municipality

[92] Some of the nutritional and metabolic diseases reported from urban areas of Nepal such as diabetes mellitus (DM), obesity and polyneuritis are not reported from Bhotkhola Rural Municipality.

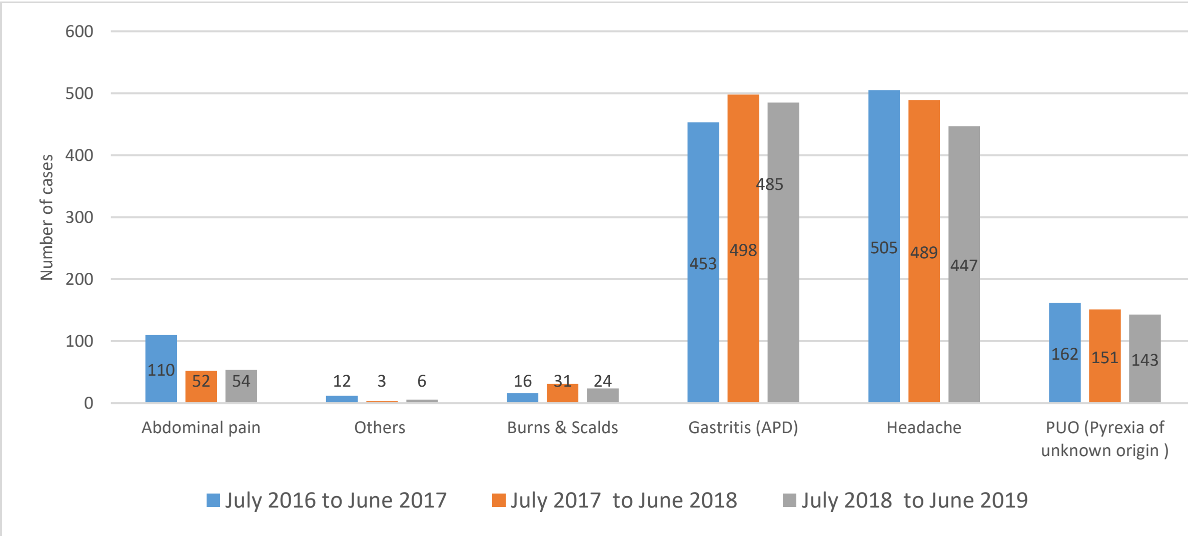
[93] The cause of these levels of anemia are likely dietary (see Section 6.3.10 for a discussion of dietary habits).

Toothache and dental caries, commonly known as tooth decay (a progressive tooth destruction caused by acids that are produced by specific bacteria in the oral cavity), were the highest reported cases of all dental diseases from 2016 to 2019.

Pelvic inflammatory disease (PID) was most prevalent of the gynecological and obstetric cases from 2016 to 2019. This trend is in line with district data, which shows that almost 300 cases of PID were reported in 2018/19.

As shown in ***Figure 6.92***, approximately 3,000 cases of other non-communicable illnesses, including abdominal pain, gastritis, headache, pyrexia of unknown origin (PUO) (consistent fever without any known reason), and burn and scalds were reported in Bhotkhola between 2016 and 2019. Of this, gastritis and headache accounted for approximately 80% of reported cases.

Figure 6.92: Other Non-Communicable Diseases in Bhotkhola, 2016–2019



Source: OPD data, Health Department, Bhotkhola Rural Municipality

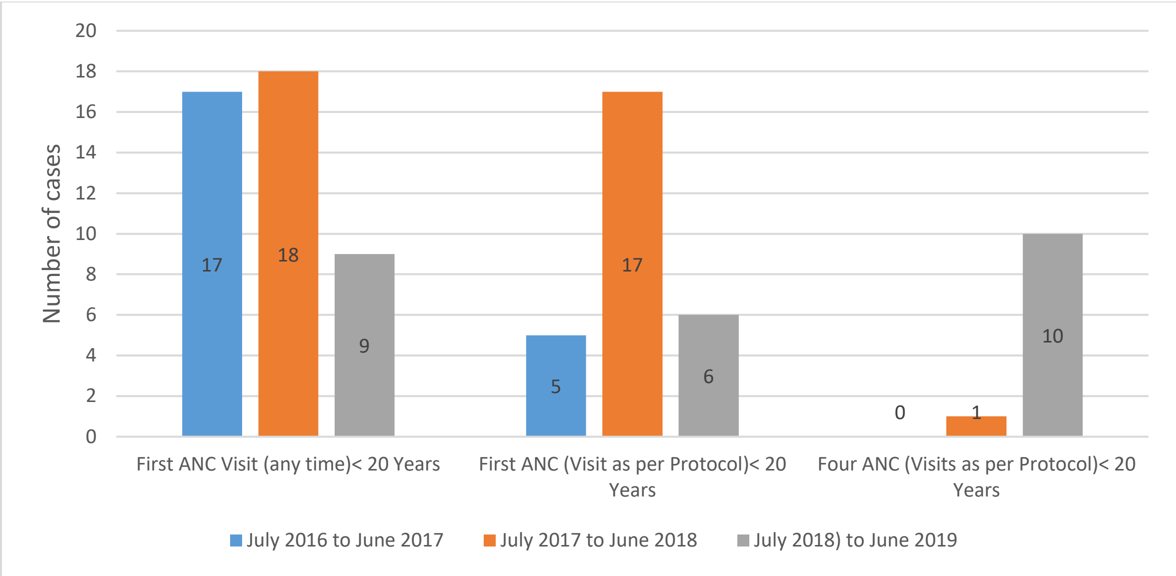
Maternal Health

Maternal, neonatal, and child health issues remain a significant public health concern in Nepal. Rates for maternal and neonatal mortality are still high when compared to the Sustainable Development Goals targets for Nepal (Nepal Health Research Council *et al.* 2019). This can be attributed, at least in part, to early marriage and the often young age of mothers at birth. During a consultation with a community health worker at Hatiya Health Post, Bhotkhola, it was revealed that many women have common problems with uterus prolapse and white water discharge (an STI). These issues can be linked back to traditional gender roles and practices in the area, as the former is caused by women returning to work – often carrying heavy agricultural loads – too soon after childbirth, and the latter is caused by the early marriage practice that exists in many villages and subsequent lack of awareness of how to prevent STIs (see also Section 6.3.4). Lack of sanitation and nutritional food during pregnancy and lactation also negatively affects the health of both the mother and child. In recent years, several mobile health units have come to treat women's diseases in Bhotkhola to address this issue, with the support of the hospitals in Dharan, Biratnagar, and Kathmandu.

In 2009, a national free delivery policy known as the Aama Program was launched in Nepal to address the financial barriers women face in accessing health facilities for delivery. Data on this program show that approximately 57 women were eligible for incentive distribution in Bhotkhola from 2016 to 2019, of which 43 women received the incentives. Similarly, 71 out of 77 eligible women received available incentives for childbirth-related transportation (Bhatt *et al.* 2018).

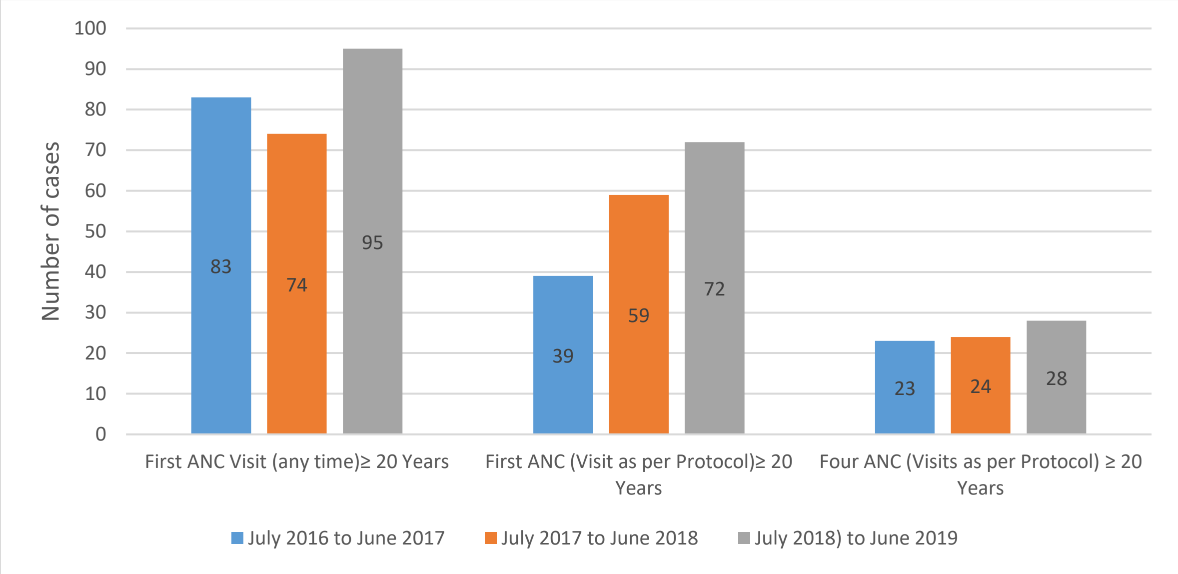
The Ministry of Health recommends that a pregnant woman have ANC visits at least four times during her pregnancy (at the 4th, 6th, 8th, and 9th month) (Aryal *et al.* 2019). The number of women in Bhotkhola receiving all four of the recommended ANC visits during their pregnancy increased between 2016 and 2019 among women aged 20 and above. The progress for women under 20 years of age is also encouraging (see ***Figure 6.93*** and ***Figure 6.94***).

Figure 6.93: Antenatal Check-up Schedule (<20 years) Followed in Bhotkhola, 2016–2019



Source: Health Section, Bhotkhola Rural Municipality

Figure 6.94: Antenatal Check-up Schedule (>20 years) Followed in Bhotkhola, 2016–2019



Source: Health Section, Bhotkhola Rural Municipality

According to the National Safe Motherhood Program, ANC should be provided by a skilled provider such as a doctor, nurse, or auxiliary nurse midwife (ANM). Overall, out of 104 women included in the Bhotkhola Rural Municipality Health Department statistics, between 2016 and 2019, 85 received ANC from a skilled provider for their most recent birth (see ***Table 6.92***). In general, there has been a decline in the proportion of deliveries attended by traditional birth attendants, as well as the number of deliveries occurring in households or out in forested areas. As per consultations with ANMs, most women prefer going to a health post for delivery, which has reduced the mortality rate of both mothers and children. In the event of a serious health complications, women are often taken to larger hospitals by chartered helicopter or heli-ambulance.

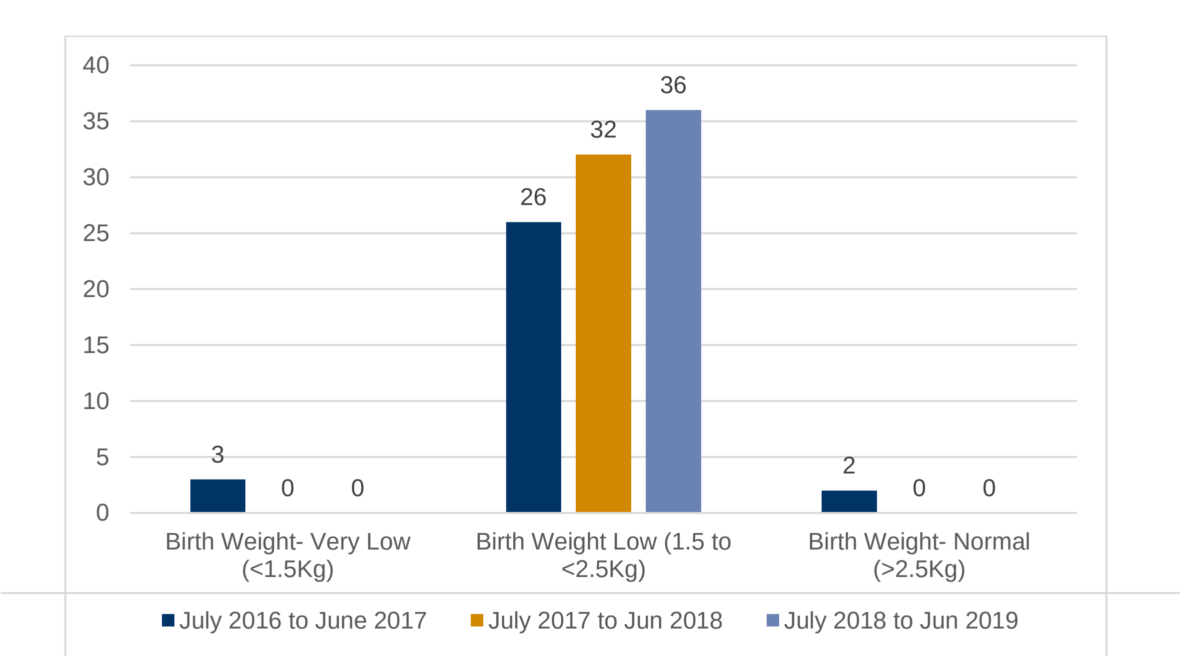
Table 6.92: Institutional Delivery Services in Bhotkhola, 2016–2019

Delivery service	Number of Services Provided			
	July 2016 to June 2017	July 2017 to June 2018	July 2018 to June 2019	Total
Non-skilled birth attendant (SBA) health worker facility	0	2	4	6
Non-SBA health worker home	5	0	3	8
SBA facility	25	30	30	85
SBA home	1	4	0	5
Grand total	**31**	**36**	**37**	**104**

Source: Health Section, Bhotkhola Rural Municipality

There were no cases of obstetric complications, such as abortion complications, antepartum hemorrhage, or eclampsia, reported in Bhotkhola from 2016 to 2019. Of the 99 live births in Bhotkhola during this time, the weight of the newborn was normal (>2.5 kgs) for approximately 90% of the births (see ***Figure 6.95***. There have been no reports of low or very low birth weight over the last two years, which shows a significant improvement from previous years.

Figure 6.95: Birthweight of Newborns in Bhotkhola, 2016–2019



Source: Health Section, Bhotkhola Rural Municipality

Maternal death is defined as death that occurs during pregnancy or childbirth, or within 42 days after the birth or termination of a pregnancy, but that is not due to accidents or violence (as defined in the municipal data). According to the municipal data, only three neonatal deaths were reported in Bhotkhola from 2016 to 2019.

Nepal made abortion legal in September 2002.The government began providing comprehensive abortion care services in March 2004. In Bhotkhola, 33 women availed themselves of abortion services between 2016 and 2019 (see ***Table 6.93***). No abortions were recorded in 2016/17 and just one case in 2017/18. Therefore, a total of 32 abortions occurred in 2018/19. Of these, 29 of the women were over 20 years of age while three were less than 20 years of age. All abortions were through medical procedures. After abortion, the majority of women opted for short-term family planning through oral contraceptive pills.

Table 6.93: Safe Abortion Services Availed in Bhotkhola, 2016–2019

Safe Abortion Services	Number of Cases			
	July 2016 to June 2017	July 2017 to June 2018	July 2018) to June 2019	Total
Number of women <20 years	0	1	3	4
Number of women ≥20 years	0	0	29	29
Total	**0**	**1**	**32**	**33**

Source: Health Section, Bhotkhola Rural Municipality

The aforementioned National Safe Motherhood Program recommends three postnatal care (PNC) visits to reduce maternal and neonatal morbidity and mortality. The first visit should be within 24 hours of delivery, the second on the third day after delivery, and the finally visit on the seventh day after delivery (Aryal *et al.* 2019). Of the total 146 PNC visits reported from 2016 to 2019, 38% of women completed three PNC visits, as per the protocol (see ***Table 6.94***).

Table 6.94: PNC Visits in Bhotkhola, 2016-2019

Row Labels	July 2016 to June 2017	July 2017 to June 2018	July 2018) to June 2019	Total
3 PNC visits as per protocol	19 (40.4 %)	20 (40%)	17 (34.6%)	56 (38.3 %)
PNC visits within 24 hours	28 (59.5%)	30 (60%)	32 (65.3%)	90 (61.6%)
Grand total	**47**	**50**	**49**	**146**

Source: Health Section, Bhotkhola Rural Municipality

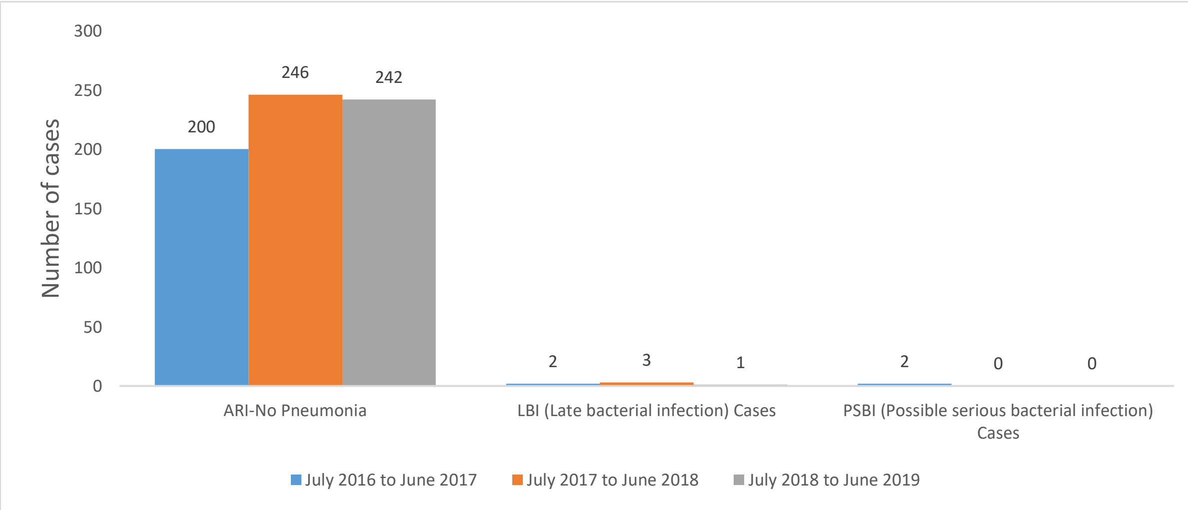
Child Health

Overall, the National Immunization Program is considered as the main contributor towards decline of infant and child mortality, and has contributed significantly in achieving MDG 4 of reducing child mortality (National Planning Commission 2016).

The data presented below is from the program Community-Based Integrated Management of Neonatal and Childhood Illnesses (CB-IMNCI). Under the program, female community health volunteers (FCHVs) are trained to assess, identify, and treat children under age five at the ward level.

A total of 696 newborn children (<2 months) were attended by FCHVs for illnesses in Bhotkhola between 2016 and 2019, and 688 were found to suffer ARIs (see ***Figure 6.96***). The remaining cases were bacterial infections, which is a very small number. The symptoms of ARI consist of cough accompanied by either short, rapid breathing that is chest-related, and/or difficulty breathing that is chest-related. ARIs are a major public health problem among children under age five in Nepal, and pneumonia has emerged as the leading cause of death among children in that age group (Aryal *et al*. 2019). Children with ARI symptoms for whom advice or treatment was sought were mostly given antibiotics.

Figure 6.96: Health Check-up of Children <2 months in Bhotkhola, 2016–2019

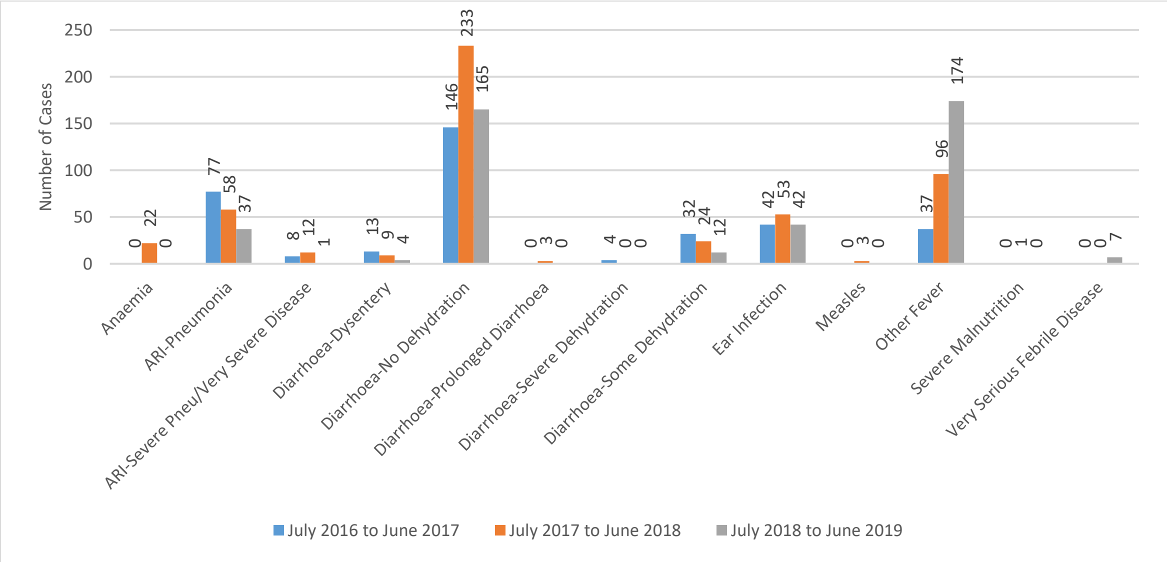


Source: CB-IMNCI, Health Department, Bhotkhola Rural Municipality

Similarly, out of the total 1,315 children (between two and 59 months) who received health check-ups between 2016 and 2019, 15 were further referred to a medical professional and 1,666 were treated by FCHVs (see ***Figure 6.97***). Diarrhea was the most prevalent disease among these children. According to the CB-IMNCI treatment protocol, oral rehydration therapy consists of giving children with diarrhea increased fluids, a fluid made from a special packet of oral rehydration salts (ORS), or government-recommended homemade fluids. Similarly, the CB-IMNCI protocol recommends that children under the age of five with diarrhea be treated with zinc for 10 days. The treatment provided in the aforementioned cases followed these recommendations.

Next to diarrhea, prevalent conditions among children in Bhotkhola between 2016 and 2019 were common fever, ARI/pneumonia, and ear infections. As per a study on maternal health care in Nepal, the cases of diarrhea increase among children under six months when additional liquid food – beyond mothers' milk – is introduced into their diets (Aryal *et al*. 2019).

Figure 6.97: Diseases Identified for Children 2–59 Months in Bhotkhola, 2016–2019

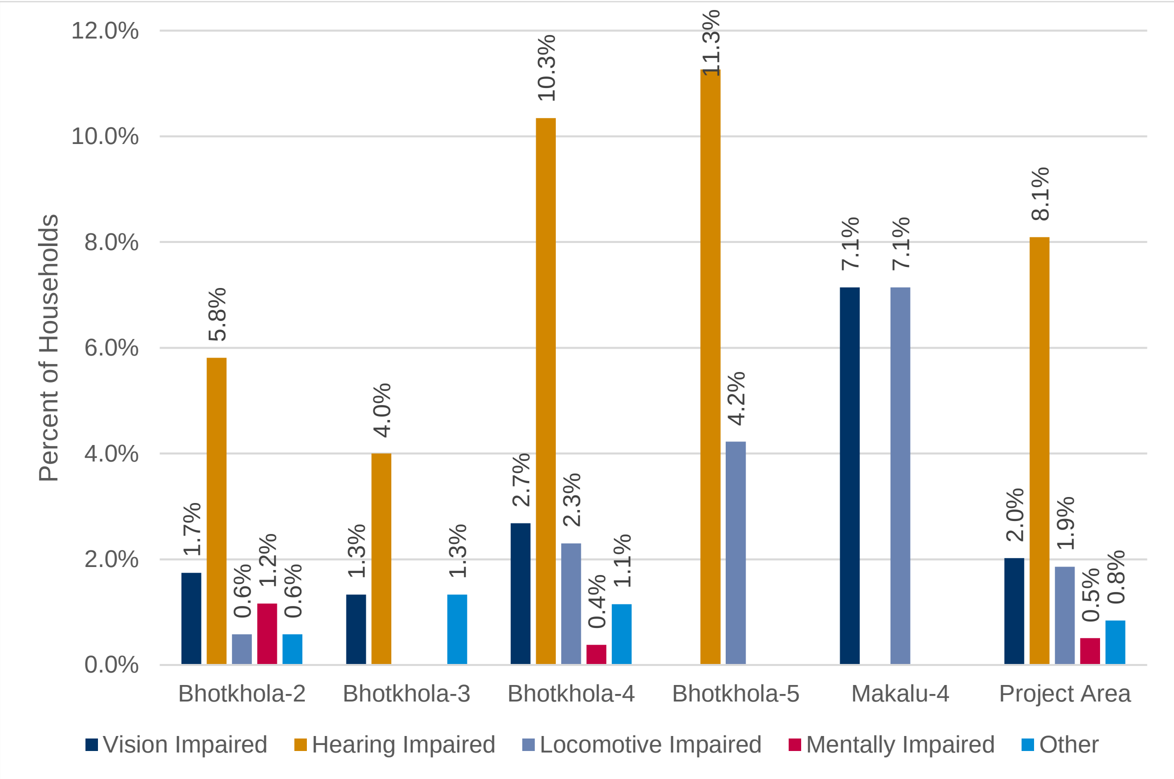


Source: CB-IMNCI, Health Department, Bhotkhola Rural Municipality

Households with Differently-abled Members

During the socioeconomic survey, ERM inquired about the presence of differently-abled members in project-affected households. Of the 593 households surveyed, 79 households (13.3%) reported having a member who was differently-abled (see ***Figure 6.98***). Specifically, 2% of total households surveyed reported having a member who is vison impaired, 8% had a member who is hearing impaired, and 1.9% had a member with problems with their limbs (e.g. partial or full paralysis). Mentally or psychologically impaired members were found to exist in 0.5% of total households. Bhotkhola-5 and -4 have a notably larger percentage of households with hearing impaired members than do other wards, while Makalu-4 has a higher percentage of locomotive and vision impaired members.

Figure 6.98: Households with Differently-abled Members



Source: ERM Socioeconomic Survey, 2019–2020

6.3.13 Vulnerability Assessment

Vulnerable people are those “who may be more likely to be adversely affected by the project impacts and/or more limited than others in their ability to take advantage of a project’s benefits” (WB ESS 1). This vulnerability may be pre-existing (i.e., present in the project impact area prior to the start of project activities) or project-induced (i.e., a result of project activities). Indicators of pre-existing vulnerability in Nepal can include (but are not limited to): age (elderly, children); gender (women); those in a state of poverty; those without land ownership or with insecure land tenure; and those who are members of an ethnic minority or other marginalized group. Clearly, where indicators of vulnerability overlap (i.e. women within ethnic minorities, elderly in a state of poverty), the risk and implications of vulnerability are higher.

Details on the prevalence of these indicators and their prominence among the project-affected population are interwoven in the preceding sections. Therefore, the purpose of this section is not to recapitulate all the details of the baseline data relating to vulnerability presented above, nor is it to identify the specific impacts of the Project and how they will affect these or other groups that may be made vulnerable by a particular impact (such is the task of Chapter 7 – particularly Sections 7.3 and 7.4). Rather, the purpose of this section is to briefly highlight two trends with respect to vulnerability wherein multiple indicators of vulnerability intersected for two particular groups: women and non-AJ groups. This will provide context for the impact assessment presented in Chapter 7, and will complement the more in-depth vulnerability assessment specific to the displaced population presented in the Project RAP.

Vulnerability among Women

One particularly vulnerable group in the project DIA is women. As discussed in Section 6.3.5 above, women tend to have lower levels of education, on average, than men, and represent 65% of the illiterate population in the project DIA (see ***Table 6.59***). Women also have less decision-making power within households, and communities more broadly, and are the primary victims of early or childhood marriage, GBV, and trafficking in persons. The culture in the Bhutia community, the indigenous group predominant in the area, gives authority to men for disciplining or punishing their wives for perceived transgressions. These vulnerabilities can be exacerbated by the arrival of a large project such as the UAHEP, if the effects are not well mitigated. Women and girls from lower-income families and ethnic monitories are likely to be even more vulnerable in the context of a project, as are – obviously – those with more exposure to particular project impacts (i.e., proximity to workers' camps) (see Chapter 7, Sections 7.3 and 7.4 for a discussion).

Women are also more vulnerable due to their particular role in the economy as caregivers and, largely, agricultural workers. This includes, but is not limited to, women who are often in charge of collecting NTFPs, fodder, and firewood for the household, and who will be disproportionately disadvantaged by the destruction of, or restricted access to, the ecosystems that provide such services (i.e., as a result of the Project). In terms of wage labor, more men than women are engaged in services, wage labor, and foreign employment (70%, 78%, and 71%, respectively) (see ***Table 6.63***), while women tend to be more dominant in agricultural and home-based activities such as unpaid labor and childcare. Because of women's unique role in the economy, they may be particularly vulnerable to project-induced impacts on the feasibility/availability of agricultural work, as well as increased pressures on the health care system (as those primary responsible for child health and wellbeing, in the absence of professional or traditional medical aid). The likelihood and severity of these particular impacts are discussed further in Chapter 7 (Sections 7.3 and 7.4).

Finally, women are also vulnerable due to their lack of land ownership in the project DIA. As discussed in Section 6.3.7 above, 18% of households owning land report that at least part of their landholdings are registered in the name of women. The average total land area of these 93 households is 3.06 ha (60 ropani), and women in these households own an average of 1.64 ha (32 ropani). Therefore, women members own an average of 54% of the total average landholding for households in which women partially own the land. As Section 6.3.7 notes, however, land transaction decisions are still usually made by male members of the family, regardless of ownership status. Therefore, women have less control over decisions pertaining to their land and whether or not/how, and to what end, their households are compensated in the context of project development.

An Assessment of Protective Mechanisms and Safety of Women and Girls in Upper Arun Region (Appendix H) found that alcohol exacerbated violence was the major cause of intimate partner violence in the community. Other major prevalent issues influencing violence against women include financial dependency on men and control by men, disproportionate workload, lack of decision-making power, and less or no access to means of production (property, land, house). Incidences of kidnap marriages and child marriages are known to occur in the area.

Economic factors relating to poverty were identified as one of the major drivers of interpersonal violence within households. Cultural practices, including polygamy and the dominance of strict patriarchal norms, compound the risk. Early childhood exposure to violence, isolated geographical locations, alcohol and substance abuse, and unequal power relations are some of the key risk factors for violence in the project DIA.

Vulnerability among Non-AJ Groups

Non-AJ groups (i.e., Kami [Bishowkarma]), are historically a vulnerable and disadvantaged group within Nepal. The baseline presented above provides some indication that this is also the case in the project DIA, particularly in terms of land ownership.

In terms of income levels, the average annual household income of non-AJ ethnic groups is 3,28,438 NPR/year, while that of aadibasi/janajati groups is 419,407 NPR/year (***Table 6.82***). Therefore, non-AJ groups' incomes on average are 22% lower than aadibasi/janajati groups in the DIA.[94] While only 3% of survey participants reported being landless, of these 25% were non-AJ; however, other AJ ethnic

[94] The most recent financial figures for Nepal (2018–2019) do not provide average annual income by household (only per capita) (Government of Nepal 2019).

groups (such as the Gurung) had even higher levels of landlessness (33%). This suggests that landlessness in this context is not biased towards non-AJ ethnic groups. However, in the context of rural Nepal, the size of one's landholding is possibly a better indication of economic wellbeing and social status, because land acts as a source or base for productive livelihoods and because it can be used as collateral for bank loans. The average landholding area of aadibasi/janajati communities ranged from 16,260 m^2 (Gurung) to 25,030 m^2 (Tamang), while the average landholding area of non-aadibasi/janajati communities (i.e., Kami [Bishowkarma]) is 4,213 m^2.

One hundred percent (100%) of non-AJ households are also in the bottom two quintiles in terms of land ownership, compared to non-AJ households which tend to be spread more evenly across the quintiles (see ***Table 6.67***). Similarly, cardamom is one of the most lucrative and important crops in the area; non-AJ households have an average of 1,625 m^2 of cardamom fields, compared to an average across all ethnic groups of 8,425 m^2. This suggests that non-AJ groups are disadvantaged and, thus, vulnerable in terms of land ownership (both quality, i.e., for cardamom fields, and quantity, i.e. overall size). This is exacerbated to the extent that non-AJ households are characterized other sources of vulnerability (some of which are indicated below and expanded upon in Chapter 7).

Other Sources of Vulnerability

Other sources of vulnerability to particular project impacts are presented in Chapter 7 (Sections 7.3 and 7.4). For example, geographic proximity to particular project components can increase vulnerability to certain effects for those communities (particularly for segments of the population with other forms of pre-existing vulnerability, such as women). Similarly, those with pre-existing health conditions can be more susceptible to dust and noise pollution, while those with low income levels and/or high levels of debt can be more likely to fall prey to land speculators and opportunistic land purchases. Finally, those with higher levels of reliance on NTFP or other ecosystem services will be more adversely affected by project impacts that increase the demand upon, or otherwise interrupt the availability of, these services.

The prominence of such vulnerabilities are presented throughout Section 6.3, and their implications in terms of interactions with particular project impacts are covered in Chapter 7, Sections 7.3 and 7.4.

6.3.14 Cultural Heritage Baseline

The following cultural heritage baseline covers both tangible (cultural and natural) and intangible heritage of the DIA and assesses the significance of these cultural resources. The tangible forms of cultural heritage include moveable or immovable objects, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and/ or religious value. The tangible natural cultural heritage includes unique natural features or tangible objects that embody cultural values, such as sacred groves, religious forests, rocks, lakes, and waterfalls. The intangible forms of cultural heritage include cultural resources such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles. ***Figure 6.99*** presents a map of all known cultural heritage sites within and around the DIA. ***Figure 100*** presents a map of all known cultural heritage sites from Khandbari to Gola.

Figure 6.99: Cultural Heritage Resources in the Project Direct Impact Area

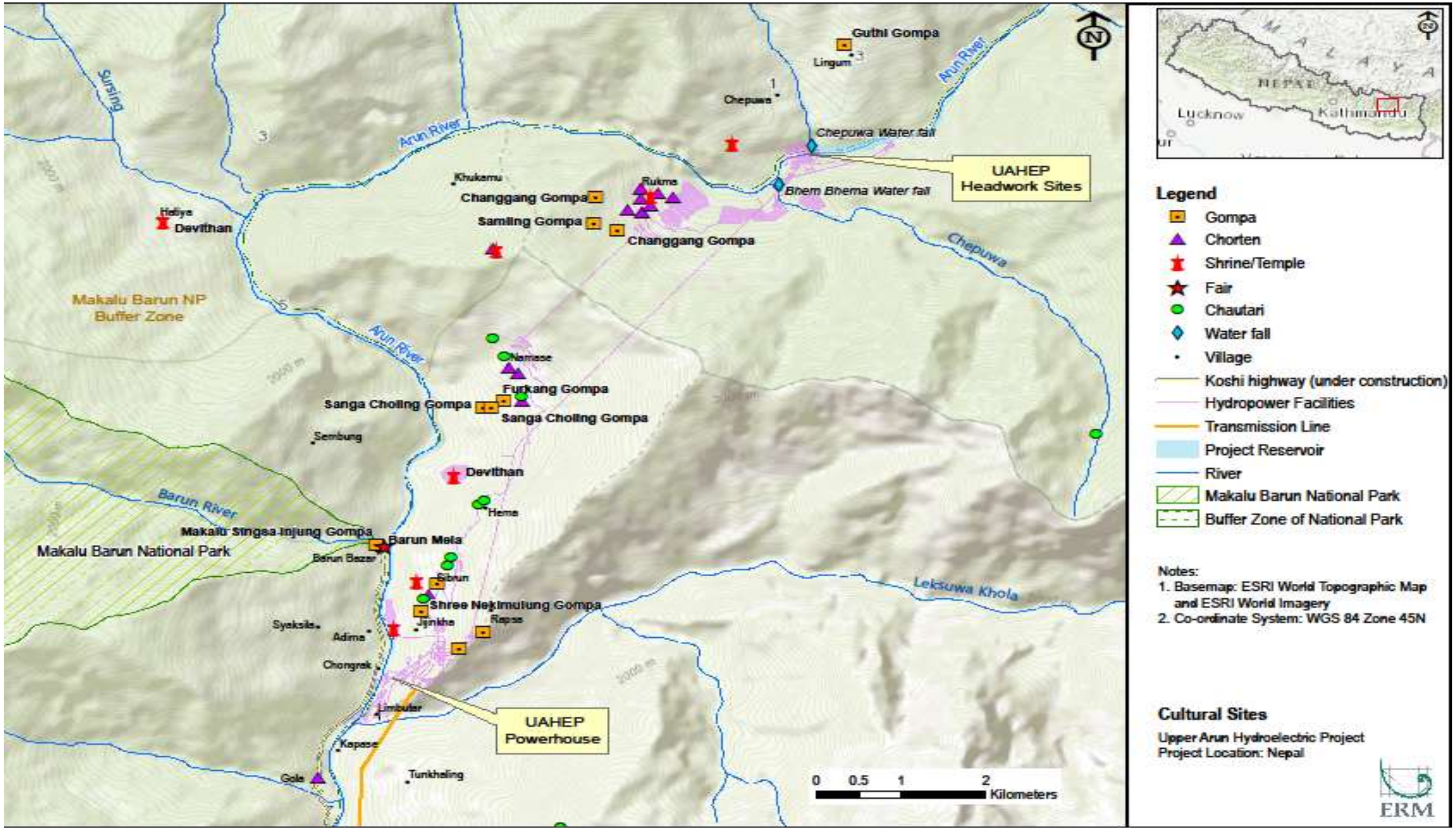
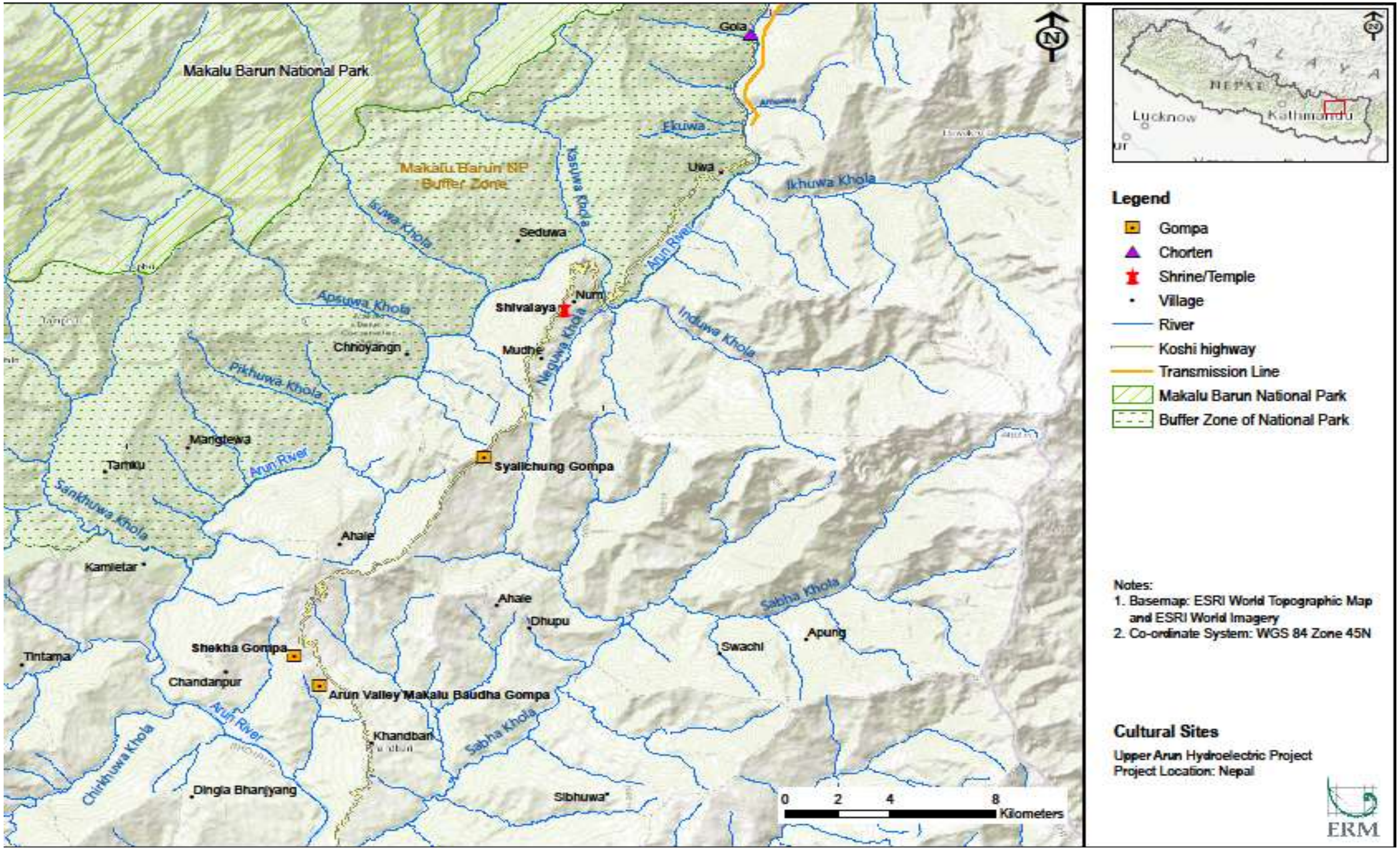


Figure 6.100: Cultural Heritage Resources along the Koshi Highway from Khandbari to Gola



Tangible Cultural Heritage

The cultural heritage baseline identified tangible resources in the project wards and municipalities including *gompas* (similar to Buddhist *vihara,* or monastery), *chhortens* (stupa or *chaityas*), *manewalls* (stone walls containing prayer wheels and/or inscribed stone slabs), temples, and traditional residential structures. The historical and cultural significance of residential structures depends significantly on the age and characteristics of the individual structures, as older structures have more historic significance reflecting historical techniques and styles.

Religious Sites: Gompa and Chhorten

In Bhotkhola, Buddhist monasteries, stupas and *manewalls* were the most common cultural heritage structures, as the local culture is heavily influenced by Buddhist teachings. A brief profile of cultural heritage and historical sites present within the project-affected villages, with photographs, is presented in ***Table 6.95***.

Table 6.95: Major Religious and Cultural Heritage Sites within Project DIA

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Makalu Singsa Injung Gompa	Barun Bazar Bhotkhola 4	Gompa is in the name of Finjo Bhote and land is in name of Kunga Lama	Built 25 years ago	Tin roof, stone pillars, plastered floor and Buddhist structure with drawings and paintings	
Shree Nekimulung Gompa	Sibrun Bhotkhola 4	Lama chief	Registered by Gompa Construction Committee on 2069-11-09 BS (February 20, 2013 AD)	Made of stones and cement; Buddha statue made of clay and contains Thanka paintings and bells Tin roof, stone pillars, and plastered floor; pillars were originally small, but later renovated and increased in size	
Chayarung Chhorten	Hatiya Bhotkhola 3	Hatiya Community	Very old, believed to be built by Tibetans	Made of stones and contains a Buddha statue	

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Chyangju Chhorten	Sibrun Bhotkhola 4	Sibrun community	Very old and managed by village people	Made of stones in stupa style and stone pillars Believed to be constructed with gold and silver in foundation.	
Sangdok Paari Gompa	Namase Bhotkhola 4	Namase community	Very old, religious events are held during Dashain	Made of stone and wood. Looks like a house; contains Thanka paintings and Rinpoche statue	

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Furkang Gompa	Namase Bhotkhola 4	Namase community, Lama	Built before living memory of community; built with belief to reduce landslides	Structure is made from stones and wood with tin rooftop; similar to that of a residential structure and contains paintings and religious books	
Kenjyur Gompa	Hatiya Bhotkhola 3	Community	Built by Thangthongh Jyabu in memory of parents	Structure is made from stones and wood with a tin rooftop; contains statues, paintings, and religious texts	
Changgang Gompa	Rukma Bhotkhola 2	Lama	Built before living memory of community	Structure is made from stones and wood with Chitra roof tiles	NA

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Sanga Choling Gompa	Namase Bhotkhola 4	Namase community, Lama	Built before living memory of community	Rebuilt after the earthquake with stones and wood; contains a large Buddhist statue, religious textbooks, and Buddhist paintings	
Sorchung Gompa	Hatiya Bhotkhola 4	Managed By Lama Chief	Built 200 years ago Branch of Yang Guthi	Built from wood and stones; contains statues of Buddha and a Rinpoche	
Mendung Gompa	Hatiya Bhotkhola 4	Lama	125 years old Rebuilt by Makalu Barun National Park	Structure is made from stones and clay with a tin rooftop	

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Rilye Gompa	Hatiya Bhotkhola 3	Lama	160 years old	Structure is made from stones and wood with a tin rooftop; contains statues, paintings, and religious texts	
Membung Gompa	Sembung Bhotkhola 4	Community, Lama	Built in 2026 BS (1969 AD) and registered in 2050 BS (1993 AD)	Structure is made from stones and clay with a tin rooftop; similar to that of a residential structure; structure is damaged and is yet to be rebuilt	

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Yaring Gompa	Chyamtan Bhotkhola 2	Chyamtan community, Lama	This was a resting place for yaks coming from Tibet Autonomous Region during ancient times.	Structure is made from stones and wood with a tin rooftop; similar to that of a residential structure; contains a statue of a Rinpoche and Manjushree	
Samling Gompa	Shyaksila Bhotkhola 4	Shyaksila community and Lama Chief	Built in ancient times, but registered four years ago	Structure is made from stones and clay with a tiled rooftop; similar to that of a residential structure; contains a statue of Buddha and a Rinpoche	

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Nangsa Pema Gompa	Hatiya Bhotkhola 4	Hatiya community, Lama	Believed to be built by Lama	Structure is made from stones, clay, and wood with a tiled rooftop; contains paintings of Buddha	
Lingang Gompa	Hatiya Bhotkhola 4	Hatiya community, Lama	This used to be a resting place for Tibetans.	Structure is made from stones and clay, cement floor with tiled rooftop; similar to that of a residential structure; contains a statue of Buddha and a Rinpoche	

Cultural Resource	Place Name	Custodians and Management	History	Structural Features	Photo
Samling Gompa	Syaksila Bhotkhola 4	Local community	Built before living memory of community.	Structure is made from stones and clay, with tiled rooftop; similar to that of a residential structure; contains a statue of Buddha and Rinpoche	

Graveyard and Cremation Sites

Death rituals vary by ethnic group, and to some extent by community. Some communities perform death rituals by river banks, whereas others have burial grounds in the hills. While there are discussions within the project-affected communities around developing a common graveyard or cemetery, communities currently have specific areas, usually close to their homes, where they perform last rites. While the Bhote, Gurung, Sherpa, and Tamang communities perform death rituals on the hills above their villages (in a place referred to as *Chihan Danda*), Brahmin, Gurung, and Kami (Bishowkarma) communities conduct their rituals by river banks. During FGDs and KIIs, community members reported that the number of Christians in the area has increased over the years and that these people, regardless of their ethnicities, have started practicing burial, rather than cremation. There are no specific burial grounds for Christians. Rai and Kirat communities usually have graveyards in their own garden.

Table 6.96 identifies the graveyards and cremation sites documented by ERM in the project DIA. Some of these sites have been used by these ethnic groups for a long time, beyond the living memory of community members. These sites are also used for carrying out rituals linked to ancestral worship. In most cases, there is not a single specific site used for cremations or cemeteries, but rather communities use a general area for such rituals.

Table 6.96: List of Graveyard and Cremation Sites in Project DIA, by Village

Village	Ethnic Group	Name of the Site
Chyamtan	Bhote	Gaang Chhyimmu, Tum Jyaksa
Guthi Gumba	Bhote	Morengmu Thanga, Che Jyaksa (Christian)
Lingam	Bhote	Paala Thanga
Chepuwa	Bhote	Chungmuk Thanga, Bhasalata, Gongba Diksum (Christian)
Jijinkha	Sherpa	Hombare
Hema	Tamang	Hema Danda
Sibrun	Bhote	Hombare Danda
	Tamang	Hombare, Angladi
	Kami	Barun Dovan (Chhiling)
	Newar	Barun Dovan (Chhiling)
Namase	Bhote	Nawam
Rukma	Bhote	Yuloma, Chhyubolak, Dogapu
Hongon	Bhote	Lagama, Panggang, Wakchema, Dogang, Chhagim, Changgang, Dera, Totofuk
Khukmu	Bhote	Khukmu, Khuyuchen
Hatiya	Bhote	Fukang Jyema, Ri Tokma,
Sembung	Bhote	Mendongma
Barun Bazar	Bhote	Syaksila
Limbutar	Rai	Kothebari (own garden land)
Syaksila	Bhote	Anglo, Dilangwa, Fukang Jyema, Higo, Ganglama, Thajungma
Chongrak/ Adima	Rai	Kothebari (own garden land)
Kapase	Rai	Kothebari (own garden land)
Gola	Rai	Kothebari (own garden land)

Village	Ethnic Group	Name of the Site
	Bhote	Syaksila
	Gurung	Laami Bagar, Barun Dovan
Tunkhaling	Rai	Kothebari (own garden land)

Source: ERM Socioeconomic Survey, 2019–2020

Devithan and Naagthan

Devithan is a religious site that has been worshipped by local people since before living memory. The *bijuwa* – or lead priest – worships the deity and religious functions are commonly held through worship and community feasts. It is believed that after the feast, natural powers will not inflict damage on the community's crops and, as such, they will grow healthy and strong. The Bhote community, in particular, reveres snakes, which are worshiped near springs and on agricultural farms on worship sites known as *naagthans*. These sites are mostly marked by a stone which is considered sacred. No structures are found in these sites. The important *devithans* and *naagthans* identified during the survey are given in ***Table 6.97***.

Table 6.97: List and Features of Devithans in Project-Affected Villages

Name and Location	Custodian	Religious Function(s)	Photos
Bopsi Devithan	Tunkhaling Community Forest	Animal sacrifice and feasts are held at this site during Ubhauli and Udhauli Parwa.	

Name and Location	Custodian	Religious Function(s)	Photos
Devithan at Namase	Namase Bhote community	Animal sacrifice is performed at this site, especially during the Ubhauli festival.	
Naagthan at Namase	Namase Bhote community	This place is used to perform rituals and make offerings to snakes.	

Source: ERM Socioeconomic Survey, 2019–2020

Chautari

A *chautari* is a rest stop built under a tree to provide shade to travelers. While it is primarily meant as a rest area, it also provides a gathering space for various community functions, meetings, and gatherings. It often symbolizes a landmark of a community. There are several *chautaris* in the UAHEP DIA. There is also a practice of building a *chautari* in the name of the deceased, which gives a spiritual significance to such places.

Archaeological Sites and Artistic Objects

The cultural heritage baseline study did not identify any protected monument or archaeological site within the DIA. The absence of any protected archaeological sites or historical monuments was also confirmed during consultation with the Department of Archaeology in Kathmandu and the project-affected communities. However, a few historical and artistic objects were found. These are discussed below.

Engraved and Etched Stones and Wood

Engraved and etched stones were noticed in some of the old gompas in the DIA. The etchings in the stone included figurines from the Buddhist pantheon and stupas. Some of them also had writing in Tibetan script. A few examples of such engraved stones are shown in ***Figure 6.101***.

Figure 6.101: Engraved Stones in the DIA

Engraved stone on the wall of Chhyorong Khessa

Stone with etched Tibetan script at Guthi Gompa

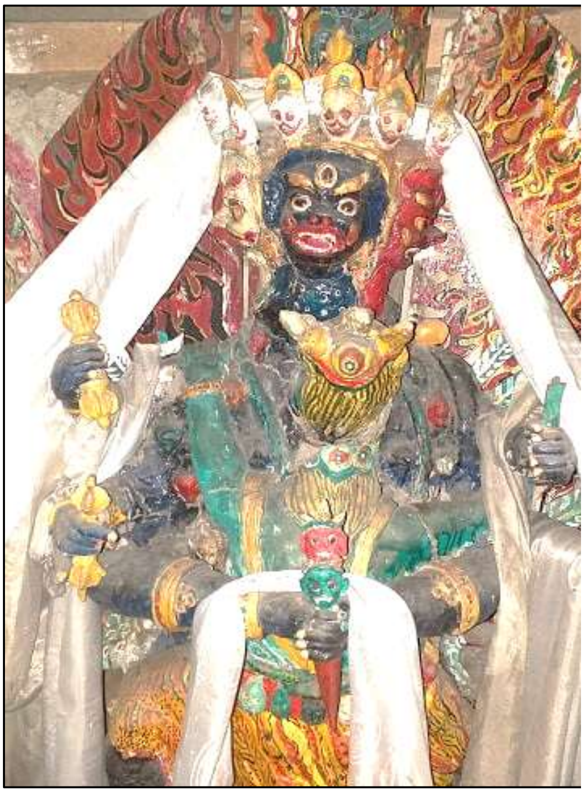
Human figurine in Guthi Gompa

Stupa and Bodhisatva in Guthi Gompa

Source: ERM Socioeconomic Survey, 2019–2020

Some of the gompas also had wooden carvings of deities. The two most prominent depiction of deities are shown in ***Figure 102***.

Figure 6.102: Wooden Carving of Deities



Dorchi Sunup deity inside Sorchung Gompa

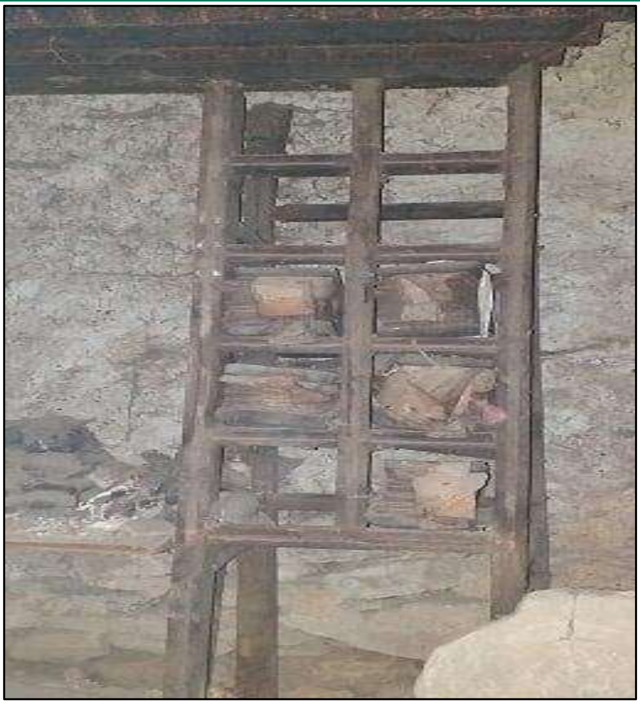
Inside view of Shire Lagang Gompa with Bodhisatva and Padma Sambhav

Source: ERM Socioeconomic Survey, 2019–2020

Holy Books and Manuscripts

Some Gompas, particularly in Hungong, Hatiya, and Guthi Gumba, have a collection of holy books and manuscripts. Some of them are stored within the dilapidated structures of the Gompa, while others are relatively well preserved and taken care of by Lamas. A list of such historical manuscripts along with their photos is provided in ***Table 6.98***.

Table 6.98: List of Holy Books and Manuscripts

Place Name	Photo	Description
Yum Gompa, Hungong		A wooden rack with some manuscripts on old hand-made paper
Kenjour Gompa, Hatiya		A rack of well-preserved manuscripts wrapped in cloth
Kenjour Gompa. Hatiya		Thunang Lama showing old holy manuscripts.

Place Name	Photo	Description
Yum Gompa, Hungong		Holy books in a rack with wooden engravings.
Yang Gompa of Guthi Gompa village		A small bundle of manuscripts with holy text inside Yang Gompa
Thonang Lama of Hatiya		Old Buddhist scripture on handmade paper
Dheyen Dhupling Gompa at Hungong		Manuscripts and ritual artefacts at Dhupling Gompa

Source: ERM Socioeconomic Survey, 2019–2020

Ritual Artefacts

A number of cultural artefacts with wooden engravings have been used by ritual and spiritual leaders (Lamas). Although these artefacts do not appear to be more than a hundred years old, they have cultural significance and are considered to be valuable possessions by their owners. Some of the typical artefacts are listed in ***Table 6.99***.

Table 6.99: List of Ritual Artefacts

Artefact Name	Location	Photo
A parka	Sembong, owned by Loben	 
Parchuk	Lama Hongon	
Pangar	Lama in Hongon	
Mio	Sembung.	
Attukpa Holy Mask	Shyaksila	

Natural Heritage

Much of the natural heritage of the project DIA has cultural importance. As discussed in Section 6.3.4, some religions revere the spirits of nature and see the surrounding hills, rivers, and streams as having cultural significance.[95] However, communities in the DIA also have specific, discernible sites, such as holy lakes, ponds, streams, confluences, caves[96], rocks, forest/groves, and festival sites, which are of cultural significance to them. It is this site-specific cultural heritage that the following sections address. There are three natural cultural heritage sites of significance, which are described in more detail below:

Tatopani Kunda (natural hot spring)

Arun-Barun Dovan (site for Barun Mela)

Bhembhema waterfall on a tributary to the Arun River

[95] The significance of natural cultural heritage areas beyond the hot spring, Barun River confluence, and two waterfalls discussed below were recognized, but not geospatially mapped, as part of ERM's fieldwork.

[96] No caves have been identified within the DIA, but they may occur within the broader landscape.

Tatopani Kunda, Hatiya

Tatopani Kunda is a natural hot spring that is believed to have healing and medicinal qualities pertaining to improved blood flow, reducing toxins, relaxing muscles, reactivating metabolism, and curing rheumatism. The spring used to be a popular destination for tourists from across Nepal and other countries (***Figure 6.103***).[97] Lately this has become a local attraction. It is believed that taking a bath and offering lights at this Kunda will protect communities from diseases and death.

Figure 6.103: Photos of Tatopani Kunda Hot Springs

Source: ERM Socioeconomic Survey, 2019–2020

Barun River and Arun Dovan

The Barun River is considered to consist of holy water that has medicinal qualities, as per the following mythology:

As cited in the Mahabharata and the Bhagwat Gita, saint Tirthaji Bhraman was killed by Balaram, brother of Krishna, for disrespecting him by not standing up in his honor. Repenting, Balaram was then advised to go on an expedition of sacred places and end it with a bath in River Barun, to clear away his sin of killing a Brahmin. The river attained sanctity by the Hindu religious community due to this incident.

It is also said that God Shiva and Goddess Parvati bathed in the river once, after which it became holy and capable of healing people’s ailments.

Every year, hundreds of believers visit the river for a holy bath. One of the biggest festivals in the area is known as “Barun Mela” or Maghi Mela, which is celebrated for three days at Barun Bazar (***Figure 104***). There is a Hindu temple as well as a Buddhist monastery on the bank of the river; thus, this festival is attended by both Buddhists and Hindus.

[97] This hot spring is also documented in Chapter 6.1 (Physical Environmental Baseline).

While the festival starts on the evening of Poush 28 in the Nepali calendar (which is typically, but not always, January 12) when people start gathering from different parts of the country, Poush 29 (January 13) is considered to be the main day of the festival. Communities perform traditional songs and dances, which are a major highlight of the festival. On Magh 1 (January 14), people perform rituals and take a holy bath in the river.

While performance of traditional music and culture is on the decline, this festival still provides a platform for cultural preservation by facilitating the celebrating of religious rituals, cultural programs that showcase traditional arts and crafts, and songs and performances by different ethnic groups and cultures. This festival is also considered important for businesses, as people run stalls selling various goods, local handicrafts, and traditional food. A management committee oversees the festival.

Figure 6.104: The Confluence of Barun and Arun River at Barun Bazar (Barun Dovan)

There is also a belief that the river flows from Kailash and, thus, the water is believed to be holy. There are no gender restrictions and people from all faiths and religions are allowed to bathe in the river.

Chhukchhuwa is observed by Bhotes, Rais, and other aadibasi/janajatis on the occasion of Barun Mela, when they light 108 lamps to propitiate their forefathers or ancestors. The people residing around the Barun River are from different ethnic groups including Kami, Damai, Chhetri, Brahmin, Khaling, Kulung and Yamphu, Bhote, Tamang, Sherpa, Gurung, and Newar.

Bhembhema Waterfall

Bhembhema Waterfall is located on the Bhembhema Khola, which enters the Arun River downstream from the proposed UAHEP dam site. In FGDs, communities reported this to be a significant cultural site for the Bhote community, particularly in Rukma and Chepuwa.

Chepuwa Waterfall

Chepuwa Waterfall is located upstream from the proposed UAHEP dam site and holds cultural significance for communities in the area.

Intangible Cultural Resources

As a part of the baseline survey, an ERM anthropologist and expert in indigenous peoples conducted a rapid ethnography, which covered intangible cultural heritage aspects of the DIA. Specifically, this ethnography covered information on migration history, belief systems, social organization, sources of oral traditions, life-cycle rites and rituals, belief systems linked to the cosmos and natural world, mystery, performing arts, craftsmanship, use of natural resources, and traditional knowledge about hand knitting straw mats, bamboo baskets, and woven woolen carpets. The following sections discuss the intangible cultural resources identified as relating to each of the major ethnic groups affected by the Project, including Bhote, Tamang, Rai, and Gurung.

Bhote

Historically, Bhote were primarily *kabilas* (shepherds), who would move seasonally between higher and lower elevations for their livestock. This practice has been mostly discontinued and Bhote have adopted settled agriculture; however, the tradition of seasonal migration is preserved in terms of their cultural practices, referred to as *udhauli* (coming down to lower altitude) and *ubahuli* (going up to higher altitudes) (see Sections 6.3.3 and 6.3.8 for further details on migration).

The *Udhauli* festival is celebrated every year on a full moon day in the Nepali month of Mangsir (November/December). This festival is meant to offer gratitude and prayers to nature, worshipped by many communities as God, in the hope of good harvests and protection from natural disasters. Communities in higher altitudes move to lower altitudes during this time.

The *Ubhauli* festival is celebrated every year on a full moon day in the Nepali month of Baisakh (May/June). During the festival, communities migrate to the higher hills. This also marks the beginning of the farming season. Prayers are offered to nature for a productive harvest.

Bhote also traditionally have a *pidam* who performs religious rituals, where he chants oral histories and myths. In this way, the *pidam* establishes a link with the community's ancestors, which they believe have control of the clan group. This collection of sacred chants is also considered to be the law of the clan, known as *phalo*. All clans have a *phalo*, which is a record of their ancestral past, which is passed on to the next generation through the *pidam*.

It is a matter of both faith and prestige to have a Lama in the family. Lamas study Buddhist teachings for two years at the monasteries and follow a disciplined life. In the present day, Lamas also receive formal education, in addition to the traditional Buddhist teachings.

Bhote men have traditional skills in woodcraft, making household utensils, and weaving baskets and making other utility items from bamboo. Bhote women are adept in knitting sweaters and bags using local wool.

Tamang

Tamangs – the majority of whom are Buddhists – have their own unique culture, traditions, and language. Tamang society has six types of spiritual leaders, each with their own distinct role in Tamang society. The names of these traditional leaders and their roles are provided in ***Table 6.51*** above.

Tamangs have a rich tradition of music and dance. Their favorite musical instrument is the damphu drum (tambourine) and Tamang selo is one of the most popular forms of traditional music (as described in Section 6.3.3). Tamang communities live together and hold strong beliefs about spiritual/sacred places, as well as evil spirits. They have a strong connection with nature (including the sky, Earth, moon, sun and stars) and revere mountains, forests, and water resources such as streams and rivers, wetlands, lakes, and ponds, all of which are seen as sacred and worshipped accordingly to show respect.[98]

In terms of traditional craftsmanship, Tamang men do carpentry, masonry, and repair baskets and agricultural equipment.

Rai

The Rai are not a homogenous group, but are rather divided into numerous sub-groups. Rai settlements in the project DIA belong to subgroups such as Khaling and Kulung (see Section 6.3.3 for additional details). These two groups have distinct languages and there are some differences in cultural practices as well. However, it is believed that Khaling and Kulung have migrated to this area from the Majh Kirat.

Rais have a rich oral tradition, known as *Mindum* or *Mudhum*. The *Mudhum* contain narratives that claim that Rais are among the original settlers of the Arun Valley. The *Mudhum* also contain chants for invoking their ancestors, nature gods, and evil spirits who influence the health of people, the success of the clan, the bounty of the harvest, the fertility of cattle, and the harmony of the community. The chants in the *Mudhum* and associated rituals connect Rais to their ancestors and are required for balancing/ adjusting the relationship between humans, ancestors, and supernatural beings. Each type of ancestor spirit and supernatural spirit is associated with certain locations and their power affects the lives of living beings.

Rais also have their traditional dances and songs. They possess the skills of traditional craftsmanship in wood work and housing construction. Women have traditional skills in knitting and sewing.

Gurung

The name Gurung is derived from the Tibetan word *Grong* which means farmers. As mentioned previously (see Section 6.3.3), Gurung call themselves *Tamu*, which means horseman in the Tibetan language. They are animists or followers of the Bon religion, which is shamanistic and animistic in nature.

Two of the most important festivals for the Gurung are Ghatu, a dance drama performed by girls in the spring, and Rodhi, which provides a meeting place where young people, supervised by an elderly woman, gather together.

Gurung women have indigenous knowledge on weaving woolen carpet (*radi*, *pakhi*), and making traditional costumes (*bakkhu*), among other skills.

Kami

There are only a few families in the DIA belonging to the Kami, which are considered part of Hindu society. These families migrated into the DIA a few generations ago from Dhankuta, which is located in the south of Nepal. They are typically blacksmiths and possess traditional skills in preparing iron tools used in agriculture and households. They do not possess any specific oral tradition that is separate from the Hindu population.

Newar

There are also a few Newari families in the DIA. Farming is their traditional occupation and they follow Hindu religious and cultural festivals.

Festival Calendar

The DIA has a heterogeneous population. ***Table 6.100*** presents the DIA's festival calendar, which reflects a combination of the major festivals of all ethnic communities.

[98] The significance of these natural cultural heritage areas was brought up during FGDs and KIIs. ERM has, therefore, recognized, but not geospatially mapped, these areas.

Table 6.100: Calendar of Major Festivals Celebrated by Different Ethnic Communities

S.N.	Festival	Observed by	Time of year	Duration	Comments
1.	Buddha Jayanti	Buddhist and Hindus of all communities. (Bhote, Buddhist Newar, Tamang, Gurung)	May/June	1 day	During this festival, communities offer lights in the Gompa and erect *dhoja* (prayer flags) as an offering to Lord Buddha. There is also a tradition of worshipping Kun Devata during this time, particularly among the Hindu communities.
2.	Chaite Dashain	Hindu, Buddhist (Hindu Newar, Tamang, Gurung, Kami)	March/April	1 day	This is traditionally celebrated as a national festival.
3.	Dashain	Hindu, Buddhist and all communities	September/ October	15 days	While this is celebrated for 15 days, the most important days are considered to be 1st, 7th, 8th, 9th, 10th, and 15th day of the festival. This is traditionally celebrated as a national festival.
4.	Gyalmo Loshar	Sherpa (Tamang, Bhote)	February/ March	1 day	Lamas perform rituals for 3 consecutive days in the Gompa.
5.	Maghe Sankranti	Hindu, Buddhist (all communities)	Mid-January	1 day	This is one of the most important festivals celebrated in the region. While the festival is for a day, the celebration goes on for 3 days.
6.	Mukhya Puja	Buddhist (Bhote)	October/ November	3 days	This festival involved dancing with masks and drums. A special ritual is also performed at the Gompa during the festival.
7.	Shrawan Sankranti	Hindu, (Tamang, Gurung, Newar)	Mid-July	1 day	This festival celebrates Lord Shiva.
8.	Sonam Loshar	Tamang	January/ February	1 day	This is celebrated as new year among the Tamang community.
9.	Tamu Loshar	Tamang, Gurung	December/ January	1 day	Tamang, Magar, Gurung community celebrate this as their new year.
10.	Tihar	Hindu, Buddhist and Kirati (all communities)	October/ November	5 days	This is celebrated as a festival of lights and traditionally celebrated as a national festival.

S.N.	Festival	Observed by	Time of year	Duration	Comments
11.	Ubhauli Puja – plantation	Buddhist (Rai)	Chaitra-Baisakh		Worship of god and goddess
12.	Udhauli Puja – harvesting main crops	Buddhist (Rai)	Kartik Mangsir		Worship of god and goddess

Source: ERM Socioeconomic Survey, 2019–2020

7. ENVIRONMENTAL AND SOCIAL RISKS, IMPACTS, AND MITIGATION

This chapter evaluates the Project's potential risks and impacts, applies the mitigation hierarchy to avoid and minimize risks and impacts on the extent possible, recommends mitigation and enhancement measures, and identifies the pre-mitigation and post-mitigation (residual) impact significance relative to impacts on the physical environment (Section 7.1), biological environment (Section 7.2), and social environment (Section 7.3). Project risks and impacts on vulnerable people are discussed in Section 7.4. A summary of potential cumulative impacts is presented in Section 7.5, with a full Cumulative Impact Assessment (CIA) provided in Appendix E.

7.1 Impacts on Physical Environment

7.1.1 Geology and Topography

The Project will have relatively little effect on geology and topography, other than the excavation of tunnels and caverns and grading relatively minor grading of the topography for roads and other aboveground facilities. Geology and topography have more potential to affect the Project via landslides and slope failures, as described below.

The Project's various facilities have the potential to trigger land instabilities due to slope disturbance, vibrations caused by use of explosives for tunnel excavation, use of heavy equipment, and placement of excavated material. The key factor in the triggering of the land instability is related to the existing topographic conditions, which will be further amplified by construction activities in some areas and placement of excavated material in other areas. Site-specific potential risk and impact areas are discussed separately hereunder for the construction and operation periods.

Avoidance and Minimization Measures

The Project will adopt the following measures to avoid and/or reduce impacts on geology, in accordance with the application of the mitigation hierarchy:

- Minimize disturbance of steep slopes by careful selection and siting of access and service roads, hydropower facility, and transmission line facilities.
- Prohibit the construction of new access roads for transmission tower construction, which will significantly reduce land disturbance and risk of erosion; rather, construction materials will be transported to tower sites by porters and pack animals.
- Avoid landslide prone areas (see ***Figure 6.2***).

Construction Phase

Construction of the project roads, spoil disposal areas, and transmission towers pose the greatest environmental and social risks to geology and topography and are discussed below.

Project Road Construction

The disturbance of slopes consisting of colluvial material inherently poses some risk of slope failure. The stable angle of repose in the regolith covered areas in the region is around 30^{o} under typical moisture conditions, even less during the monsoon season; slopes steeper than this are inherently unstable. Approximately 9 km of the access road crosses slopes greater than 30^{o} (i.e., stations 0+300 to 0+900, 1+700 to 5+000, 7+000 to 10+900, 12+700 to 14+100, and 20+200 to 21+650). In addition, 14 internal service roads totaling 16.65 km are also planned to provide access to various project facilities. Unlike the project access road, these are narrow roads that mostly cross steep slopes greater than 30^{o}.

The construction of these roads will inevitably make the hillside cut slopes even steeper, destabilize the slopes, and disturb the natural drainage, increasing the risk of land instabilities, particularly during the monsoon season. Slope failure would most likely consist of debris flows with limited deep-seated circle failure. These failures could affect downslope agricultural land and poses risk of injury to residents and damage to structures.

The Project's potential risk from project access and service road slope failure would be direct, adverse, high in magnitude, local in extent, potentially long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

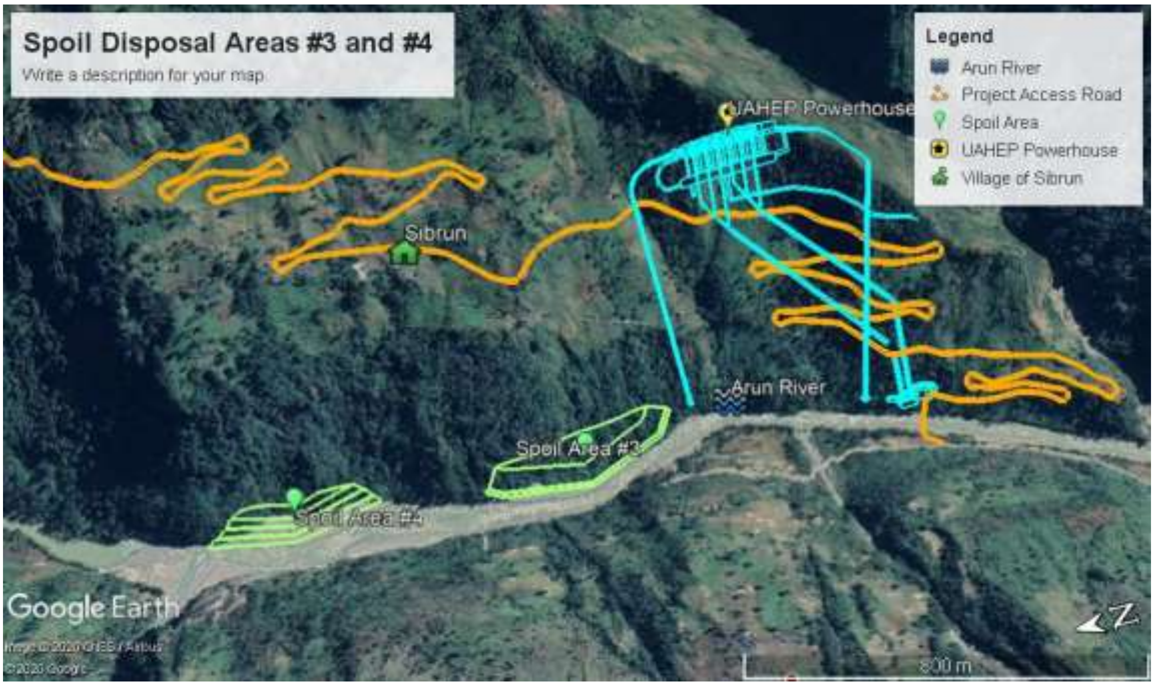
- Conduct a risk assessment for each segment of the access and service road, taking into consideration location (e.g., downslope land uses), ground conditions, terrain, and the nature of construction activities, and implement appropriate precautions and mitigation measures.
- Limit the size of individual blast charges to reduce the risk of triggering landslides.
- Provide bioengineering stabilization techniques as recommended by the Road Engineer.
- Provide adaptive management approaches to stabilizing cut slopes during construction to fit field conditions.
- Provide appropriate slope protection and drainage controls even for the smaller internal service roads.

These measures will reduce the magnitude of project access and service road slope failure to medium. Therefore, the Project's potential risk from project road slope failure during construction will be direct, adverse, medium in magnitude, local in extent, and potentially long term in duration, with an overall residual significance of ***Substantial***.

Spoil Disposal Areas

The access Road Contractor will use four spoil disposal areas, but all of these are relatively small and pose negligible environmental and social risks. Three of the access road spoil disposal areas will be used and expanded by the Hydropower Contractor, plus an additional site. The hydropower spoil disposal areas are much larger. The four hydropower spoil disposal areas will be located in terrain varying from 0º to 40º slopes. Hydropower spoil disposal areas #3 and #4 are located on level ground along the inside bend of the Arun River in a natural sediment deposition area at the toe of steep slopes (***Figure 7.1***). The risks with these two spoil disposal areas is from a slope failure above the facilities, which would damage the facilities, but would not pose a risk to people, structures, or agricultural land.

Figure 7.1: Spoil Areas #3 and #4



Spoil disposal areas #1 and #2 are located on moderately sloping land high above the Arun River and are more susceptible to erosion and slope failure, which could result in the spoil moving or cascading down the hillslope. Neither of these sites have any houses located downslope from the facility, but Spoil Disposal Area #2 has agricultural land located downslope (see ***Figures 7.2*** and ***7.3***). Failure of these facilities would damage downslope forest and agricultural land and introduce large quantities of spoil into the Arun River.

Figure 7.2: Spoil Area #1

Figure 7.3: Spoil Area #2

The Project's potential risk from spoil disposal area slope failure during construction would be direct, adverse, high in magnitude, local in extent, potentially long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Provide engineering design for all spoil disposal areas.
- Ensure the geotechnical design of the Spoil Disposal Areas #1 and #2 considers the environmental, social, and financial risks associated with a slope failure at with these facilities.
- Ensure the Owner's Engineer closely monitors the construction of these spoil disposal areas.

Taking into consideration these mitigation measures, the Project's potential risk from spoil disposal area slope failure during construction will be direct, adverse, medium in magnitude, local in extent, potentially long term in duration, with an overall residual significance of ***Substantial***.

Transmission Line Tower Foundations

Construction of the transmission line towers will require about 25 m^3 of excavation. Ten of the 19 towers are situated on slopes above 30^o. Disturbance of these slopes could increase the risk of slope failure. As opposed to the project roads, there are no residences and very little agricultural land downslope from the towers, so the risk to people would be less.

The Project's potential risk from transmission tower slope failure during construction would be direct, adverse, low in magnitude, local in extent, short term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Consider slope stability in the micro-spotting of the towers.
- Use manual excavation for tower foundations on slopes greater than 30^o to minimize slope disturbance and the potential for slope failure.

- Limit clearing within the RoW to only those trees approved by the Division Forest Office as necessary for construction and operation of the transmission line, ensuring the government's minimum required conductor clearance to trees of 5.5 m. The tree stump and root systems, smaller understory trees, shrubs, and the herbaceous layer will be left intact to protect and stabilize the soil from erosion.

The Project's potential risk from transmission tower slope failure during construction will be direct, adverse, low in magnitude, site-specific in extent, short term in duration, with an overall residual significance of ***Low***.

Operation Phase

The primary geology and topography related risks during operation are related to slope failures along the project roads and transmission lines, in the reservoir, and spoil disposal sites, which are evaluated below.

Project Roads Slope Failure

Even with the application of appropriate slope stabilization measures during the construction phase, project roads located in the steep terrain of the project impact area are still at risk from slope instabilities/failures. This may be the result of improper maintenance of storm drainage, creeping cut slopes, or damage to gabion/retaining walls, especially during and immediately after the monsoon season.

The Project's potential risk of slope failure along project roads and transmission towers during the operation phase will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Conduct regular monitoring and inspection of storm drainage, retaining walls, and slopes along project roads, facilities, and transmission lines.
- Provide prompt maintenance/corrective actions where the need is identified.

These measures will reduce the risk of slope failure to low. Therefore, the Project's potential risk from road and transmission tower slope failure during operations will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Moderate***.

Transmission Tower Slope Failure

Even with the application of appropriate slope stabilization measures during the construction phase, transmission line towers located in the steep terrain of the project impact area are still at risk from slope instabilities/failures. This may be the result of improper maintenance of storm drainage, creeping cut slopes, or damage to gabion/retaining walls, especially during and immediately after the monsoon season.

The Project's potential risk of slope failure along transmission towers during the operation phase will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Conduct regular transmission line monitoring and inspection of storm drainage, retaining walls, and slopes.

- Provide prompt maintenance/corrective actions where the need is identified.

These measures will reduce the risk of slope failure, but it is still considerate medium. Therefore, the Project's potential risk from road and transmission tower slope failure during operations will remain direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

Reservoir Slope Failure

Colluvium and deluvium deposits are distributed on both banks of the proposed reservoir. The volume of the deposit on the right bank is about 1.25 million m^3 and on the left bank is 0.26 million m^3. The two deposits are considered to be stable under the present natural conditions. There is, however, a risk of slope failure associated with the Project's peaking operation where water levels within the reservoir will increase and decrease quickly, which could weaken these slopes. Stability analysis of these deposits reveals that the calculated factor of safety does not meet the minimum requirement during different operation modalities (CSPDR 2020). A slope failure would introduce a large volume of material into the reservoir and reduce its available water storage capacity.

The Project's potential risk from reservoir slope failure during the operation phase will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Excavate and remove the left and right bank deposits along the reservoir margins leaving 10 m high benches and an overall excavation ratio of 1:3.
- Provide bolt-shotcrete and drainage holes to further stabilize these facilities.
- Limit the rate of water level rise or fall to no more than 2.5 m/h during initial reservoir filling and during peaking operations.

These measures will reduce the risk of reservoir slope failure to low. Therefore, the Project's potential risk from reservoir slope failure during operations will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

Spoil Disposal Area Slope Failure

Spoil Disposal Areas #1 and #2 are located on moderately steep slopes that are susceptible to erosion, which can increase the risk of slope failure. Spoil disposal areas often receive little maintenance attention, but, in this case, present potentially significant environmental and social risks if they were to fail.

The Project's potential risk of slope failure at the spoil disposal sites during the operation phase will be direct, adverse, high in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Properly manage uphill drainage in the design of the spoil disposal facilities.
- Conduct regular monitoring and inspection of the spoil disposal areas, especially for the first five years after construction and during and after each monsoon season.
- Provide immediate maintenance and corrective action as needed.

These measures will reduce the risk of slope failure to medium. Therefore, the Project's potential risk from spoil disposal area slope failure during operations will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Substantial***.

7.1.2 Natural Hazards

Natural hazards, as defined herein, include earthquakes, landslides, GLOFs, and flooding. The risks associated with each of these hazards are evaluated below. These natural hazards are not directly or indirectly related to project activities, but are inherent to the project setting (e.g., climatic and geologic forces acting on the terrain), could potentially occur during the construction or operation phases, and represent contextual risk to the Project. This section focuses on the potential effect the Project may have on the severity of these natural hazards.

Avoidance and Minimization Measures

The Project will adopt the following measures to avoid and minimize the risk of natural hazards, in accordance with the application of the mitigation hierarchy:

- Design critical facilities (e.g., dam, powerhouse) to withstand earthquakes, GLOFs, and flooding.
- Avoid disturbance of landslide prone areas.
- Locate several facilities underground (e.g., powerhouse).
- Prohibit the construction of new access roads for transmission tower construction, which will significantly reduce land disturbance and risk of erosion.
- Avoid placement of any transmission towers in natural drainage channels and floodplains.

Construction Phase

Project construction is unlikely to trigger any earthquakes, GLOFs, or floods, and the Project is designed to withstand these hazards. Project construction should not affect the severity of these events. Construction activities will have the potential to trigger landslides or slope failures, especially in the reservoir area, along the project access and service roads, and as a result of vibrations from the use of explosives for tunnelling. A landslide or slope failure could pose risks to structures, agricultural land, and possibly people, depending on the location and severity of the failure.

In summary, the Project's potential impact on the severity of natural hazards during construction will be direct, adverse, potentially high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Contractor will implement the following mitigation measures:

- Limit the size of individual blast charges to reduce the risk of triggering landslides.
- Implement appropriate slope protection measures during construction, taking into consideration site-specific geotechnical and drainage conditions, to reduce the probability and severity of any landslides or slope failures.
- Prepare an Emergency Preparedness and Response Plan describing in detail the procedures the Construction Contractor will put in place in the event of a natural disaster. This plan, which will be prepared by the Contractor and approved by UAHEL, will describe emergency procedures and communication protocols for alerting local villages of any emergency conditions. The Project's ESMP provides minimum requirements for this plan (see Appendix C, ESMP).

Therefore, the Project's potential impact on the severity of natural hazards during construction will be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Moderate***.

Operation Phase

Project operation is unlikely to trigger any GLOFs or flooding, and the Project is designed to withstand these hazards (see Chapter 3 – ***Table 3.7*** Salient Features of the Hydropower Facility). Project operation should not affect the severity of these events.

The project design has considered the earthquake potential in accordance with ICOLD recommendations for the design of the dam and the other appurtenant infrastructure, thus minimizing the risks of dam break-related floods in the downstream areas (***Table 7.1***).

Table 7.1: Hydropower Facility Earthquake Design Criteria

Standard	Reference	Applicable UAHEP Facility	Return Period	Ground Acceleration
Safety Evaluation Earthquake	ICOLD Bulletin 148	Dam	475 years	0.661
Design Basis Earthquake	ICOLD Bulletin 148	Appurtenant structures not related to dam safety	475 years	0.253 (dam) 0.254 (powerhouse)
Operating Basis Earthquake	ICOLD Bulletin 148	Dam appurtenant structures	145 years	-0.146

Source: ICOLD. 2016; Adamo *et al*. 2020.

There is evidence that large hydropower projects can induce seismic activity in some areas, because of the pressure placed on the underlying geology by the water stored in the reservoir, which is referred to as reservoir induced seismicity (RIS). Research suggests that RIS is related to the surface area of the reservoir, depth of the reservoir, and volume of stored water (Baoqi 1992). CSPDR's analysis concluded that the maximum magnitude earthquake resulting from the UAHEP's RIS would be 3.5, which is far less than the Project's Design Basis Earthquake (CSPDR 2020).

In summary, the Project's potential impact on the severity of natural hazards during operation will be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Facility Operator will be required to implement the following mitigation measures:

- Prepare a detailed Emergency Preparedness and Response Plan, which will include the same minimum requirements as described above for the construction phase.
- Coordinate with Chinese government to develop a cross-border approach for an early warning system to improve management of geo-hazards, sediment, and water resources.

These measures should reduce the extent of the impacts. Therefore, the Project's potential impact on the severity of natural hazards during operations will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

7.1.3 Soil

Soil, particularly topsoil, is a highly valued resource in moderately to steeply sloping terrain such as the project impact area, where soil development is slow and erosion risks are high. High quality topsoil is generally limited to a few sites with gentle to moderate slopes.

Avoidance and Minimization Measures

The Project will adopt the following measures to avoid and minimize impacts on soils, in accordance with the application of the mitigation hierarchy:

- Minimize disturbance of steep slopes, which are especially susceptible to erosion, in terms of siting of the access road, hydropower facility, and transmission line facilities.
- Prohibit the construction of new access roads for transmission tower construction, which will significantly reduce land disturbance and risk of erosion.
- Reduce land disturbance by locating some project facilities (e.g., powerhouse, portion of access road) underground.
- Locate transmission towers so that the transmission lines can span stream valleys without requiring forest clearance or disturbance of steep slopes.

Construction Phase

The risks posed to soils from project construction primarily relate to the loss of soils (i.e., soil erosion) and damage to soils (e.g., compaction) such that the soils are not suitable for reuse. Each of these potential impacts are described below.

Erosion and Sedimentation

Although many project facilities will be underground, project construction will still disturb approximately 292.1 ha of land, of which approximately 169.3 ha are forested and 102.4 ha are in agricultural use, with the balance under other land cover (see Section 7.1.11 – Land Cover). Much of this disturbed land will be on steep slopes that are susceptible to erosion and sedimentation, especially during the monsoon season. If not properly managed, this land disturbance could result in significant erosion and down slope sedimentation.

Side casting is a common practice in Nepal where excavated soil is simply pushed off to the side. This practice damages downslope vegetation and crops, causes property damage, and can trigger land instabilities in the form of debris flows, which can undermine the stability of the road or facility being constructed above.

The Project's potential impact on soils during the construction phase will be direct, adverse, high in magnitude, local in extent, and medium term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures to reduce the risk of erosion and sedimentation during construction:

- General mitigation measures:
  - Prohibit the Contractor from clearing or disturbing any land beyond those approved by the Government of Nepal in the EIA and Forest Clearance Permit approvals.
  - Require the Contractor to prepare a detailed Erosion and Sediment Control Plan, with special provisions for controlling all disturbed areas during the monsoon season, for approval by UAHEL and the WB.
  - Implement a grievance mechanism, which will allow local stakeholders to inform UAHEL and the Contractor of any erosion and sedimentation issues. Install approved sediment control measures before initiating land disturbing activities such that drainage from all disturbed areas is directed to a sediment control facility (e.g., silt fence, sediment trap, sediment pond).
  - Preserve as much natural vegetation as possible especially near streams, floodplains, wetlands, steep slopes, and residential areas.

- Remove, store, and seed or cover topsoil, along with associated leaf litter and organic matter, for post-construction land stabilization.
- Manage excavated material by providing silt fencing/straw bales/berms around all topsoil/soil stockpiles and spoil disposal sites prior to commencement of earthworks.
- Prohibit the Contractor from side-casting or discharge to streams of any excavated material. All excavated material must either be re-used as fill material or hauled and properly disposed of at an approved spoil disposal site.
- Provide proper drainage controls to manage water flow through disturbed areas and to direct surface water away from steep slopes or other erodible areas to natural drainage ways.
- Protect exposed slopes by installing cut-off drains above and toe-drains below high cuts and provide terracing as needed so as to avoid the potential concentration of stormwater runoff across disturbed soil.
- Conduct grading, excavation, and slope stabilization in a progressive manner across the site to minimize soil exposure both in terms of area and duration.
- Stabilize disturbed areas as soon as possible in a progressive manner.
- Provide properly designed gabions/retaining walls for all spoil disposal sites.
- Ensure all erosion and sediment control measures are in place and functioning properly before the advent of the monsoon season.
- Provide regular (at least monthly) inspection of all erosion and sediment control structures to ensure they are working properly.
- Provide gravel or concrete pathways along routes expected to receive heavy pedestrian traffic to reduce the risk of erosion.
- Apply the stockpiled topsoil to help stabilize disturbed areas and promote the re-establishment of local native vegetation.
- Use native grass seed and species to vegetatively stabilize disturbed areas; the use of invasive or foreign species is expressly prohibited.
- Restrict vehicular traffic and pedestrian movement over vegetatively stabilized areas.
- Maintain, and repair as needed, the erosion and sediment control facilities until vegetation is successfully established and the disturbed areas are effectively stabilized.
- Provide special sediment control measures to minimize the increase of sediment entering the micro-hydropower plant intakes to avoid affecting the turbines, or provide electricity to the local villages.
- Include an experienced sediment and erosion control inspector as part of UAHEL's Environmental, Social, Health, and Safety (ESHS) Team.

■ Project roads – specific mitigation measures:

- Require the Road Contractor to prepare a Construction Material Sourcing Management Plan to be reviewed and approved by UAHEL and the WB, which will identify sources for all construction material, required permits and approvals, site specific mitigation measures, and restoration plans.
- Strictly enforce the prohibition on side casting of excavated material, which is a common practice in road construction in Nepal; instead, require excess excavated material to be hauled to a designated spoils site.
- Balance earthwork, to the extent possible, to minimize spoil disposal requirements.

  - Reuse rock from tunnel excavation as aggregate for concrete production and for other road construction purposes, to the extent possible.
  - Implement the bioengineering slope stabilization methods proposed by the Road Engineer (KEC 2019a).
- Hydropower – specific mitigation measures:
  - Strictly enforce the prohibition on side casting of excavated material, which is a common practice in dam construction in Nepal; instead, require excess excavated material to be end-hauled to a designated spoils site.
  - Install proposed reinforced gabions to protect downstream riverbanks from water released from the LLO and MLO gates and sediment bypass tunnel (see Section 3.3.2).
  - Protect riverbank stability, especially around the diversion, headrace, and tailrace tunnel inlets and/or outlets, with structural control measures to prevent slope failures.
  - Reuse rock from tunnel excavation as aggregate, for road construction (e.g. for use in gabion retaining walls), and to backfill the Chepuwa Quarry.
  - Ensure Spoil Disposal Areas #3 and #4 are designed with measures to protect the integrity of the facilities from Arun River monsoon flows.
- Transmission line – specific mitigation measures:
  - Limit clearing within the RoW to only those trees approved by the Division Forest Office as necessary to construction the line and trees that pose safety risks to the operation of the transmission line. The tree stumps, root systems, smaller understory trees, shrubs, and the herbaceous layer will be left intact to protect and stabilize the soil from erosion.
  - Prohibit the construction of new access roads to Towers 4–16, which will not otherwise have vehicular access. The Contractor will use existing trails, or establish new narrow trails, that do not require any tree clearing, to minimize soil disturbance and forest clearing.
  - Limit use of mechanized construction equipment for Towers 4–16, which will not have vehicular access. For these towers, manual excavation will be conducted.

Even with these mitigation measures in place, erosion and sedimentation remain a medium magnitude risk given the size of the area to be disturbed, proximity to the Arun River and other streams, presence of steep slopes, and the high rainfall, especially during the monsoon season. Therefore, the Project's potential impact on erosion and sedimentation during the construction phase will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of ***Moderate***. Robust monitoring and maintenance of erosion and sediment control measures will be necessary to effectively manage this risk.

Soil Compaction and Damage

Project construction could damage soils, especially topsoil, primarily as a result of soil compaction from the construction of buildings or the use of heavy equipment. This damage could affect the ability to return agricultural and other lands back to their original use and productivity after completion of construction. Approximately 102.4 ha of agricultural land will be disturbed during project construction, although most of this agricultural land will be converted to project uses and, thus, not reused for agricultural purposes.

In summary, the Project's potential impact on soils during construction will be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following measures to conserve soil resources at the site:

- Prohibit the Contractor from clearing or disturbing any land beyond those approved by the Government of Nepal in the EIA and Forest Clearance Permit approvals.
- Install and maintain approved erosion control measures before initiating land disturbing activities to protect soil resources.
- Remove, store, and cover topsoil, along with associated leaf litter and organic matter, for post-construction land stabilization.
- Apply the stockpiled topsoil to help stabilize disturbed areas and promote the re-establishment of local native vegetation.
- Aerate compacted soils and provide soil amendments (e.g., fertilizer) as needed to restore the productivity of agricultural soils.

These measures will reduce the magnitude of the impact on soil resources to low and the extent to site-specific. In summary, the Project's potential impact on soil resources during the construction phase will be direct, adverse, low in magnitude, site-specific in extent, short term in duration, with an overall residual significance of ***Low***.

Operation Phase

There will be little if any additional land disturbance during the operation phase, so impacts on soil should be negligible.

Erosion and Sedimentation

The Construction Contractor will be required to stabilize all disturbed areas and restore them to their pre-construction condition as part of the construction close-out activities (see Section 3.4.4), and there will be no new ground disturbing activities during operation, so the only erosion and sedimentation issues should be related to maintenance and repair of slopes that become unstable. The Project's potential impact on erosion and sedimentation during the operation phase will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures consistent with international good practice:

- Conduct regular inspections and correct and drainage that may be contributing to soil erosion and stabilize/restore any identified eroding areas using appropriate vegetative or structural stabilization measures.
- Avoid any ground-disturbing maintenance activities.

Therefore, the Project's potential impact on soils during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

7.1.4 Hydrology

Hydropower projects will intrinsically affect water resources and hydrology as they use water to generate electricity. This section evaluates the Project's effects on flow in the Arun River, on springs and small streams as a result of tunnel excavation, and on rivers and streams as a result of project water demands.

Avoidance and Minimization Measures

The Project will adopt the following measures to avoid or reduce impacts on hydrology, in accordance with the application of the mitigation hierarchy:

- Adopt a PRoR operation mode with a relatively small reservoir storage volume, which reduces Project impacts on hydrology as compared to large water storage or peaking hydropower operations. The Project's ability to affect river flow is often measured as a Degree of Regulation, which is defined as the ratio between the total reservoir storage and the average annual flow volume at the project site. The EIB considers a Degree of Regulation greater than 5% as significant. The UAHEP has a Degree of Regulation of 0.07%, taking into consideration a total storage volume of 5.07 million m3 and an average annual flow of 217 m3, which is quite low.
- Avoid transmission line impacts on floodplains, rivers, streams, and springs by spanning these waterbodies in all cases.

Construction Phase

Effects on Arun River Flow

During the construction phase, the Contractor will construct a 490 m long diversion tunnel with a capacity of 257 m^3/s, which will be used to divert Arun River flow to allow construction of the Project dam. Flows in excess of 257 m^3/s will initially be allowed to overtop the dam foundation and in later stages of construction will flow through open gates. During construction, the rate of flow in the Arun River downstream from the dam should remain relatively unchanged, as flow will be diverted through the diversion tunnel, although there may be some slight attenuation of high flows greater than 257 m^3/s.

As project construction is completed, the diversion tunnel will be plugged and the reservoir filled, which is scheduled to occur in late February of the sixth year of construction. Assuming mean monthly February flow at the dam site (54.1 m^3/s), and allowing for the required Environmental Flow (EFlow) release of 5.41 m^3/s, it will only take approximately 34 hours to fill the proposed reservoir's 5.97 million m^3 of gross storage volume at FSL. For slope stability reasons, the reservoir can be filled at a rate of no more than 2.5 m/hr, which would equate to about 36 hours for a 91 m high dam. In either case, it will take less than two days for mean February flows to fill the reservoir.

The Project will also construct a bridge for the project access road across the Arun River. The bridge is designed to provide a 3 m freeboard above the 100-year floodplain (see ***Table 3.2***), so should have no effect on Arun River flow.

Therefore, the project effects on Arun River flow during the construction phase will be direct, adverse, low in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following measure, consistent with international good practice:

- Ensure there will be no interruption in downstream flows and provide a minimum flow equal to at least the proposed EFlow (5.41 m^3/s) at all times, including during reservoir filling. Section 7.2 provides a more detailed rationale for the proposed EFlow.

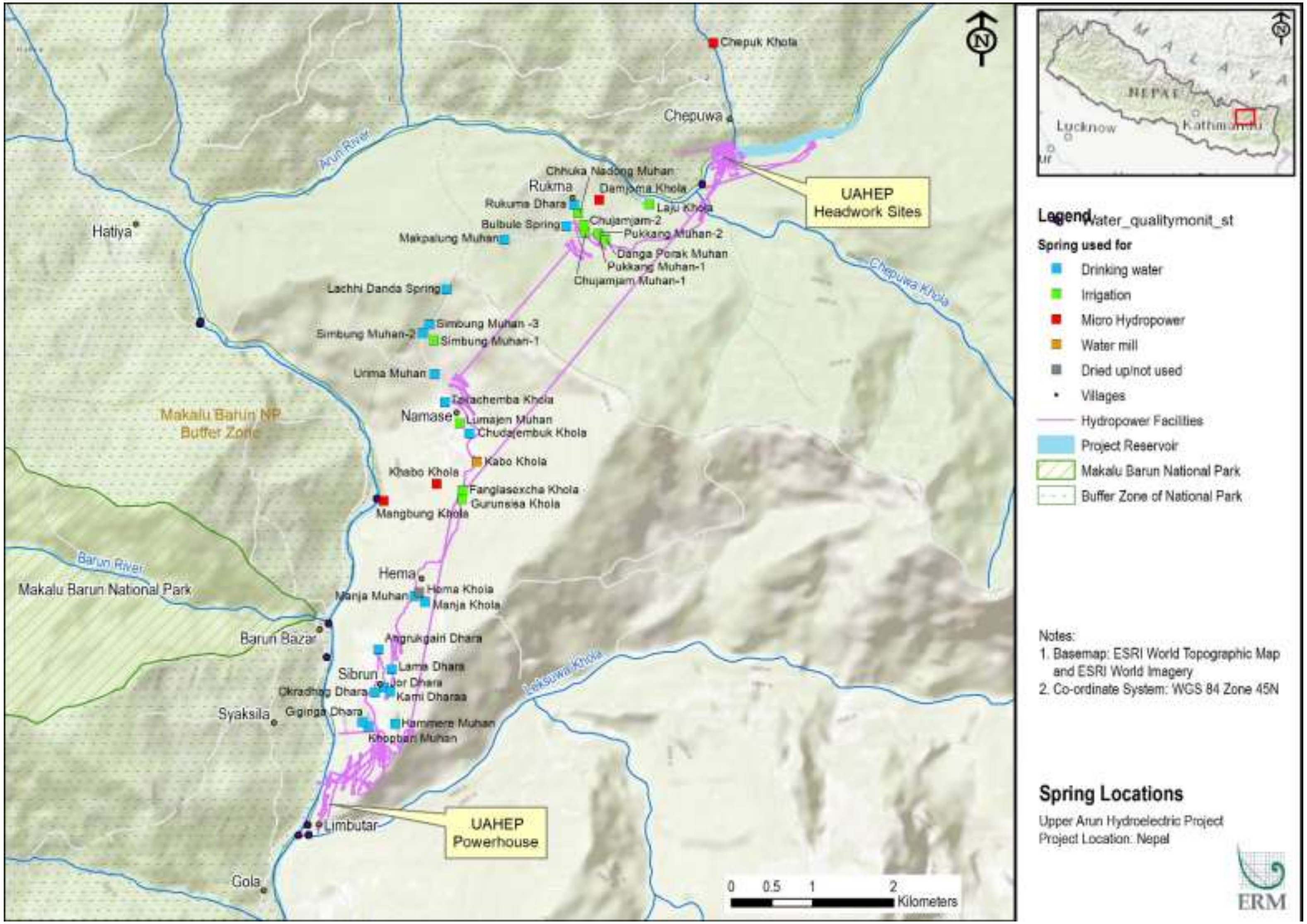
In summary, the Project's potential impact on Arun River flow during construction will be direct, adverse, low in magnitude, site-specific in extent, short term in duration, with an overall residual significance of ***Low***.

Effects of Tunnelling on Local Springs

The Project has the potential to affect flow in at least some springs within the project DIA, as a result of the access road tunnel, headrace tunnel, and powerhouse cavern, as well as other underground excavation. The project access road itself is not considered a risk, as all potentially affected springs are located upslope from the access road.

The construction of these facilities could intercept a fault/fracture zone. As the groundwater pressure head can be quite high for these facilities, as they have in some cases over 1,000 m of overlying rock, there is the risk of encountering high-pressure seepage during excavation. This seepage into the excavation areas could lower the groundwater table, thereby reducing or eliminating flow in some overlying springs or streams within the zone of influence. The construction of these tunnels using drill and blast techniques could also result in some localized fracturing of rock, which could create a preferential groundwater flow path that could also reduce or eliminate flow in some springs and streams. ***Figure 7.4*** shows the Project tunnels relative to the location of springs and streams that local communities rely on for drinking water, irrigation, micro-hydropower generation, mills, and other purposes. Note that in several cases, the “spring” location shown in ***Figure 7.4*** actually reflects the location of the spigot used by local residents, with the actual spring being located farther upslope. See ***Table 6.8*** for additional information on the springs and streams shown in ***Figure 7.4***.

Figure 7.4: Location of Project Tunnels relative to Local Springs and Stream



The access road tunnel primarily extends through gneiss and schist, both of which are metamorphic rocks, which typically have very low groundwater primary porosity (i.e., the empty space between crystals that can hold water). These rocks are typically strong, but are still susceptible to fracturing and weathering, which can create preferential flow paths through which groundwater can move. As ***Table 7.2*** indicates, most of this rock is fresh (unweathered) or only slightly weathered, indicating that weathering is unlikely to have increased the rock's porosity, which is consistent with the fact that the tunnel lies below as much as 700 m of rock overburden. Further, geological mapping has not identified any regional or small-scale faults near the access road tunnel. Finally, the access road tunnel does not pass under any known springs. Therefore, the access road tunnel is not expected to result in any drawdown of the groundwater table or dewatering of springs used by local villages.

Table 7.2: Access Road Tunnel Geology Characteristics

Tunnel Stations	Length (m)	Rock Type	Weathering Pattern
14+163 to 14+700	537	Gneiss/quartzite/amphibolite	Fresh to slightly weathered
14+700 to 15+250	550	Gneiss/schist	Fresh to slightly weathered
15+250 to 15+350	100	Schist/gneiss	Fresh
15+350 to 16+223	873	Schist	Slightly weathered

Source: *Road Tunnel Final Report*, Table 4.13 (KEC 2019a)

The headrace tunnel lies below 30 to 1,315 m of overlying rock, with the groundwater table generally 100 to 620 m above the tunnel, except at the intake and end section. The permeability of the overlying rock (primarily gneiss) is low, although there are four small fault and fracture zones present that likely transmit groundwater, referred to as F21 to F24. The headrace tunnel ranges in elevation from about 1,611 m at the headworks to 1,578 m at the surge tank near the powerhouse and passes under or near several springs and streams used by local communities (see ***Table 7.3***). The risk of groundwater drawdown is greatest for Fanglasexcha and Gurunsisa kholas. The project design calls for the headrace tunnel to have a reinforced concrete lining. Selective backfill grouting will also be used to manage infiltration into the tunnel.

Table 7.3: Proximity of the Headrace Tunnel to Springs and Streams

Spring/Stream	Spring or Stream	Water Uses	Horizontal Distance	Vertical Distance (Headrace Tunnel to Spring)
Khabo Khola	Stream	Water mill	~80 m	226 m below
Fanglasexcha Khola	Stream	Irrigation	~10 m	178 m below
Gurunsisa Khola	Stream	Irrigation	~45 m	236 m below
Hema Khola	Stream	None	~160 m	152 m below
Manja Khola	Piped spring	Potable	~220 m	142 m below
Manja Muhan	Piped spring	Potable	~90 m	205 m below
Hammere Dhara	Piped spring	Potable	~180 m	68 m above

The powerhouse cavern and access tunnel will be excavated into bedrock and will be overlain with about 300 to 400 m of fresh to slightly weathered gneiss rock and will have one small scale fault (i.e., F22) within 10 m of the cavern wall. This cavern and access tunnel are near Hammere Muhan, Khopbari Muhan, and Jijinkha Dhara, which collectively provide potable water to about 16 households.

There is the potential that the Project could reduce flow in these or other local springs and streams, at least during the dry season. This is very difficult to confidently predict, as it would require an extensive network of geologic borings to map faults and fractures to create a three-dimensional geologic map of the tunnel areas.

In summary, the Project's potential impact on springs during construction, as a result of tunnel construction, will be direct, adverse, high in magnitude, local in extent, and short term in duration, with a pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The flow in the springs has been measured as part of the baseline study (see ***Table 6.8***). Flow in these springs will vary seasonally, but any significant reduction in flow beyond what would be expected based on monitoring can be documented. UAHEL will implement the following mitigation measures:

- Apply engineering controls such as grouting and reinforced concrete lining to reduce or eliminate seepage into the excavated area (these will be applied immediately even before any documentation of reduced flows in the springs.
- In the event that the Project does affect flow in these springs, UAHEL will:
  - Provide potable water to all affected households on a temporary basis until it is determined if flow in the springs will be restored during project operations, at no cost to the affected households.
  - Provide power to replace any reduction in micro-hydropower generation or mill operation on a temporary basis until it is determined if flow in the springs will be restored during project operations, at no cost to the affected households.

In summary, the Project's potential impact on springs and stream flow during construction, as a result of tunnel construction, will be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Moderate***.

Effects of Construction Phase Water Demands

Construction of the project access road, hydropower facility, and transmission line will each have unique water demands, as described below.

Access Road

Construction of the access road, tunnel, and bridge will require the following total amounts of water for concrete production:

- Road work – 470 m^3 of water: The road water demand will primarily occur during the second year of construction. By this time, the road track will be opened and graded and water can be transported to the locations where water will be needed by water tankers.
- Tunnel work – 275 m^3 of water: Similar to the road work above, the tunnel water demand will primarily occur during the second year of construction, once the tunnel excavation has been completed. Therefore, water can be transported to the tunnel by water tankers.
- Bridge work – 330 m^3 of water: There is more than sufficient water available in the Arun River and Chepuwa Khola to meet this water demand without any downstream effects.

Sourcing water locally from the small streams found along the route instead of from the Arun River or Chepuwa Khola, however, could conflict with the use of these streams by various villages and households for potable or irrigation water and/or could reduce water available for the operation of mills and micro-hydropower projects found along the access road route.

Hydropower Facility

Construction of the hydropower facility will require potable water for workers as well as water for concrete production. The Project proposes to construct two water treatment plants, one in the headworks area and one in the powerhouse area, to meet the Project's water demands. The water will be sourced from

Chepuwa Khola for the headworks area and Leksuwa Khola for the powerhouse area. The Arun River will not be used as a potable water source, as it has much higher turbidity levels and would require much more significant and expensive treatment to bring the water to an acceptable quality. There is ample water available in Chepuwa Khola and Leksuwa Khola to meet these water demands.

Transmission Line

The water demand for transmission line construction is small, primarily just water needed to hand mix with cement and aggregate to form concrete for the transmission tower foundations. This water will be sourced from Leksuwa Khola and transported to the tower sites.

Summary

The impact of the Project's water demands during the construction phase will be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

Although the impact of the Project's water demands is considered low, the Project will implement the following measures, consistent with international good practice:

- Limit sourcing water for access road construction to only the Arun River, Leksuwa Khola, Chudajembuk Khola (downstream from the point where households in Namase obtain water), Laju Khola, and Chepuwa Khola. Avoid sourcing water from other streams used by local villages for potable water, and mill and micro-hydropower operation.

Implementation of this measure will reduce the magnitude of the impact to low. Therefore, the Project's potential impact on hydrology from water demands during construction will be direct, adverse, low in magnitude, site-specific in extent, short term in duration, with an overall residual significance of ***Low***.

Operation Phase

The Project will have the following effects on hydrology during the operation phase.

Effects on the Arun River

The UAHEP will operate in a PRoR mode, with essentially no net water storage on a daily basis (i.e., all inflow into the reservoir will be discharged on a daily basis, with only temporary storage to allow daily peaking operations). This operations regime will affect flow in the Arun River differently upstream from the project dam, in the diversion reach, and downstream from the powerhouse. Each of these effects are evaluated below. The potential effects of project operations on hydrology are primarily related to aquatic ecology (Section 7.2.4), water uses (Section 7.3.5), and public safety (Section 7.3.11) and are discussed in those sections. Therefore, a separate significance rating is not provided for these hydrology impacts in this section.

Upstream from the UAHEP Dam

The Project will have no effect on Arun River flow or the hydrology upstream from the project dam. The dam, however, will create a 2.1 km long reservoir with a surface area of 20.1 ha. The peaking operation will result in up to 15 m of water level fluctuations within the reservoir on a daily basis. During high flows during the monsoon season (i.e., flows larger than or equal to 575 m^3/s), the Project will operate in a sediment flushing mode, which could lower water levels by approximately 40 m for two days, before gradually refilling the reservoir. The Project will conduct long-term hydrological monitoring of the Arun River inflow into the reservoir.

Diversion Reach

The Project will have its most significant effect on flow along the 15.6 km long diversion reach between the UAHEP dam and the powerhouse. ***Table 7.4*** shows the project effects on mean monthly flows in the diversion reach immediately below the dam, which indicates flows will be reduced by over 90%

during the dry season (October to May) and between 39–79% during the monsoon season (June to September), as all flows up to the powerhouse's hydraulic capacity of 235.4 m^3/s, except for the required EFlow release of 5.41 m^3/s (see EFlow Assessment, Artelia and Hydolab 2024), will be diverted to the powerhouse and bypass the diversion reach.

Table 7.4: Historic and Proposed Arun River Flow Immediately Downstream from the UAHEP Dam Site

Month	Historic Mean Monthly Flow (m^3/s)	Proposed Mean Monthly Flow (m^3/s)	Percent Flow Reduction (%)
January	54.1	5.41	90%
February	56.3	5.41	91%
March	62.8	5.41	91%
April	71.1	5.41	92%
May	113	5.41	95%
June	304	63	79%
July	529	288	46%
August	615	374	39%
September	460	219	52%
October	193	5.41	97%
November	75.5	5.41	93%
December	60.5	5.41	91%

The Project will continuously release the EFlow of 5.41 m^3/s from the dam (through the Eco-Flow Power Station) to the diversion reach at the toe of the dam. The diversion reach will also benefit from inflow from major tributaries (Chepuwa Khola, Barun River), as well as from minor tributaries and groundwater, which collectively contribute an additional 13.0 m^3/s to the diversion reach during the lowest mean monthly flow, and more during other months of the year.

Downstream from the UAHEP Powerhouse

Flows in the section of the Arun River downstream from the UAHEP powerhouse to the headwaters of the Arun-3 HEP reservoir, which is approximately 11.8 km downstream, will vary significantly during the dry season (October to May), as a result of the Project's PRoR operations. The most extreme fluctuation in downstream flows will occur during the periods with the lowest flows in the Arun River (i.e., December through April), when the Project will be operating almost exclusively in a peaking mode. At its most extreme (i.e., during January, which has the lowest mean monthly flow), only about 18 m^3/s of flow from the diversion reach would be reaching the tailrace area when the Project is not peaking (i.e., 5.41 m^3/s from EFlow, 0.49 m^3/s from Chepuwa Khola, 9.34 m^3/s from Barun River, and 3.17 m^3/s from other inflow). During the dry season, peaking operations are planned from 18:00 to 24:00 hours daily. When peaking operations begin, the flow in the Arun River immediately downstream from the tailrace will nearly instantaneously increase from 18 m^3/s to 155 m^3/s (i.e., 18.4 m^3/s baseflow + 155 m^3/s powerhouse discharge). This increased flow will continue until 24:00 hours (midnight), when peaking operations terminate, and then the powerhouse discharge will cease and the flow in the river will return to the baseflow of 18 m^3/s.

Under worse-case average January flow conditions, Hydrologic Engineering Center's River Analysis System (HEC-RAS) modelling indicates that peaking operations will quickly raise water depths, velocities, and the wetted area in the 11.8 km reach from the powerhouse to the Arun-3 HEP reservoir headwaters. ***Table 7.5*** compares natural flow conditions (i.e., no UAHEP) with baseflow (no peaking) and peaking flow conditions downstream from the tailrace. The peaking discharge will create a medium (average of about 1.2 m high) “wave”, which will travel downstream until it reaches the Arun-3 HEP headwaters (cross-section 3), which is predicted to take about 96 minutes from when peaking operations begin.

Table 7.5: Project Effects on Downstream Flow during Peaking under Low Flow Conditions

Flow Scenarios[1]	Mean January Monthly Flow (m^3/s)[2]	Mean Water Depth (m)[2]	Mean Water Velocity (m/s)[2]	Mean Wetted Area (ha)[2]
Natural flow	74.0 (0%)	0.9 (0%)	2.8 (0%)	34.9 (0%)
Baseflow	25.3 (-66%)	0.6 (-33%)	2.0 (-29%)	24.9 (-29%)
Peaking flow	260.7 (+352%)	1.8 (+100%)	4.3 (+54%)	43.4 (+24%)

[1] Natural flow (67.1 m^3/s), baseflow (18.4 m^3/s), and peaking flow (253.8 m^3/s) at the tailrace have been increased to account for downstream inflow from Leksuwa Khola (2.6 m^3/s) and Ikhuwa Khola (4.3 m^3/s).
[2] Mean water depths, velocities, and wetted areas include cross-section 3 to 25)

Figures 7.5, 7.6, and ***7.7*** show changes in water depth, velocity, and wetted area during peaking at cross-sections from the UAHEP powerhouse (cross-section 25) to the Arun-3 HEP dam (cross-section 1) under low flow conditions (average January monthly flow of 54.1 m^3/s).

Figure 7.5: Project Effects on Downstream Water Depths during Peaking under Low Flow Conditions

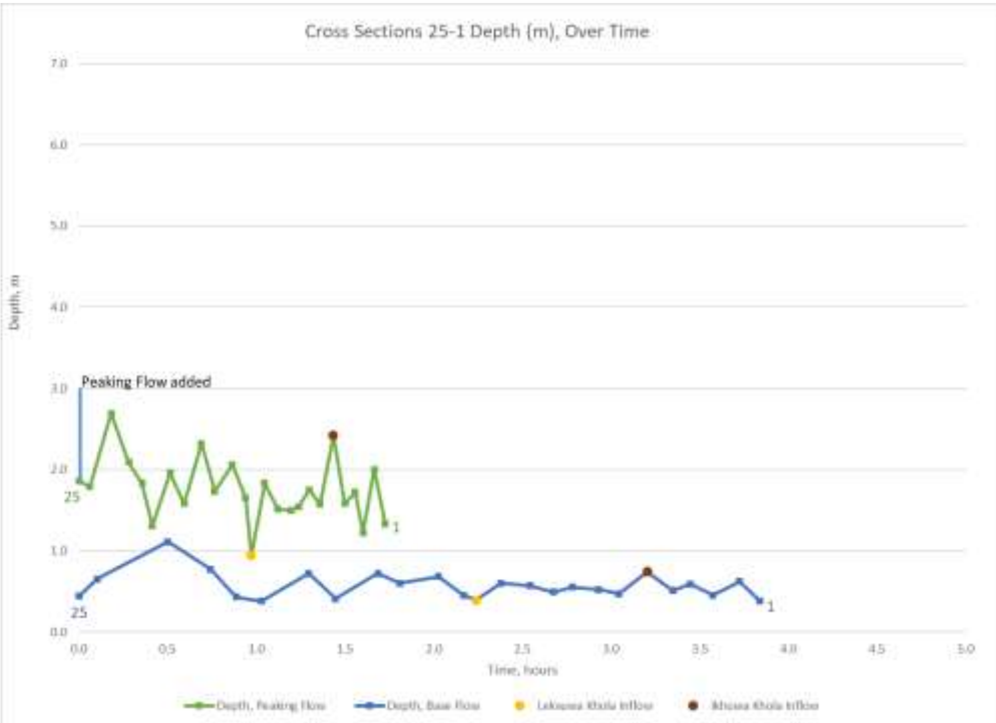


Figure 7.6: Project Effects on Downstream Water Velocities during Peaking under Low Flow Conditions

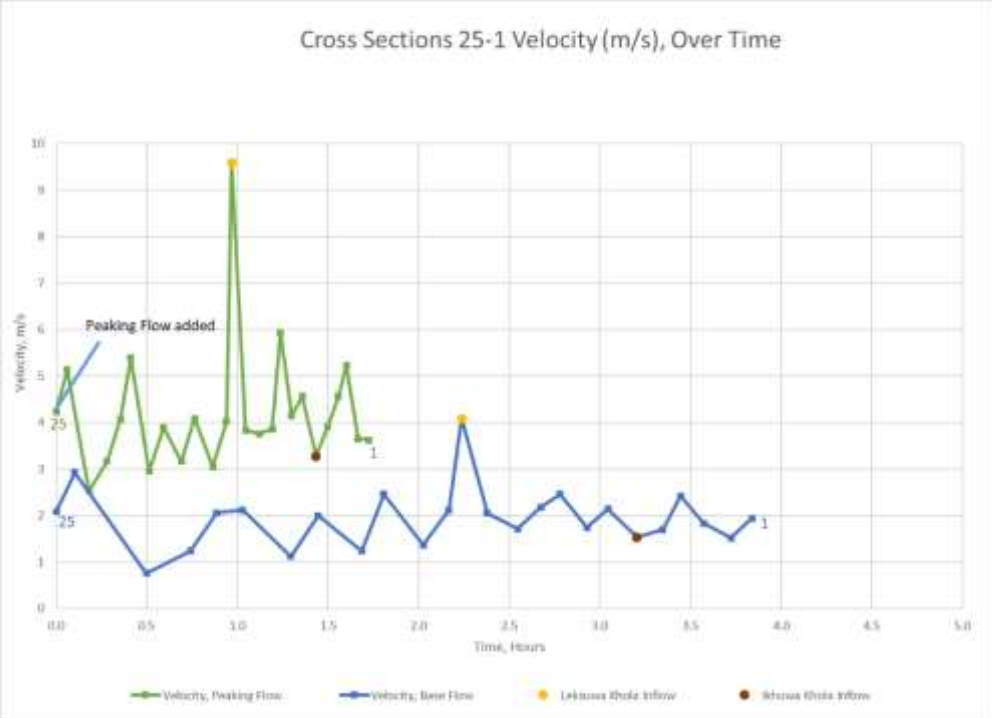
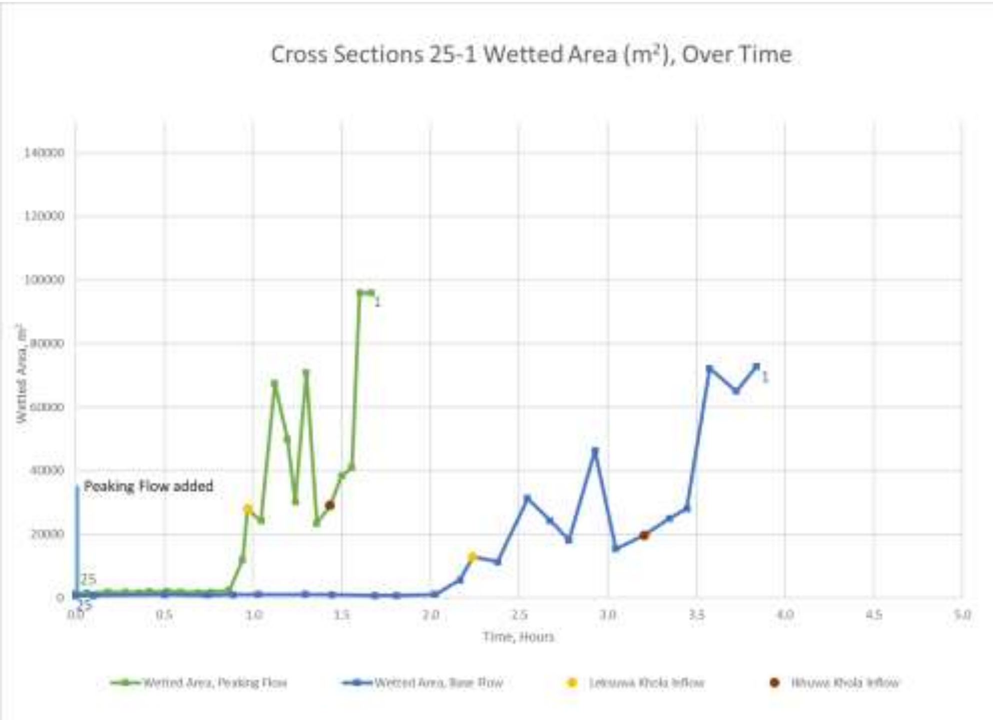


Figure 7.7: Project Effects on Wetted Area during Peaking under Low Flow Conditions



As ***Table 7.5*** and these figures indicate, peaking operations under worst case low flow conditions will result in daily fluctuations of flow (235 m^3/s), water depths (1.2 m), velocities (2.3 m/s), and wetted area (9,124 m^2).

Project operations will have no transboundary effect on flows downstream in India because:

- The Project will operate in a PRoR mode on a daily basis with very limited water storage.
- Although the Project with operate as a peaking facility on a seasonal basis, the effects of peaking will be attenuated both by the operations of the downstream Arun-3 HEP and the approximately 200 km distance to the India border.

In summary, the Project's impact on Arun River flow during operation has the potential to be direct, adverse, high in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following measures, consistent with international good practice:

- Provide a continuous, uninterrupted EFlow of at least 5.41 m^3/s. (Section 7.2 provides a more detailed rationale for the proposed EFlow).
- Conduct a continuous program of downstream monitoring to include flow as well as environmental and social impacts (also see Section 7.2.4 and 7.3.5).

In summary, the Project's potential impact on Arun River flow during operation will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Substantial***.

Effects of Tunnelling on Local Springs

Any project effects on local springs as a result of underground excavation should be observed during construction. Nearly all of the tunnels with the potential to affect springs are low pressure tunnels, which means there will still be potential for the tunnels to continue to drawdown groundwater elevations during operations (i.e., a high pressure tunnel would tend to exfiltrate water, whereas a low pressure tunnel can infiltrate water). As indicated above, the Contractors will use grouting and reinforced concrete to reduce or eliminate groundwater seepage into the tunnels and caverns. If these measures are not effective, then the Project may have a permanent effect on flow in at least some springs within the project DIA.

In summary, the Project's impact on springs during operation as a result of tunnel construction has the potential to be direct, adverse, high in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

If monitoring of the springs documents a reduction in flow, the Project will implement the following proposed mitigation measures:

- Provide a permanent alternative source of water to the affected households or villages. The Project already includes two permanent water treatment plants (one each in the powerhouse and headworks areas) with the capacity to meet local water demands, along with a water distribution system that extends from the headworks water treatment plant to Contractor's Camp #1 near Rukma, and from the powerhouse water treatment plant to Contractor's Camp #2 at the Headrace Tunnel Adit near Hema. Therefore, the infrastructure will be in place, with only minor extensions required, to provide water to any local village in the event that the Project affects local streams. This water will be provided at no cost to affected households (i.e., this would be a project cost).
- Provide power to replace any reduction in micro-hydropower generation or mill operation, at no cost to the affected households.

In summary, the Project's potential impact on springs and stream flow during operations as a result of underground excavation will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

Effects of Operation Phase Water Demands

The access road and transmission line will have no ongoing water demands during the operation phase. Water demand for the operation of the hydropower facility will be limited to the potable water needs of the operations workforce, which is estimated at approximately 130 workers (see Section 3.6.2), and miscellaneous water demand for cleaning and other maintenance purposes. This demand is estimated at no more than 10,000 liters/day. The Project will construct two permanent water treatment plants (one at the headworks and one at the powerhouse area), which will withdraw water from Chepuwa Khola and Leksuwa Khola, respectively, and will be operated by UAHEL. These streams have ample supply to meet this demand without any adverse effects on other local uses (i.e., the lowest monthly mean flow in Chepuwa Khola, the smaller of the two water sources, is 0.49 m^3/s, or about 42 million liters/day).

The potential Impacts from the Project's water demands during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation Measures and Residual Significance

No additional mitigation measures are proposed and the residual significance of the Project's potential impact from project operational water demands remains ***Low***.

7.1.5 Sediment

Hydropower projects intrinsically affect sediment transport dynamics in rivers, as they modify flow velocities (and their associated sediment transport capacity). This section evaluates the project effects on sediment transport within the Arun River.

Avoidance and Minimization Measures

The Project did not identify any avoidance or minimization measures to reduce impacts on sediment management, although it has adopted a sediment management strategy, which is described below.

Construction Phase

The Project will have negligible effect on sediment transport and deposition patterns in the Arun River during construction as the river flow is diverted through the SBT and the LLO gates with little water storage or retention time.

Therefore, the Project's potential impact on sediment transport during construction will be direct, adverse, low in magnitude, site-specific in extent, short term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

No additional mitigation measures have been identified or are proposed and the residual significance of the Project's potential impact on sediment transport and deposition patterns in the Arun River during construction remains ***Low***.

Operation Phase

The Project has the potential to affect sediment transport in the Arun River upstream from the dam and downstream from the dam, in both the diversion reach and below the powerhouse.

Sediment Deposition in the UAHEP Reservoir

The Arun River is glacier fed and transports a high sediment load with a long-term annual average of 16.24 million tons, or 14.73 tonnes (13.81 million tons [12.53 million tonnes] of suspended sediments and 2.43 million tons [2.20 million tonnes] of bedload sediment). The project dam has the potential to cause this sediment to be deposited within the reservoir, which could reduce its ability to operate in a peaking mode and reduce the Project's useful lifespan and sustainability. The trapping of these sediments in the reservoir would also deprive the downstream reach of this sediment and disrupt the river's sediment balance.

Therefore, the Project's potential impact on sediment deposition in the Project's reservoir during the operation phase could be direct, adverse, high in magnitude, regional in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

Section 3.6.2 describes the Project's sediment management strategy, which essentially involves using the SBT to divert high sediment loads associated with flows less than 575 m^3/s, opening the LLO gates to flush accumulated sediments when flows are equal to or greater than 575 m^3/s, and opening the MLO gates to sluice sediments during flood events without needing to draw down the reservoir.

Sediment transport modeling indicates that sediment deposition will occur rapidly within the reservoir with the initiation of project operations, reducing reservoir capacity. After about three years, and applying the proposed sediment management strategy, the silting and scouring of sediment in the reservoir will reach an equilibrium condition, with only about 19% of the reservoir's storage volume lost to sedimentation. This volume lost to sediment deposition fluctuates on an annual basis based on the river's sediment load, but only ranges from 14 to 26% of the gross storage volume at the end of each of the 78 years modeled. This suggests that the Project's proposed sediment management strategy will be effective.

The sediment modeling also indicates that the Project will have little effect on sediment loads downstream, and negligible effect on transboundary sediment transport to India, as the Project's equilibrium sediment volume only represents about 0.08% of the Arun River's sediment transport over the 78 years modeled at the dam, and a much lower percentage at the India border.

Therefore, the Project's potential impact on sediment deposition in the Project's reservoir during the operation phase will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

Sediment Transport and Deposition Downstream from the UAHEP Dam

Because of the sediment deposition that could occur within the reservoir, the Project could reduce the delivery of sediment to the diversion reach and downstream from the powerhouse, which would disrupt the natural sediment balance in the river and potentially cause geomorphic changes (e.g., erosion of riverbanks).

Therefore, the Project's potential impact on sediment transport and deposition downstream from the UAHEP dam during the operation phase could be direct, adverse, high in magnitude, regional in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measure:

- Implement the project sediment management strategy.

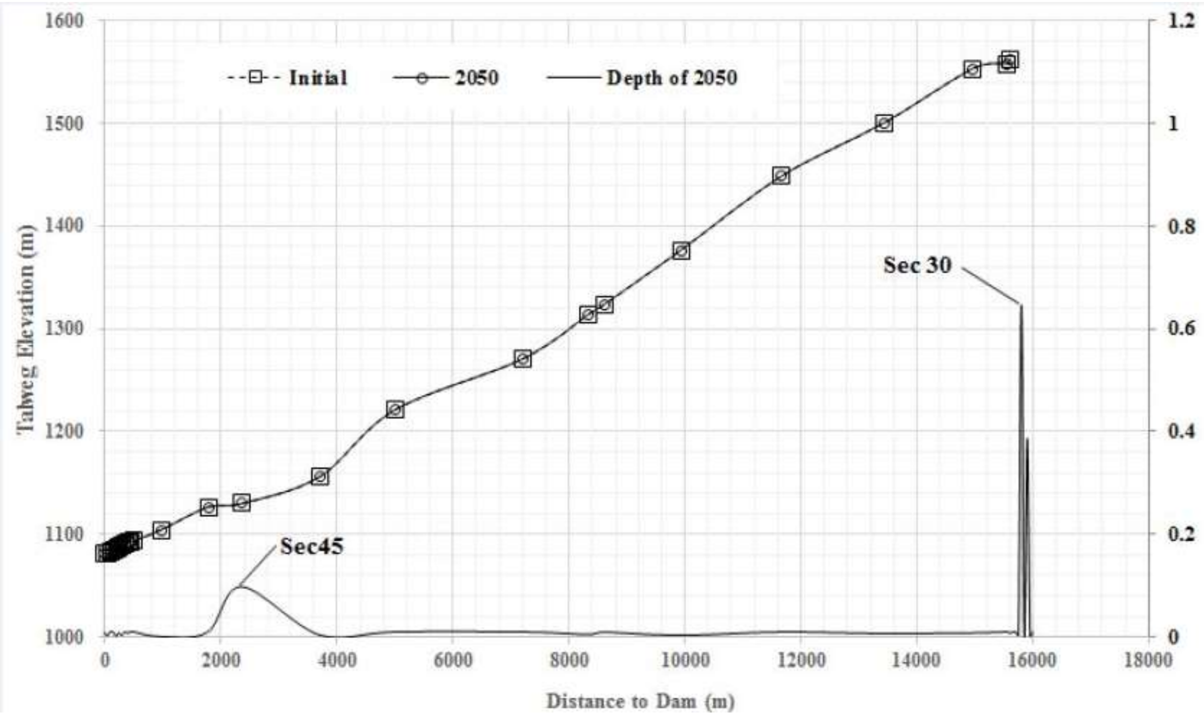
As described in Section 3.6.2, the sediment management strategy will use the SBT and the LLO gates to bypass and flush sediments, respectively, from the reservoir. The MLO gates will be used for sediment sluicing during flood events without drainage of the reservoir. The SBT is expected to primarily bypass suspended solids and project operations should not affect the transport capacity of this flow, so no significant change in sediment deposition is anticipated as a result of SBT flows. The fate of sediments flushed from the LLO gates over a 78-year period was modelled using the U.S. Bureau of Reclamation Sediment and River Hydraulics-One Dimension (SRH-1D) model.

The model results indicate that the cumulative amount of sediment deposition in the diversion reach will be small, with little change in the thalweg cross-section or depth (***Figure 7.8***). There are only two areas that will incur any appreciable sedimentation, which are just below the dam near the SBT outlet (0.64 m of deposition at SRH-1D cross-section 30) and in a flat pool area just above the confluence with the Barun River (0.1 m of deposition at SRH-1D cross-section 45).

Project operations are also unlikely to result in increased sediment deposition in the reach downstream from the UAHEP powerhouse. During the monsoon season, when over 95% of the river's annual sediment load occurs, the Project will be operating in a RoR mode, as inflow exceeds the Project's hydraulic capacity, and will be using the SBT and LLO, and to a lesser extent the MLO, to bypass and flush sediments, so there will be no meaningful change in flow conditions or sediment transport capacity.

Therefore, the Project's potential impact on sediment transport downstream from the dam and deposition within the diversion reach during the operation phase will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

Figure 7.8: Sediment Deposition in the Diversion Reach



7.1.6 Water Quality

Hydropower projects can affect water quality by modifying river flow (i.e., creating a reservoir), discharging pollutants into the river, and the potential for spills of hazardous materials. These potential impacts are described below.

Avoidance and Minimization Measures

The Project will adopt the following measure to avoid or reduce impacts on water quality, in accordance with the application of the mitigation hierarchy:

- Adopt a PRoR operation mode with a relatively small reservoir storage volume, which reduces the risk of reservoir stratification and potential for eutrophication, as compared to large water storage or peaking hydropower operations.

Construction Phase

Construction of the project access road, hydropower facility, and transmission line all have the potential to impact water quality. These impacts primarily relate to stormwater runoff, wastewater disposal, solid waste disposal, and hazardous materials/waste management.

Stormwater Runoff

The Project will generate stormwater runoff from various facilities, including project roads, workers' camps, fuel depots, crusher plants, batch plants, fabrication shops, maintenance yards, and spoil disposal areas, as well as from potential seepage from tunnel portals. This stormwater can carry various contaminants, including oil, grease, and metals, which can degrade water quality. There is also the risk that the excavated spoil could include rock with the potential for causing acid rock drainage. In addition, groundwater intercepted from tunnel excavation can have elevated levels of dissolved and suspended solids. The water quality of these project-affected streams will be degraded. Although they should still be suitable for irrigation purposes, these streams should not be used for any potable uses, at least without appropriate treatment. There are several open (unpiped) springs and streams currently used for potable water located downstream from proposed construction areas that may be exposed to project-related stormwater runoff (e.g., Chudajembuk Khola used by 55 households near Namase, Okradhag Dhara used by four households near Sibrun, Khopbari Muhan used by one household near Jijinkha).

Therefore, the Project's potential impact on water quality from stormwater runoff during the construction phase will be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation Measures and Residual Significance

The Contractor will be required to prepare a Stormwater Management Plan describing in detail the methods it will use to minimize impacts on water quality. At a minimum, the Contractor will be required to implement the following mitigation measures to avoid or minimize potential water quality risks from stormwater runoff:

- Workers' camps and crusher plant:
  - Ensure all drainage from these facilities is directed to one or more stormwater basin to allow settling of suspended solids prior to discharge.
- Batch plant specific mitigation measures
  - Store bagged cement on an impervious surface in a covered area to prevent exposure to water.
  - Direct all drainage from the batch plant, including concrete trucks wash water, to one or more stormwater basins prior to discharge. The basin(s) will be regularly maintained to maintain storage volume and the pH tested on a regular basis, as the runoff can be highly alkaline (i.e.,

high pH). Treat water in the basin for high pH with a neutralizing acid (e.g., muriatic acid), as needed before discharge to a receiving stream.

- Fuel depot, maintenance shops, and fabrication shops:
  - Provide an impervious surface and covered area for all work spaces.
  - Use a drip tray to collect oil and grease during vehicle maintenance.
  - Repair any leaking vehicles or equipment immediately.
  - Direct all drainage potentially exposed to oil and grease to an oil/water separator.
  - Ensure all drainage from the crusher plant is directed to one or more stormwater basins to allow settling of suspended solids prior to discharge.
- Spoil disposal areas:
  - Redirect surface drainage around the spoil disposal areas.
  - Provide a settling basin for drainage from the spoil disposal areas.
  - Test the pH of the water in the settling basins and add neutralizing material (e.g., lime) if any evidence of acidic conditions, which can promote the mobilization of metals.
  - Pipe flow from Chudajembuk Khola below Road Contractor's Spoil Disposal Area #4, which is the only spoil disposal area over a stream.
- Tunnel portals:
  - Construct a stormwater basin near each tunnel portal and direct any intercepted groundwater to the basin to allow settling of suspended solids prior to discharge. Test the pH of water in this basin and add neutralizing acid if tunnel seepage has been contaminated by concrete or shotcrete.
- General:
  - Provide safe potable water to households relying on water sources downstream from construction activities. The provision of safe water could include extending the Project's water system, installing a well, or piping water from locations upstream from any project facilities.

Implementation of these measures will reduce the magnitude of the impact to medium. Therefore, the Project's potential impact on water quality from stormwater runoff during construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of ***Moderate***.

Wastewater Disposal

Project construction will require between 300 and 4,500 staff (see Section 3.5.2) depending on the construction year. These staff will generate up to 225,000 liters of domestic wastewater per day, assuming an average of 50 liters/day/person, which is a significant volume of wastewater. ***Table 7.6*** identifies the general locations where this domestic wastewater will be generated, which primarily include the several owner and contractor's camps, but also includes the various work fronts (e.g., headworks area, headworks adit tunnel portal area, powerhouse area, and the many ancillary facilities).

Table 7.6: Construction Phase Domestic Wastewater Generation

Wastewater Sources	Nearest Village	# of Workers	Volume (L/day)	Likely Discharge Stream	Downstream Uses
Road Contractor Camp #1	Chongrak	85	4,250	Arun River	No nearby potable uses
Road Contractor Camp #2	Namase	75	3,730	Chudajembuk Khola	55 households
Road Contractor Camp #3	Rukma	70	3,500	Laju Khola	Irrigation
Owner Camp #1	Rukma	50	2,500	Laju Khola	Irrigation
Contractor Camp #1	Rukma	2,500	125,000	Laju Khola	Irrigation
Contractor Camp #2	Hema	120	6,000	Mangbung River	Micro-hydro
Owner Camp #2	Limbutar	100	5,000	Leksuwa Khola	None
Contractor Camp #3	Sibrun	1,000	50,000	Leksuwa Khola	None
Contractor Camp #4	Chongrak	700	35,000	Arun River	No nearby potable uses
Various Work Fronts	Varies	Up to 4,500	Varies	Varies	Varies

The relatively shallow depth to bedrock in much of the DIA and the quantity of wastewater requiring treatment make a traditional septic system unfeasible (i.e., too little soil and too much wastewater to allow for adequate treatment). If untreated, this wastewater would increase nutrient and fecal coliform concentrations in areas downstream from these works and living areas and increase the public health risk of various communicable diseases.

Construction of the transmission line is different in terms of domestic wastewater management. As described in Section 3.4.4, transmission line construction typically involves small crews of up to about 20 workers working at each tower site for a short duration (a few weeks to a month, depending on the stage of construction). For Towers 4–16, the work crews will be accessing the tower sites using trails. The use of pit toilets for these few workers for a short duration is appropriate and will not present a public health risk (see ***Table 3.14***).

Therefore, the Project's potential impact on water quality as a result of untreated wastewater disposal during the construction phase, at least for the access road and hydropower facility, will be direct, adverse, high in magnitude, regional in extent, and short term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Prohibit the discharge of any untreated wastewater to any receiving water.
- Prohibit open defecation by project workers.
- Provide an enhanced septic system with a bioreactor or similar design, or a package wastewater treatment facility, for each of the project access road workers' camps. The wastewater treatment system selected must be designed to meet the Nepal's water quality standards and the WB EHS Guidelines, whichever are stricter, and avoid any contamination of local potable water sources.
- Provide a wastewater treatment facility (e.g., a package wastewater treatment plant) at each of hydropower workers' camps to treat domestic wastewater prior to discharge to a receiving water. The wastewater treatment facility will provide secondary treatment and ensure, through regular/frequent monitoring that the effluent meets Nepal's water quality standards and the WB General EHS Guidelines, whichever are stricter.

- Ensure the effluent discharge locations for all wastewater treatment plants are downstream from all sites used by local residents for potable water.
- Provide pit toilets for the transmission tower work camps.
- Provide separate portable toilets for men and women at each of the project work areas. These toilets will be emptied on a regular basis by sewage trucks, which will transport and discharge the wastewater into the wastewater treatment facility influent for treatment prior to discharge to a receiving water.
- Maintain the wastewater treatment facilities in accordance with manufacturer specifications and conduct daily monitoring of effluent water quality.

Implementation of these measures will reduce the magnitude of the impact to low and reduce the extent of the impact. Therefore, the Project's potential impact on water quality as a result of wastewater disposal during construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of Moderate. However, considering the magnitude of wastewater to be generated, and the inexperience in operating wastewater treatment facilities in Nepal, the residual risk to water quality from wastewater during construction is considered ***Substantial***.

Solid Waste Management

The Project will generate a variety of solid waste, primarily domestic solid waste and construction debris. Improper disposal of this waste can impact water quality, create a nuisance for local residents, and detract from the scenic beauty of the landscape. The Project does not propose to construct an on-site solid waste landfill.

The Project's potential impact from improper solid waste disposal during the construction phase will be direct, adverse, high in magnitude, regional in extent, and short term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation Measures and Residual Significance

The Contractor will be required to prepare a detailed Solid Waste Management Plan describing in detail the methods it will use to manage waste in accordance with international good practice. At a minimum, the Contractor will be required to implement the following mitigation measures to avoid improper solid waste disposal:

- Maintain all facilities in a neat and tidy condition and keep all construction sites free of litter. The random disposal of solid waste shall be strictly prohibited.
- Provide easily identifiable and marked litter bins/garbage receptacles at convenient locations within the workers' camps and work areas to reduce the potential for litter and discourage negligent behavior.
- Train workers on the principle of the 3Rs (reduce, reuse, and recycle) and apply this to the extent possible, including the following:
  - Segregate recyclables and perishables at the workers' camps and provide separate clearly marked containers.
  - Collect, recycle, reuse, or make available to local scrap dealers all metal, empty cement bags, various containers, glass, wood, plastics, packaging material, wooden pallets, spent batteries, and rejected materials.
- Prohibit the on-site disposal of domestic solid waste, as no sanitary landfill is proposed and burning and burial within fill or backfill areas will be prohibited.
- Store solid waste temporarily on site in designated areas. The storage area shall include a covered concrete pad to avoid direct contact with precipitation and surface runoff, and be fenced to prevent

wind-blown litter. Waste storage containers shall be covered, tip-proof, weatherproof, and scavenger proof.

- Separate domestic waste from construction waste.
- UAHEL will conduct a due diligence of the Khandbari Municipal Landfill, and any other proposed solid waste disposal site, and identify measures necessary to upgrade the facility or its operations to meet the WB ESS for appropriate disposal of solid waste from the Project.
- Transport all non-recyclable domestic waste by an approved waste collector in covered trucks/containers to an approved solid waste landfill at least once a week for disposal. If an approved waste collector is not identified, the Construction Contractor will be responsible to ensuring the safe transport of solid waste to an approved solid waste landfill.
- Inert construction debris (e.g., waste concrete) can be disposed of within the spoil disposal areas.
- Transport all other construction debris offsite for disposal at government-approved solid waste disposal facilities.
- Remove all construction-related debris from the site at the completion of construction.

Implementation of these measures will reduce risk and magnitude of impacts associated with improper waste disposal. Therefore, the Project's potential impact from improper solid waste disposal during construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of Moderate, but this rating is dependent on identifying/upgrading an acceptable waste collector and disposal facility, so the residual risk is still considered ***High***.

Hazardous Material/Waste Management

Project construction will require the transport, storage and use of relatively large quantities of various hazardous materials, especially diesel fuel, but also various oils, lubricants, paints, concrete additives and other materials. Accidental spills are impossible to completely prevent and, depending on the material and the volume spilled, could result in significant impacts on soils and degradation of water quality. The risk from these potential spills is especially significant in the DIA, because of the dependence of local residents on local streams for potable and irrigation water. The Project will also generate hazardous waste, which could pose risks to water quality and public health if not properly managed. The use of pesticides and/or herbicides will not be allowed and is not typical transmission line RoW maintenance practice in Nepal.

The Project's potential impact on water quality from hazardous materials and waste during construction would be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation Measures and Residual Significance

The Contractor will be required to prepare a detailed Waste Management Plan and a Hazardous Material Spill Prevention and Response Plan describing the methods it will use to prevent and respond to hazardous material spills. At a minimum, the Contractor will be required to implement the following mitigation measures to avoid or minimize potential water quality risks from stormwater runoff:

- Waste management and spill prevention:
  - Prohibit the disposal of any hazardous material or waste on-site.
  - Provide training for staff using hazardous materials regarding proper care, handling, storage, transport, and disposal of hazardous materials and waste. Only trained and authorized personnel shall handle hazardous materials and waste.
  - Maintain an inventory of all hazardous materials (e.g., diesel fuel, oils, solvents, paints).
  - Store all hazardous materials/waste in designated and controlled (i.e., fenced with restricted entry) locations in suitable containers as prescribed by the manufacturer or the GoN.

- Locate hazardous material/waste storage facilities at least 100 m from any perennial or intermittent stream channel.
- Identify all hazardous materials with hazard signage and have appropriate material safety data sheets posted at the storage facility, and kept on file at the site office.
- Provide an impervious floor and secondary containment with capacity of at least 110% of the largest container for all hazardous liquids, including access road, hydropower facility, and transmission line components.
- Provide spill kits at all work areas where hazardous materials are used and in all vehicles transporting hazardous materials, and ensure staff are trained in their effective use.
- Check storage tanks and vehicles for leaks on at least a weekly basis.
- Practice good housekeeping to store hazardous materials in accordance with their hazard category.
- Prohibit the storage of empty fuel or oil drums.
- Use an approved waste transport company to transport hazardous waste.
- Dispose of hazardous waste at an approved waste disposal site or recycling company, in accordance with Nepal regulations and international good practice.
- Include in the Construction Contractor's bid documents a requirement that, in the event that there are no approved disposal facilities for hazardous and/or special waste in Nepal, the Contractor is responsible for properly transporting and disposing of such waste in the country of origin, or in another country where facilities exist for treating and disposing of such waste, consistent with the requirements of the Basel Convention on the international transport of hazardous waste.
- Retain transport and disposal certificates documenting proper chain of custody for disposal of hazardous waste.

- Spill response:
  - Prepare a Spill Response Plan that identifies required preventative measures, the chain of command, and roles and responsibilities in the event of a spill; the required spill control materials to have available; spill control, containment, and clean-up procedures; and notification requirements, for review and approval by UAHEL and the WB.
  - Conduct periodic (approximately every six months) training in the Spill Response Plan and at least annual spill response drills.
  - Prohibit the flushing of spilled hazardous materials onto the ground or into drainage systems or surface water courses.
  - Ensure that the appropriate PPE and necessary response supplies are available at the site and in good condition, and that staff are trained in their proper use and maintenance.
  - Conduct a root cause analysis so the Contractor learns from this experience and makes necessary modifications to improve the Project's spill prevention measures.

Implementation of these measures will reduce the risk of improper hazardous material/waste management to low. Therefore, the Project's potential impact on water quality from hazardous material/waste during the construction phase will be direct, adverse, low in magnitude, local in extent, short term in duration, with an overall residual significance of ***Low***.

Operation Phase

Operation of the transmission line will not result in any measurable impact on water quality; therefore, the following impact assessment focuses on various aspects of access road and hydropower operations.

Stormwater Runoff

Many of the project facilities are underground, which limits their exposure to precipitation and reduces the volume of stormwater runoff. Several permanent facilities, however, will be located above ground, such as the project roads, switchyard, water treatment plants, parking areas, and the two permanent owner's camp complexes. Stormwater runoff from these facilities has the potential to marginally degrade downstream water quality. The water quality of these streams should still be suitable for irrigation purposes, but should not be used for any potable uses, at least not without appropriate treatment. The three open (unpiped) springs/streams used for potable purposes downstream from permanent project facilities (e.g., Chudajembuk Khola used by 55 households near Namase, Okradhag Dhara used by four households near Sibrun, Khopbari Muhan used by one household near Jijinkha) will be exposed to project-related stormwater runoff.

Therefore, the Project's potential impact on water quality from stormwater runoff during the operation phase will be direct, adverse, high in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Provide stormwater basins downslope from the two owner's camps, switchyard, water treatment plants, and parking areas to allow for pollutants to settle out and to moderate stormwater runoff.
- Provide oil/water separators for drainage from any vehicle maintenance areas.
- Provide an alternative source of water to any households sourcing potable water downstream from project discharges (e.g., provide a piped water supply sourced from upstream from project facilities).

Implementation of these measures will reduce the magnitude of the impact to low and reduce the extent of the impact. Therefore, the Project's potential impact on water quality from stormwater runoff during the operation phase will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

Wastewater Disposal

The Project will not have any operational industrial wastewater discharges. Project operations will require about 130 staff who will primarily work at the powerhouse and live at the Owner's Camp #2, although a small group will work at the headworks and live at Owner's Camp #1. These workers will generate approximately 6,500 liters of domestic wastewater per day, assuming an average of 50 liters/day/person of domestic wastewater, which is very small compared to the median Arun River flow. Nevertheless, if untreated, this wastewater would increase nutrient and fecal coliform concentrations in areas downstream from these works and living areas. The Owner's Camp #1 wastewater treatment plant will discharge to Laju Khola, which is currently only used for irrigation purposes downstream from the discharge location. Most of the land in the vicinity of this irrigation withdrawal is proposed for acquisition by the Project, and the continuation of this withdrawal is questionable. The Owner's Camp #2 wastewater treatment plant will likely discharge directly into either Leksuwa Khola or the Arun River and will not impact on any nearby springs or streams used for potable water. The operation of these wastewater treatment plants will be contracted by UAHEL.

The Project's potential impact on water quality as a result of wastewater disposal during the operation phase will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Provide a wastewater treatment facility (e.g., retain the package wastewater treatment plant from the construction phase or install a septic system) at each owner's camp to treat domestic wastewater prior to discharge into a receiving water. The wastewater treatment facility will be designed to meet Nepal's water quality standards and the WB EHS guidelines, whichever are stricter.

- Ensure that the effluent discharge locations for all wastewater treatment plants are downstream from all sites used by local residents for potable water.
- Maintain the wastewater treatment facilities in accordance with manufacturer specifications and conduct daily monitoring of effluent water quality.
- Prohibit any open defecation, and any washing, bathing or urination in any water courses or springs.
- Provide a sufficient number of toilets facilities (separate toilets for men and women) at each work site. Regularly clean out these toilets and dispose of waste at the wastewater treatment facility described below.
- Prohibit the discharge of any untreated wastewater to any receiving waterbody.

Implementation of these measures will reduce the magnitude of the impact to low and reduce the extent of the impact. Therefore, the Project's potential impact on water quality as a result of wastewater disposal during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

Reservoir Water Quality

The Project will impound water behind the dam, which can result in increases in water temperature, decreases in dissolved oxygen, stratification of the reservoir, and potential eutrophication. These impacts, however, are not anticipated for the UAHEP primarily because the reservoir has relatively little water storage volume, with a residence time of only about 16 hours under median flow conditions (i.e., 87.4 m^3/s, see ***Figure 6.13***). Further, the low flow period, when the longest residence time would occur in the reservoir, is during the late winter when air and water temperatures are cold and the potential for decreases in dissolved oxygen and stratification of the reservoir is negligible. Project wastewater discharges will occur downstream from the reservoir and, therefore, will not contribute nutrients to the reservoir, which could otherwise promote eutrophication.

Eutrophication modelling indicates that the project reservoir will be between ultra-oligotrophic to oligotrophic, based on Vollenweider's normalized phosphorus loading, with no risk of eutrophication (Chang *et al.* 2019; Rast *et al.* 1983).

The Project's potential impact on water quality in the proposed reservoir during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation Measures and Residual Significance

The following mitigation measure will be implemented:

- Clear and remove vegetation within the reservoir inundation zone to reduce the biological oxygen demand within the reservoir and to help maintain dissolved oxygen levels at levels that will support aquatic life (i.e., generally above 6 mg/L).
- Conduct a monitoring program to confirm that reservoir water quality meets WB and Nepal standards, especially relative to DO, and that there is no evidence of potential eutrophication.

Taking into consideration the proposed mitigation measure, the residual significance of the Project's potential impact on water quality in the proposed reservoir during operations will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall residual significance of ***Low***.

Diversion Reach Water Quality

The domestic wastewater discharge from Owner's Camp #1 will occur in the upstream portion of the diversion reach (Laju Khola, about 1 km downstream from the UAHEP dam), while the domestic wastewater discharge from Owner's Camp #2 will occur downstream from the diversion reach. There will be no industrial discharges. The diversion reach is a high gradient (>3% channel slope), high energy river segment, so dissolved oxygen levels will remain high and conditions promoting eutrophication will remain low, even under the reduced flow conditions. River water temperature will increase marginally (1^oC +/-), but no other impacts on water quality are anticipated.

The Project's potential impact on water quality in the diversion reach during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation Measures and Residual Significance

No additional mitigation measures are proposed and the residual significance of the Project's residual impact on water quality in the diversion reach remains ***Low***.

Downstream from Powerhouse Water Quality

Water quality downstream from the powerhouse will not change in any meaningful way. There will be no industrial wastewater discharges, and the domestic wastewater will be small in volume relative to river flow and treated prior to discharge. The water released (EFlow) or discharged (spillage) from the dam will be close to ambient conditions, with only marginal increases in water temperature and decreases in dissolved oxygen and turbidity expected, and will not degrade downstream water quality. The Project will have no impact on transboundary water quality at the India border.

Therefore, the Project's potential impact on water quality downstream from the powerhouse during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation Measures and Residual Significance

No additional mitigation measures are proposed and the residual significance of the Project's residual impact on water quality downstream from the powerhouse remains ***Low***.

Hazardous Materials/Waste Management

During project operations, there will still be need for the transport, storage, and use of various hazardous materials, including diesel fuel and various oils, lubricants, paints and other materials, but in significantly smaller quantities than was required during construction. There will still be the potential for accidental spills, which, depending on the material and the volume spilled, could result in significant degradation of water quality. The Project will still generate some hazardous waste.

The Project's potential impact on water quality from hazardous materials and waste during the operation phase would be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation Measures and Residual Significance

The Facility Operator will be required to implement the following measures:

- Prepare a detailed Spill Prevention and Response Plan and a Waste Management Plan, which will include the same minimum requirements as described above for the construction phase.
- Ensure that transformers oils do not include polychlorinated biphenyls (PCBs) and that measures are in place to contain these oils in the event of any transformer leak or failure.

Implementation of these measures will reduce impacts resulting from improper hazardous material/waste disposal and spills to low. Therefore, the Project's potential impact on water quality from hazardous material/waste disposal and spills during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, short term in duration, with an overall residual significance of ***Low***.

7.1.7 Air Quality

The UAHEP Project will emit a variety of air emissions, such as total particulate matter (PM), particulate matter with diameter less than 10 microns (PM_{10}), particulate matter with diameter less than 2.5 microns ($PM_{2.5}$), nitrogen oxide (nOx), carbon monoxide (CO), carbon dioxide (CO_2), and Sulphur dioxide (SO_2), which are evaluated below.

Avoidance and Minimization Measures

There were no avoidance or minimization measures related to air quality identified.

Construction Phase

Project air emission sources during construction will be from large diesel generators, aggregate crushing plants, concrete batch plants, small diesel generators, non-road construction equipment, construction vehicles, and fugitive dust.

Much of the stationary construction equipment will be powered by the diesel generators via connection to the local electric distribution system, therefore, there will be no direct fuel combustion emissions from this equipment. However, there will be fugitive emissions associated with these pieces of equipment when operated at the construction site (e.g., a significant portion of the fugitive emission will be from the aggregate crushing and concrete mixing involved in crushing and batch process, respectively). There will be vehicular and diesel-powered equipment emissions at the construction site, but these emissions will be negligible.

Large Diesel Power Plants

The Project's power requirements during construction will be met by several large diesel generator sets. The access road construction will have three workers' camps (one near the Arun River bridge work site, one at the South Road Tunnel Portal, and one at the North Road Tunnel Portal), each with a 250 kW diesel generator to meet the electricity requirements at the camps for the two-year projected construction period.

The hydropower facility construction will also have three power plants. There will be six 2 MW diesel generators (total of 12 MW) at Power Plant #1 in the headworks area, three 0.7 MW diesel generators (total 2.1 MW) at Power Plant #2 in the headrace adit tunnel area, and three 2 MW diesel generators (total of 6 MW) at Power Plant # 3 in the powerhouse area for the six-year projected construction period.

The emissions associated with diesel generator, assuming high Sulphur diesel fuel, were based on the U.S. EPA AP-42 emission factors (USEPA 2010a). ***Table 7.7*** presents a detailed calculation of annual diesel generator emissions based on these emission factors.

Based on the emissions identified below, the Project's potential impact on air quality from large diesel power plants during the construction phase would be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Properly maintain diesel generators – the Contractors will be required to provide manufacturer-specified maintenance.
- Use low Sulphur diesel fuel.
- Use diesel particulate matter filters to collect particulate matter in the exhaust stream.

Taking into consideration these mitigation measures, the Project's potential impact on air quality during the construction phase will be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Moderate***.

Table 7.7: Pollutant Emission Rates for Diesel Generators from Road and Hydro Construction Power Plants

Access Road Construction	Quantity	Capacity (MW)	Power (hp)	Load Factor	Annual Hours of Operation (Hours/Year)	Annual Emissions (Tons/Year)[a]				
						NO_X	CO	SO_2	$PM/PM_{10}/PM_{2.5}$	CO_2
Work Camp No. 1	1	0.25	335	0.48	8,760	21.8	4.70	1.4	1.6	810
Work Camp No. 2	1	0.25	335	0.48	8,760	21.8	4.70	1.4	1.6	810
Work Camp No. 3	1	0.25	335	0.48	8,760	21.8	4.70	1.4	1.6	810
					Total	**65.4**	**14.1**	**4.2**	**4.8**	**2,430**

Hydropower Construction	Quantity	Capacity (MW)	Power (hp)	Load Factor	Annual Hours of Operation (Hours/Year)	Annual Emissions (Tons/Year)[a]				
						NO_X	CO	SO_2	$PM/PM_{10}/PM_{2.5}$	CO_2
Power Plant #1	6	2.0	2,682	0.48	8,760	1,048.0	225.8	69.3	74.4	38,907
Power Plant #2	3	0.7	938	0.48	8,760	183.4	39.5	12.1	13.0	6,804
Power Plant #3	3	2.0	2,680	0.48	8,760	524.0	112.9	34.7	37.2	19,439
					Total	**1,755.4**	**378.2**	**116.1**	**124.6**	**65,150**

[a] Emissions factors obtained for USEPA AP-42 (USEPA 2010a):

- NO_x 0.031 lb/hp-hr
- CO 0.00668 lb/hp-hr
- SO_2 0.00205 lb/hp-hr
- $PM/PM_{10}/PM_{2.5}$ 0.0022 lb/hp-hr
- CO_2 1.15 lb/hp-hr[b] load factor = max power required (12,200 kW/max potential power generation [25,000kW])

Aggregate Crushing Plant

There are two 100 ton/hour (91 tonnes/hour) aggregate crushers proposed for construction of the access road (one near Namase and one near Rukma). One aggregate crushing plant is proposed in the headworks area for construction of the hydropower facility with a capacity of 320 tons/hour (290 tonnes/hour) of coarse aggregate and 140 tons (127 tonnes) of fine aggregate per hour. The detailed calculation of fugitive emissions from the aggregate crushing plants is shown in ***Table 7.8***. Emissions were calculated based on the maximum operating capacity, hours of operation, and the emission factors.

Table 7.8: Pollutant Emission Rates for Aggregate Crushing Plant

Emission Source/ Activity	Control Factor (%)	Emission Estimates (tonnes/year)[a, b]		
		PM	PM_{10}	$PM_{2.5}$
Process Plant Area				
Primary crushing at process plant	50	7.78	3.11	0.58
Secondary crushing at process plant	50	23.35	9.34	1.75
Total		**31.13**	**12.45**	**2.34**

[a] Emission factors obtained from US EPA AP-42, Section 11.24. Metallic Minerals Processing – Table 11.24-1, US EPA August 1982 (Reformatted January 1995).

	Where:
$EF_1 = 0.01$	EF_1 = TSP emission factor for primary crushing in kg/ megagram or kg/tonne
$EF_2 = 0.004$	EF_2 = PM_{10} emission factor for primary crushing in kg/ megagram or kg/tonne
$EF_3 = EF_1 \times 0.075$	EF_3 = $PM_{2.5}$ emission factor for primary crushing in kg/ megagram or kg/tonne
$EF_4 = 0.03$	EF_4 = TSP emission factor for secondary crushing in kg/ megagram or kg/tonne
$EF_5 = 0.012$	EF_5 = PM_{10} emission factor for secondary crushing in kg/ megagram or kg/tonne
$EF_6 = EF_1 \times 0.075$	EF_6 = $PM_{2.5}$ emission factor for secondary crushing in kg/ megagram or kg/tonne
$EF_7 = 1.4$	EF_7 = TSP emission factor for tertiary crushing in kg/ megagram or kg/tonne
$EF_8 = 0.08$	EF_8 = PM_{10} emission factor for tertiary crushing in kg/ megagram or kg/tonne
$EF_9 = EF_1 \times 0.075$	EF_9 = $PM_{2.5}$ emission factor for tertiary crushing in kg/ megagram or kg/tonne
EF_{10} = Negligible	EF_{10} = TSP emission factor for wet grinding in kg/ megagram or kg/tonne
EF_{11} = Negligible	EF_{11} = PM_{10} emission factor for wet grinding in kg/ megagram or kg/tonne
EF_{12} = Negligible	EF_{12} = $PM_{2.5}$ emission factor for wet grinding in kg/ megagram or kg/tonne
$E_{1\text{-}12} = EF_{1\text{-}12} \times TM \times (1\ \text{tonne}/1000\ \text{kg}) \times (1 - CF/100)$	$E_{1\text{-}12}$ = Emissions estimates in tonnes/year
	TM = Total material to be crushed and grinded in tonnes/year
	CF = Control factor (%)

[b] Total material to be crushed and grinded, TM, is based on the total capacity of the 3 crushers per hour, 10 hours a day and 5 days a week.

In summary, the Project's potential impact on air quality from the aggregate crushing plant during construction phase will be direct, adverse, medium in magnitude, local in extent, and short-term in duration, with an overall pre-mitigation significance of ***Moderate.***

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Locate crushers on the crusher site to maximize distance from the Village of Rukma and worker housing.
- Ensure that crushers use a high-efficiency dust collector or baghouse suppression/control systems, and be enclosed with 3 m high barriers to minimize the spread of dust.
- Spray stockpile areas with water to suppress dust during dry periods.

Based on these mitigation measures, the Project's potential impact on air quality from the aggregate crushing plant during construction phase will be direct, adverse, low in magnitude, local in extent, and short-term in duration, with an overall residual significance of ***Low***.

Concrete Batching Plants

Access road construction will require two concrete batching plants for its two-year construction schedule and the hydropower construction will require three concrete batching plants for its subsequent six-year construction schedule, as described below:

Access Road Construction

The access Road Contractor will have batching plants at both ends (portals) of the tunnel, each with a capacity of 120 m^3 per hour or 24,000 m^3 per month. These batching plants will provide the concrete needs of the road tunnel, both in terms of the road and tunnel wall lining. Pollutant emission rates from these batching plants are presented in ***Table 7.9***.

Table 7.9: Pollutant Emission Rates for Access Road Batching Plant

Air Pollutant	Total Usage of Concrete ($yard^3$/hour)a	Emission Factor (lb/yard3)b	Annual Hours of Operation[c] (hours/year)	Annual Emissions (TPY)
PM	104.8	2.820	2,600	384.2
PM_{10}	104.8	0.444	2,600	60.5
$PM_{2.5}$	104.8	0.066	2,600	8.9

Note: lb = pounds; TPY = tons per year

[a] Sum from the three proposed concrete batching plants.

[b] Emissions factors obtained for USEPA AP-42, 11.12 Concrete Batching, Equation 11.12-2 (USEPA 2010a).

[c] Assuming 5 days of operation/week with 10 hours per day.

Hydropower Facility Construction

- Batching Plant #1 will be located in the headworks area adjacent to the aggregate crushing plant. This plant will supply concrete for the works within the dam area and for part of the low-pressure headrace tunnel. It will meet peak concrete requirements of 55,000 m^3 per month and will be equipped with two mixing plants. The first is a 2×3 m^3 forced mixing plant for both RCC and conventional concrete, while the second is a 3×1 m^3 self-falling mixing plant for conventional concrete only.
- Batching Plant #2 will be located at the headrace tunnel adit near Namase. This plant will produce concrete for the low-pressure headrace tunnel. It will meet the peak requirement of 5,600 m3 per month and will be equipped with a 1×1.5 m3 self-falling mixing plant.
- Batching Plant #3 will be located in the powerhouse and tailrace area. This plant will produce concrete for the high-pressure headrace tunnel, the shaft, the powerhouse, the tailrace tunnel and

the outlet. It will meet the peak requirement of 14,000 m^3 per month and will be equipped with a 3×1 m^3 self-falling mixing plant.

The detailed calculation of fugitive emissions from the three hydropower concrete batching plants are shown in ***Table 7.10***. Emissions, were calculated based on the maximum operating capacity, hours of operation, and the emission factors. These emissions should not exceed the Nepali or WB air quality standards beyond the facility property boundary.

Table 7.10: Pollutant Emission Rates for Three Hydropower Batching Plants

Air Pollutant	Total Usage of Concrete (yard^3/hr)[a]	Emission Factor (lb/yard^3)[b]	Annual Hours of Operation[c] (hours/year)	Annual Emissions (TPY)
PM	325.8	2.820	2,600	1,194.21
PM_{10}	325.8	0.444	2,600	187.94
$PM_{2.5}$	325.8	0.066	2,600	27.74

Note: lb = pounds; TPY = tons per year

[a] Sum from the three proposed concrete batching plants.

[b] Emissions factors obtained for USEPA AP-42, 11.12 Concrete Batching, Equation 11.12-2 (USEPA 2010a).

[c] Assuming 5 days of operation/week with 10 hours per day.

In summary, the Project's potential impact on air quality from the emissions from the concrete batching plant during the construction phase will be direct, adverse, high in magnitude, local in extent, and short-term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Locate batching plants downwind and/or as far as possible from any residences and worker housing.
- Use a high-efficiency dust suppression/control systems and enclose the plant with 3 m high barriers to minimize the spread of dust.
- Unload cement delivery trucks on pallets, which shall be covered with tarpaulin sheets during non-working periods.

Taking mitigation measures into consideration, the Project's potential impact on air quality from the emissions from the concrete batching plant during construction phase will be direct, adverse, medium in magnitude, local in extent, and short-term in duration, with an overall residual significance of ***Moderate***.

Road and Non-Road Diesel Engine Emissions

Road diesel engines include trucks, buses, and cars that use public roads and the project access and service roads. Non-road engines include non-road equipment and non-road service vehicle used for purposes other than the engine of a vehicle operated on public roadways. Non-road engines are used in an extremely wide range of applications, including as machinery and engines for vehicles in construction, mining, recreational, and agricultural activities.

With regards to the Project, non-road diesel equipment consists of major equipment and service vehicles necessary for proper and effective construction. Emissions from non-road engines were estimated based on US EPA's AP-42 Chapter 1.5 (USEPA 2008) based on the power rating of the equipment. ***Table 7.11*** summarizes the emissions from the non-road diesel engines.

In summary, the Project's potential impact on air quality from the emissions from non-road diesel engine during construction phase would be direct, adverse, medium in magnitude, local in extent, and short-term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Provide regular (monthly) maintenance of all vehicles in accordance with manufacturer specifications.
- Use construction equipment with idling control technology .
- Turn off machinery when not in use.
- Do not allow construction equipment/vehicles that generate significant air pollution (above the applicable limit) and those that are poorly maintained on-site.
- Use low Sulphur diesel fuel for diesel-powered equipment and vehicles.

Taking into consideration these mitigation measures, the Project's potential impact on air quality from the emissions from road and non-road diesel engines during construction phase would be direct, adverse, low in magnitude, local in extent, and short-term in duration, with an overall residual significance of ***Low***.

Table 7.11: Pollutant Emission Rates for Non-Road Diesel Vehicles and Equipment*

Emission Source/ Description	SCC	# of Units	Load Factor	Max Rated Capacity (hp)	Operating Hours (hrs/yr)	In-use Adjusted Emission Factors, EF_{adj} (g/hp-hr)[a]									Emission Estimates (tonnes/year)								
						nOx	CO	VOC[b]	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4[c]	N_2O[d]	nOx	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O
Belt crane	2270002045	1	0.25	320	2,080	3.213	0.823	0.203	0.133	0.129	0.004	530.43	10.61	2.12	0.5	0.14	0.03	0.022	0.021	0.001	88.3	1.8	0.35
Cable crane	2270002045	1	0.25	550	2,080	3.213	0.823	0.203	0.133	0.129	0.004	530.43	10.61	2.12	0.9	0.24	0.06	0.038	0.037	0.001	151.7	3.0	0.61
Truck crane	2270002045	2	0.25	268	2,080	2.271	0.491	0.198	0.103	0.100	0.004	530.44	10.61	2.12	0.6	0.14	0.06	0.029	0.028	0.001	147.8	3.0	0.59
Truck crane	2270002045	1	0.25	480	2,080	3.213	0.823	0.203	0.133	0.129	0.004	530.43	10.61	2.12	0.8	0.21	0.05	0.033	0.032	0.001	132.4	2.6	0.53
Temporary bridge crane	2270002045	1	0.25	48.6	2,080	3.922	0.975	0.224	0.161	0.157	0.005	589.69	11.79	2.36	0.1	0.02	0.01	0.004	0.004	0.000	14.9	0.3	0.06
Crawler crane	2270002045	2	0.25	185	2,080	2.271	0.491	0.198	0.103	0.100	0.004	530.44	10.61	2.12	0.4	0.09	0.04	0.020	0.019	0.001	102.1	2.0	0.41
Crawler crane	2270002045	1	0.25	185	2,080	2.271	0.491	0.198	0.103	0.100	0.004	530.44	10.61	2.12	0.2	0.05	0.02	0.010	0.010	0.000	51.0	1.0	0.20
Excavator	2270002036	11	0.25	125	2,080	1.824	0.797	0.183	0.195	0.189	0.004	536.28	10.73	2.15	1.3	0.57	0.13	0.139	0.135	0.003	383.4	7.7	1.53
Bulldozer	2270002069	19	0.25	215	2,080	1.855	0.630	0.180	0.123	0.120	0.004	536.28	10.73	2.15	3.9	1.34	0.38	0.262	0.254	0.009	1,139.2	22.8	4.56
Loader	2270002060	13	0.25	801	2,080	4.435	1.505	0.312	0.209	0.203	0.004	535.89	10.72	2.14	24.0	8.15	1.69	1.134	1.100	0.024	2,901.7	58.0	11.61
Dump truck	2270002051	2	0.25	733	2,080	1.631	0.990	0.155	0.105	0.101	0.004	536.36	10.73	2.15	1.2	0.75	0.12	0.080	0.077	0.003	408.9	8.2	1.64
Dump truck	2270002051	10	0.25	733	2,080	1.631	0.990	0.155	0.105	0.101	0.004	536.36	10.73	2.15	6.2	3.77	0.59	0.398	0.387	0.015	2,044.4	40.9	8.18
Dump truck	2270002051	70	0.25	733	2,080	1.631	0.990	0.155	0.105	0.101	0.004	536.36	10.73	2.15	43.5	26.42	4.13	2.789	2.706	0.108	14,310.8	286.2	57.24
Vibrating roller[e]	2270002015	2	0.25	100	2,080	2.821	2.592	0.266	0.343	0.333	0.005	536.16	10.72	2.14	0.3	0.27	0.03	0.036	0.035	0.001	55.8	1.1	0.22
hydraulic casing extractor	2270006010	2	0.25	268	2,080	4.219	1.194	0.362	0.236	0.229	0.005	529.95	10.60	2.12	1.2	0.33	0.10	0.066	0.064	0.001	147.7	3.0	0.59
Geological drilling rig[f]	2270002033	4	0.25	2000	2,080	5.831	1.614	0.437	0.259	0.251	0.005	589.69	11.79	2.36	24.3	6.72	1.82	1.077	1.044	0.019	2,453.1	49.1	9.81
Vibrating roller/vibrating joint cutter	2270002015	9	0.25	134	2,080	2.376	0.961	0.221	0.226	0.219	0.004	536.16	10.72	2.14	1.5	0.60	0.14	0.142	0.137	0.003	336.2	6.7	1.34
Concrete mixer truck	2270002051	32	0.25	605	2,080	1.631	0.990	0.155	0.105	0.101	0.004	536.36	10.73	2.15	16.4	9.97	1.56	1.052	1.021	0.041	5,399.7	108.0	21.60
Flat truck	2270002051	2	0.25	330	2,080	1.627	0.637	0.156	0.104	0.101	0.004	536.36	10.73	2.15	0.6	0.22	0.05	0.036	0.035	0.001	184.1	3.7	0.74
Penstock transport truck	2270002051	2	0.25	500	2,080	1.627	0.637	0.156	0.104	0.101	0.004	536.36	10.73	2.15	0.8	0.33	0.08	0.054	0.052	0.002	278.9	5.6	1.12
Total															**19.31**	**11.12**	**1.83**	**1.28**	**1.25**	**0.05**	**6,198.88**	**123.98**	**24.80**

Notes:

[a] USEPA. 2010b. *Exhaust and Crankcase Emission Factors for Non-road Engine Modeling – Compression-Ignition*. Report No. NR-009d, EPA-420-R-10-018, July 2010

[b] Emission factors of total hydrocarbons (THC) for non-road sources were converted to volatile organic compounds (VOCs) by multiplying by a factor of 1.053 (Source: USEPA. 2010c. *Conversion Factors for Hydrocarbon Emission Components*. Report No. NR-002d, EPA-420-R-10-015, July 2010)

[c] CH_4 emission factor based on the ratio of CH_4 and CO_2 from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98: General Stationary Fuel Combustion Sources.

[d] N_2O emission factor based on the ratio of N_2O and CO_2 from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98: General Stationary Fuel Combustion Sources.

[e] 101 HP is assumed for the 100 HP equipment for CO2 emissions since there is no CO2 emission factor available for equipment under 101 HP.

[f] The emission factor for CO2 is assumed to be the same as that for a temporary bridge crane (the highest emission factor among all), as there is no CO2 emission factor available for equipment.

* All values based on use of high Sulphur diesel fuel.

Small Diesel Generators

The construction of the transmission line will be performed mainly using manual labor with support from a portable 10-kilowatt (kW) diesel generator, which will provide required power at each transmission tower work camp. The estimation of emissions associated with diesel generator were based on the U.S. EPA AP-42 emission factors (USEPA 2010a). ***Table 7.12*** presents detailed calculation of diesel generator emissions, based on these emission factors. These emissions are low and will not result in any violation of air quality standards.

Table 7.12: Pollutant Emission Rates for Each Portable 10 kW Diesel Generator

Air Pollutant	Power (hp)[a]	Emission Factor (lb/hp-hr)	Annual Hours of Operation[b] (hours/year)	Annual Emissions (TPY)	Annualized Hourly Emissions (g/s)
nOx	14	0.011	1,440	0.019	0.111
CO	14	0.00696	1,440	0.012	0.070
SO_2	14	0.000591	1,440	0.001	0.006
$PM_{10}/PM_{2.5}$	14	0.000721	1,440	0.001	0.007
CO_2	14	1.08	1,440	1.905	10.886

Notes: g/s = grams per second; hp = horsepower; lb/hp-hour = pounds per horsepower per hour; TPY = tons per year

[a] Actual generator specifications were not available; emission estimates based on specification for a Kohler Model PA-PRO90E-3001-PC Industrial Diesel Generator (400–500 kW/500–625 kVA, 1,800 rpm)

[b] Based on a conservative assumption of 90 days of operation with 16 hours per day. Tower construction is anticipated to occur in three stages, each of about two weeks in duration.

In summary, the Project's potential impact on air quality from the emissions from small diesel generators during the construction phase would be direct, adverse, low in magnitude, site-specific in extent, and short-term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following mitigation measure:

- Use low Sulphur fuel for the small diesel generators.

Taking into consideration the above mitigation measure, the Project's potential impact on air quality from the emissions of small diesel generators during the construction phase will be direct, adverse, low in magnitude, site-specific in extent, and short-term in duration, with an overall residual significance of ***Low***.

Fugitive Dust Emissions

In addition to tailpipe emissions from fuel combustion, vehicles also create fugitive dust emissions in a process known as entrainment. When vehicles travel on unpaved surfaces, the force of the wheels on the road surface pulverizes the surface material. Particles are lifted and dropped from the rolling wheels, and the turbulent wake behind the vehicle continues to act on airborne particles and road surfaces after the vehicle has passed. Project construction activities and wind will both generate fugitive dust, especially during the dry season along the project access road (approximately 61 ha of disturbed area) and the headworks area (approximately 107 ha of disturbed land on the Rukma side and 36 ha on the Chepuwa side of the Arun River), where there will be large areas of exposed soil.

Based on the emissions identified above, the Project's potential impact on air quality during the construction phase would be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation Measures and Residual Significance

The Project will implement the following measures, consistent with international good practice:

- Limit clearing and grubbing to only those areas needed for immediate (i.e., within the next month) construction activities. Avoid clearing and grubbing of areas not required for construction activities within the next month.
- Stabilize disturbed areas as soon as possible and in a progressive manner – as soon as construction is completed, all disturbed areas will be stabilized and restored, either for agricultural reuse, or planted with fast growing vegetation and properly maintained to establish a vegetative cover.
- Protect stockpiled topsoil – stockpiled topsoil will be covered (e.g., with leaf litter, cleared vegetation, tarpaulins) or seeded with native grasses and stabilized until the material is needed for site restoration.
- Spray disturbed areas – spraying water to control dust generation at disturbed areas and along the project roads during dry periods, especially the dry season, and in response to any complaints/grievances.
- Prohibit burning and open fires – the Contractors will be prohibited from burning cleared vegetation and solid waste, as well using as wood as a cooking fuel in the camps.
- Limit vehicle speed – vehicles traveling on earthen roads will have a speed limit of 20 km/h to minimize dust generation and will be equipped with GPS transponders to allow remote monitoring of vehicle speeds.
- Transmission line fugitive dust mitigation measures:
  - Use existing access trails – use local trails to transport construction equipment and materials to the tower sites as far as possible to minimize soil disturbance and vegetation clearance. No tree clearing will be permitted for new trails required to access tower sites.
  - Limit clearing within the transmission line RoW – only clear those trees approved by the Divisional Forest Office. The tree stump and root system, smaller understory trees, shrubs, and the herbaceous layer will be left intact to minimize the generation of fugitive dust.

Implementation of these measures will reduce the magnitude of the impact to medium. Therefore, the Project's potential impact on air quality from fugitive dust during construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of **Moderate**.

Operation Phase

The Project will emit few air pollutants during the operation phase, as the Project will operate using clean renewable electricity generated by the Project. The Project will generate some emissions from project-related vehicular use, but most project staff will live at the powerhouse and headworks owner's camps or in the nearby villages. None are expected to "commute" to work using vehicles. There will likely be a few vehicular trips per day between the powerhouse and the headworks site (~40 km round trip) and there will be periodic deliveries of supplies from Khandbari or other district cities on a weekly basis, but these vehicular trips will result in negligible air emissions.

In summary, the Project's potential impact on air quality during operations will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project is predicted to have negligible impacts on air quality during operations, but UAHEL will implement the following measures, consistent with international good practice:

- Provide manufacturer-specified maintenance of vehicles and any back-up diesel generators.
- Spray water as needed on any dirt roads, spoil disposal sites, and other areas with exposed soils to reduce wind-induced erosion until they are stabilized with vegetation.

In summary, the Project's potential impact on air quality during the operation phase will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

7.1.8 Greenhouse Gas Emissions

The Project will generate greenhouse gas (GHG) emissions during both construction and operation phases:

- Construction phase emissions from the power plants, equipment, and vehicles
- Operation phase emissions related to reservoir emissions and vehicular use

Avoidance and Minimization Measures

The Project will adopt the following measure to avoid or reduce GHG emissions, in accordance with the application of the mitigation hierarchy:

- Use renewable energy.

Construction Phase

Project construction is estimated to require approximately 58,000 tons (53,000 tonnes) of diesel fuel for the diesel power plants and 1,400 tons (1,270 tonnes) of diesel fuel for construction vehicles over the seven-year construction period. This will result in the emission of 81,836 $CO_{2\text{-}e}$ in total, or about 13,639 $CO_{2\text{-}e}$, per year

Operation Phase

During the operation phase, GHG emissions will be generated from reservoir-related emissions and vehicular emissions, as described below.

Reservoir Emissions

The Project is expected to change the flow dynamics, trap riverine sediment and organic material, and flood terrestrial ecosystems, which will subsequently alter the cycle and fluxes of carbon dioxide (CO_2) and other GHGs, including methane (CH_4), within the project footprint. The GHG Reservoir Tool (G-Res Tool) developed by the International Hydropower Association (IHA) and the UNESCO Chair for Global Environmental Change was used to estimate reservoir GHG emissions. The methodology takes into consideration pre-impoundment conditions (land cover to be inundated), post-impoundment conditions (GHG fluxes associated with diffusive, bubbling, and degassing emission pathways), and anthropogenic sources associated with land use activities within the upstream catchment flowing downstream that may be affected by the presence of the reservoir. ***Tables 7.13*** and ***Table 7.14*** present the results of the G-Res model analysis.

Table 7.13: Reservoir GHG Information

Net Predicted Annual CO_{2e} Emissions	Units	Post-Impoundment	Pre-Impoundment	Unrelated Anthropogenic Sources	Net GHG Footprint
Emission rate	tCO_{2e}/yr	219	-14	13	220
of which CO_2		12	-15	n/a	27
of which CH_4		208	0	13	194
Emission rate	gCO_{2e}/m^2/yr	1,091	-67	63	1,095
of which CO_2		58	-74	n/a	132
of which CH_4		1,033	6	63	963

Note: tCO_{2e} = tons of carbon dioxide equivalent; gCO_{2e} = grams of carbon dioxide equivalent

Table 7.14: Total GHG Footprint Information

Emission	Units	Post-Impoundment	Pre-Impoundment	Unrelated Anthropogenic Sources	Net GHG Footprint
Areal emission	gCO_{2e}/m^2/yr	1,091	-67	63	1,095
Reservoir wide emission	tCO_{2e}/yr	219	-14	0	220
Total lifetime emission	tCO_{2e}	21,925	-1,356	1,266	22,015

Note: tCO_{2e} = tons of carbon dioxide equivalent; gCO_{2e} = grams of carbon dioxide equivalent

The assessment found that the GHG emissions from the Project are expected to be 220 tCO_{2e}/yr, with a power intensity of 5,273.6 W/m^2 and a GHG emission intensity of 0.05 gCO_2/kWh (***Table 7.15***).

Table 7.15: Hydroelectricity and Net GHG Footprint

Parameter	Unit	Output
Power density	W/m^2	5,273.6
GHG emission Intensity	gCO_2/kWh	0.05

Note: gCO_{2e} = grams of carbon dioxide equivalent; W = watt

The IHA applied the G-Res Tool to a global database of 498 reservoirs with installed capacities ranging from 1.2 to 2,735 MW. The global median GHG emission intensity for the hydropower reservoirs included in the study was 18.5 $gCO_{2\text{-}eq}$/kWh (***Table 7.16***). The UAHEP's GHG emission intensity is significantly less than IHA study median of 18.5 $gCO_{2\text{-}eq}$/kWh for hydropower projects and lower than all of the other power generation types evaluated (see ***Table 7.16***).

Table 7.16: Median Life-Cycle Carbon Equivalent Intensity ($gCO_{2\text{-}eq}$/kWh)

Power Generation Type	Median Life-Cycle Carbon Equivalent Intensity ($gCO_{2\text{-}eq}$/kWh)
Coal	820
Gas	490
Solar (utility)	48
Hydropower	18.5
Wind offshore	12
Nuclear	12
Wind Onshore	11

Note: $CO_{2\text{-}eq}$ = grams of carbon dioxide equivalent

Vehicular Emissions

Project operation phase emissions are limited to vehicular GHG emissions, as all other project electricity demands will be self-supplied from renewable energy generated by the Project. Vehicular emissions are estimated at approximately 1,500 tons (1,360 tonnes) of $CO_{2\text{-}eq}$/year.

Project GHG Emissions Summary

The Project is predicted to generate the following GHG emissions on an annual basis:

- Construction – 13,639 tons (12,373 tonnes) $CO_{2\text{-}eq}$/year
- Operation – 1,720 tons (1,560 tonnes) $CO_{2\text{-}eq}$/year (220 tons/200 tonnes per year from the reservoir and 1,500 tons/1,360 tonnes per year from vehicles)

These annual GHG emissions are less than the threshold established by IFC (part of the World Bank) for annual quantification and reporting (25,000 tonnes of $CO_{2\text{-}eq}$/year). Based on the analysis above, the Project's contributions to GHG emissions during the construction and operation phases would be direct, adverse, low in magnitude, regional in extent, and long term in duration, with an overall pre-mitigation significance of Substantial. To a large extent, this significance rating is an artefact of the evaluation system where regardless of the magnitude, any impact with regional and long term effects is deemed to have a significance of Substantial.

These emissions, however, are offset by the fact that this is a large renewable energy generation project and, as indicated in ***Table 7.16***, has a life-cycle carbon equivalent intensity less than all other evaluated energy sources. To the extent the power generated by this project offsets power generated by another source, the Project would result in a net reduction in GHG emissions. Therefore, the Project's contributions to GHG emissions during the construction and operation phases is considered ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following measure, consistent with international good practice, to reduce the generation and release of methane and other GHGs into the atmosphere:

- Clear and remove forest and other decomposable vegetative material within the reservoir's FSL before inundating – this forest should not be cleared until the reservoir is ready to be filled to minimize erosion and slope stability hazards.

The residual significance of the Project's contribution to GHG emissions would remain ***Low***.

7.1.9 Noise

This section presents the predicted project noise levels during project construction and operation and compares them to applicable noise criteria. Vibration effects are discussed in section 7.1.10.

Avoidance and Minimization Measures

The Project has adopted the following measures to avoid or reduce noise impacts, in accordance with the application of the mitigation hierarchy:

- Selected a headworks site that maximizes the distance from local villages (e.g., about 0.8 km from Chepuwa and 1.8 km from Rukma).
- Routed the transmission line alignment to avoid elevations over 2,000 meters and require use of ACSR conductors to minimize the potential corona effect and related audible hissing or cracking noise, as the corona effect is less at lower elevations.

Construction Phase

The three major project components (i.e., access road, hydropower facility, transmission line) will generate noise in different locations at different points in time and for different durations, so are described separately below. In addition, there will be noise associated with the transport of equipment, supplies, and personnel along the project transportation corridor, which is evaluated first. To avoid redundancy, the proposed mitigation and the Project's residual impact significance for each of these project components is described at the end of this section.

Project Transportation Corridor

Project construction will require the transport of equipment, supplies, and personnel along the transportation corridor, which is defined as the Koshi Highway from the city of Khandbari to the project site, which totals approximately 72 km (see Section 3.2.1). The Project Engineers (CSPDR) estimate the average number of vehicles travelling this route as 23 trucks and 5 buses per day, or 56 vehicle trips per day.

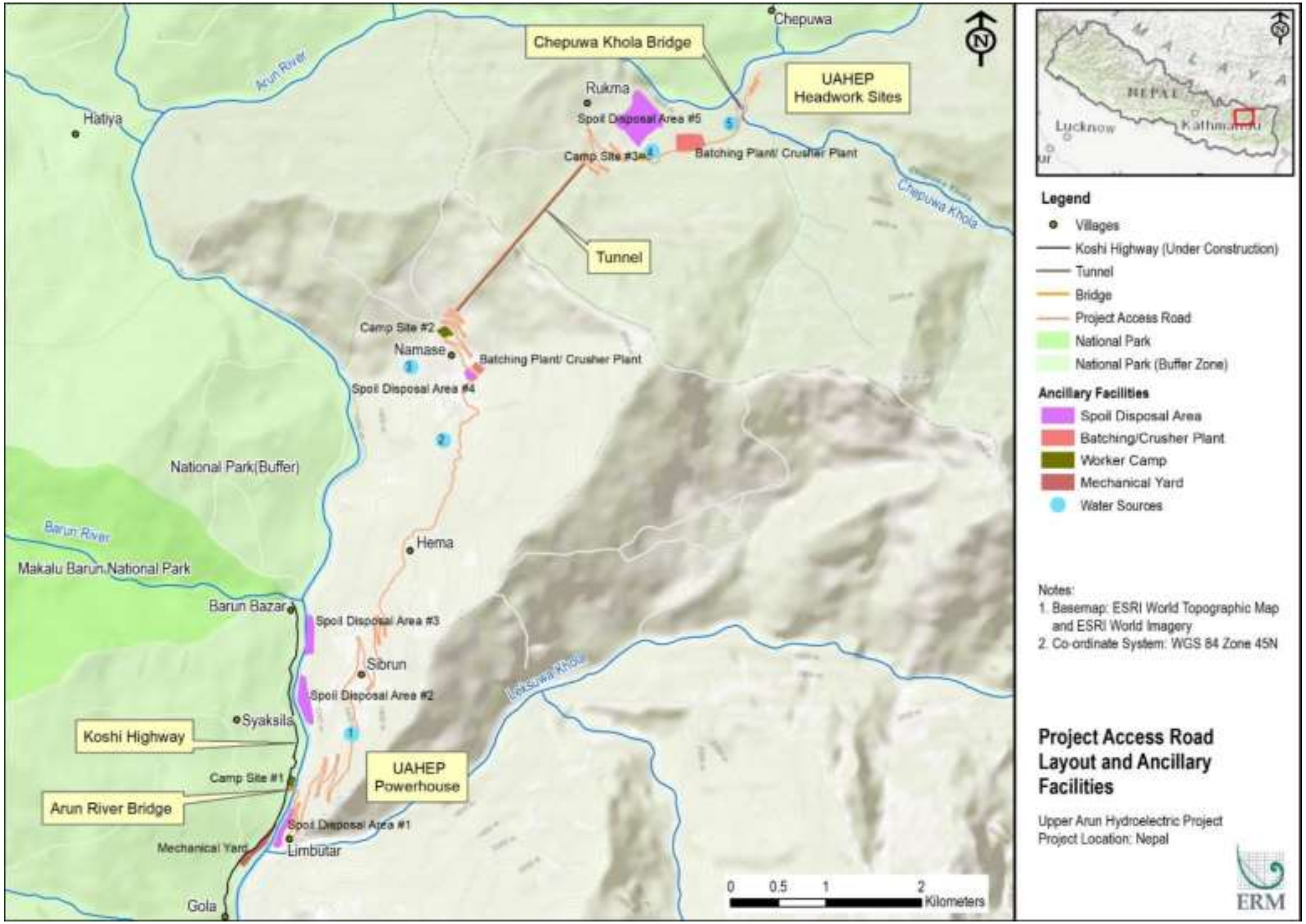
The Project's potential impact on the acoustic environment during the construction phase along the Koshi Highway would be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Moderate***.

Project Access Road Construction

Project access road construction will generate noise from the two proposed crushers and batch plants, three workers' camps/generators, and construction vehicles and equipment along the access road and at the five spoil disposal sites. This construction is expected to last for approximately two years. ***Figure 7.9*** shows the location of these facilities relative to the nearest villages. The access road goes through the villages of Sibrun and Hema and passes very near the villages of Namase and Rukma. The project access road will be immediately adjacent (e.g., less than 5 m) to Sibrun basic school, approximately 60 m from Rukma basic school, and approximately 80 m from the Namase basic school.

The Project's potential impact on the acoustic environment during project access road construction would be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Figure 7.9: Location of Project Access Road and Ancillary Facilities relative to Local Villages



Hydropower Facility Construction

The hydropower facility is the largest element of the overall project construction and will generate the most noise and for the longest period (approximately six years). The major noise generating facilities are listed below:

- Headworks area:
  - Power Plant #1
  - Headworks construction area
  - Quarry
  - Crusher and Batch Plant #1
  - Owner's and contractor's camps
  - Spoil Disposal Area #1
- Headrace tunnel adit portal area:
  - Power Plant #2
  - Batch Plant #2
  - Contractor's Camp #2
  - Spoil Disposal Area #2
- Powerhouse area:
  - Batch Plant #3
  - Power Plant #3
  - Powerhouse construction area
  - Spoil Disposal Area #3
  - Owner's and contractor's camps

Table 7.17 indicates the type and number of noise-generating pieces of equipment and facilities at each construction area*.* ***Figure 7.10*** shows the location of these facilities relative to the nearest villages and ***Table 7.18*** shows the distance from the village to the nearest major noise generating facility, which indicates that the villages of Rukma, Sibrun, Jijinkha, and Barun Bazar are located within 200 m of noise generating facilities.

Table 7.17: Type and Number of Noise-Generating Equipment

Type of Equipment	Headworks Area				Headrace Tunnel Adit Portal Area			Powerhouse			
	Dam	Quarry	Crusher & Batching Plant	Spoil Disposal Area #1 and Owner's and Contractor's Camp	Batch Plant #2	Spoil Disposal area #2	Contractor's Camp #2	Batch Plant	Powerhouse	Spoil Disposal Area#3	Workers' Camp
Excavator	3	2	0	1	0	2	0	0	1	2	0
Bulldozer	4	0	1	1	1	1	0	1	0	1	0
Loader	4	1	1	3	2	0	0	2	0	0	0
Dump truck	20	10	10	20	0	10	0	0	0	10	0
Vibrating roller	1	0	0	1	0	0	0	0	0	0	0
Anchor hole drill	3	0	0	0	2	0	0	0	2	0	0
Concrete spray	10	0	0	0	5	0	0	0	5	0	0
Impact reverse circulation drill	10	0	0	0	0	0	0	0	0	0	0
Hydraulic casing extractor	2	0	0	0	0	0	0	0	0	0	0
Geological drilling rig	2	0	0	0	1	0	0	0	1	0	0
Grout pump	2	0	0	0	1	0	0	0	1	0	0
Axial flow fan	0	0	6	0	3	0	0	4	0	0	0
Belt crane	0	0	1	0	0	0	0	0	0	0	0
High speed belt conveyor	0	0	1	0	0	0	0	0	0	0	0
Cable crane	0	0	1	0	0	0	0	0	0	0	0
Vacuum chute	0	0	1	0	0	0	0	0	0	0	0
Temporary bridge crane	0	0	0	0	0	0	0	1	0	0	0
Concrete pump	0	0	5	0	2	0	0	3	0	0	0
Crawler crane	2	0	0	0	0	0	0	0	0	0	0
Crawler crane	1	0	0	0	0	0	0	0	0	0	0
Vibrating roller, Vibrating joint cutter	6	0	0	1	1	0	0	1	0	0	0
Concrete mixer truck	0	0	16	0	8	0	0	8	0	0	0
Crane on placement surface	2	0	0	0	0	0	0	0	0	0	0
Telescoping steel form	2	0	0	0	2	0	0	0	2	0	0
Flat truck	1	0	0	0	0	0	0	1	0	0	0
Truck crane 50t	1	0	0	0	0	0	0	0	1	0	0
Truck crane 100t	1	0	0	0	0	0	0	0	0	0	0
Penstock transport truck	1	0	0	0	0	0	0	1	0	0	0
Concrete batching plant	0	0	1	0	1	0	0	1	0	0	0
Aggregate crushing plant	0	0	1	0	0	0	0	0	0	0	0
Generators	0	0	0	1	0	0	1	0	0	0	1

Figure 7.10: Location of Hydropower Facilities relative to Local Villages

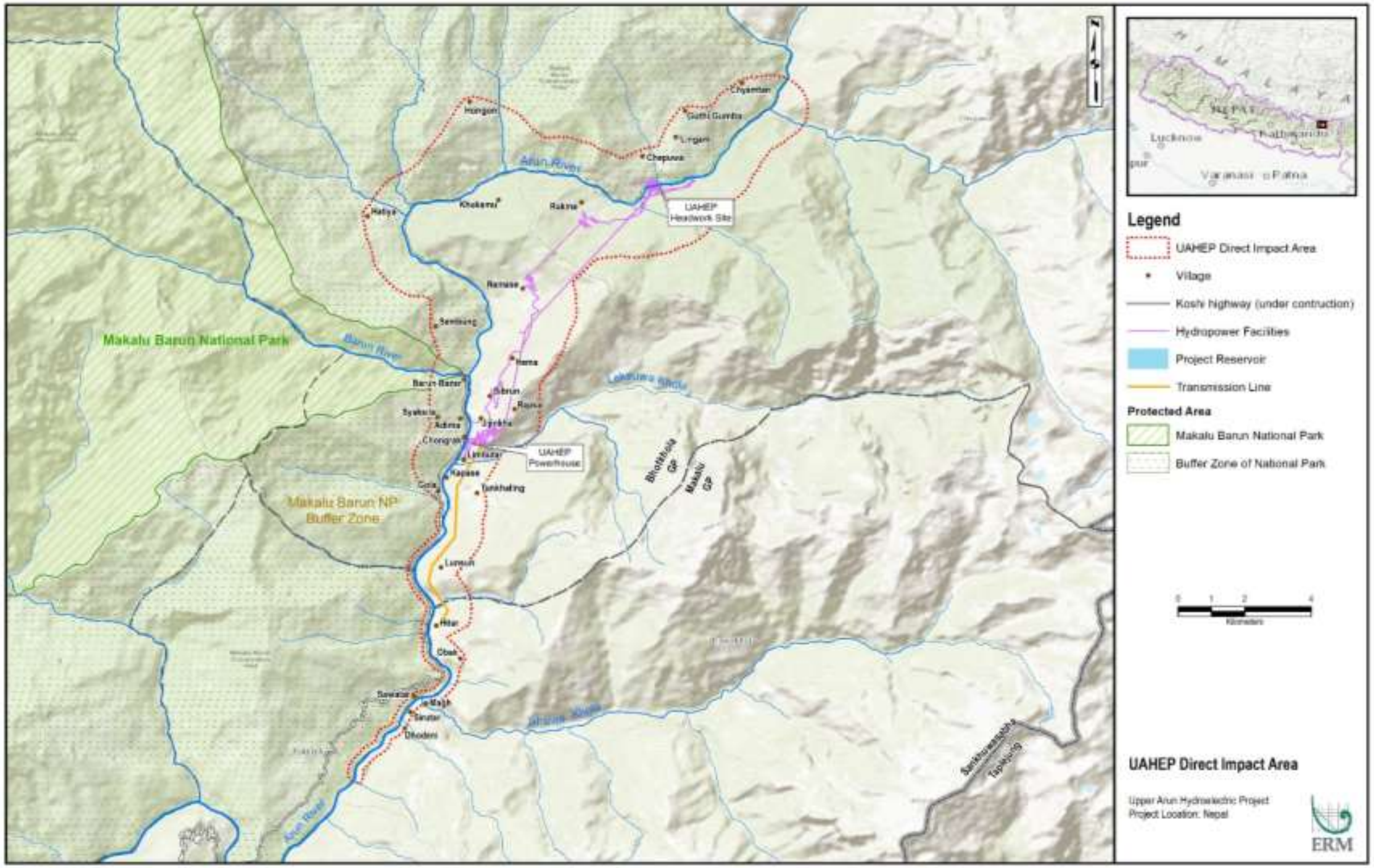


Table 7.18: Proximity of Hydropower Noise Generating Facilities to Villages

Village	Nearest Project Noise Generating Facility	Distance to Nearest Edge of Village
Chepuwa	Headworks construction area	540 m
Rukma	Spoil Disposal Area #1	170 m
Namase	Contractor's Camp #2 and Power Plant #2	600 m
Hema	Spoil Disposal Area #2	400 m
Sibrun	Contractor's Camp #3	100 m
Jijinkha	Contractor's Camp #3 and Spoil Disposal Area #3	190 m
Barun Bazar	Spoil Disposal Area #4	90 m
Syaksila	Contractor's Camp #4	600 m
Gola	Batching Plant #3	1,000 m

Table 7.19 shows the proximity of local schools to hydropower noise generating facilities. Rukma Basic School will have the greatest noise exposure.

Table 7.19: Proximity of Hydropower Noise Generating Facilities to Schools

Village	Nearest Project Noise Generating Facility	Distance
Lingam Secondary School	Headworks construction area	1,200 m
Rukma Basic School	Spoil Disposal Area #1	170 m
Namase Basic School	Contractor's Camp #2 and Power Plant #2	600 m
Sibrun Basic School	Contractor's Camp #3	500 m
Gola Secondary School	Batching Plant #3	1,100 m

The Project's potential impact on the acoustic environment during hydropower facility construction would be direct, adverse, high in magnitude, local in extent, and medium term in duration, with an overall pre-mitigation significance of ***High***.

Transmission Line Construction

The primary source of noise during construction of the transmission line will be portable diesel generator sets and concrete mixers. There will be little to no vehicular access to the tower sites and most construction activities will be done by hand. ***Table 7.20*** shows that noise contribution from transmission tower construction activities will be 56 dBA at 100 meters, which is near the WB's daytime noise standard (55 dBA) for residential areas. Construction of the transmission lines will increase noise in the immediate vicinity of the Project and this will occur periodically as the various waves of work crews pass through each tower site. However, the noise increases will be temporary (i.e., up to about a month duration for a work crew mobilization).

Table 7.20: Predicted Noise Levels during Transmission Line Construction

Equipment Description (Representative)	Reference Sound Pressure Level at 10 meters (dBA)	Predicted Sound Pressure Level (dBA) at Multiple Distances from Construction Site		
		100 meters	200 meters	400 meters
Portable diesel generator (15 kW)	65	45	39	33
Concrete mixer (167 kW)	76	56	50	44
Total noise contribution	76	56	50	44

Note: dBA = A-weighted decibel

Based on the predicted noise levels in ***Table 7.20***, the Project's potential impact on the acoustic environment during transmission line construction is expected to be adverse, direct, medium in magnitude, local in extent (impacts extend only about 100 meters from the tower locations), and short-term in duration (only about four-weeks maximum duration for each work crew mobilization), with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

As a result of these potential noise impacts on local villages, UAHEL will require the Construction Contractor to prepare a Noise and Vibration Management Plan, which will include, at a minimum, the following good practices to minimize noise during construction:

- Prohibit noise-generating construction activities at night (20:00–7:00 hours). Pile driving will only be undertaken during daylight hours (7:00–20:00 hours). Below ground construction activities that do not generate above ground noise are allowed (likely 24 hours/day).
- Provide regular maintenance of equipment and vehicles in accordance with manufacturers' specifications and lowest noise levels possible.
- Use properly designed silencers, mufflers, acoustically dampened panels/noise barriers and acoustic sheds or shields. Mufflers and other noise control devices shall be repaired or replaced if defective.
- Place all hydropower diesel power plants within an acoustic enclosure to reduce impacts on workers at the camps and nearby residences, specifically the workers' camps near the villages of Sibrun, Hema/Namase, and Rukma.
- Install noise barriers (walls, berms or acoustic panels) between the workers' camps and the villages of Sibrun and Rukma;
- Orient equipment known to emit a strong noise in one direction so as to direct noise away from noise sensitive receivers.
- Shut down machines and equipment that may be used intermittently between work periods or throttled down to a minimum.
- Install noise barriers (walls, berms or acoustic panels) between the noise source and nearby receptors, especially for noisy sources such as the crusher, batching plants, and generators. This is specifically required for noise generating facilities near the Sibrun and Namase schools.
- Coordinate with the village to schedule road construction activities near (within approximately 100 m) Sibrun basic school, so as to not conflict with school activities (e.g., schedule construction in this area for late afternoons after school is out or on weekends);
- Construct a new basic school in Rukma on a site agreed upon with the village that is at least about 500 m from the nearest hydropower noise source.

- Avoid disrupting festivals, community rituals, and gatherings, in consultation with communities, including temporarily halting the disposal of spoil in the Spoil Disposal Areas #2, #3 and #4 across the river from Barun Bazar during the Barun Mela (see Section 7.3.15).
- Provide rubber padding and/or noise isolators for fixed construction equipment/machinery to reduce noise and vibration.
- Restrict vehicle speeds to 20 km/hr on site, including on project access and service roads, and the use of horns will be prohibited at night and in villages, except for in an emergency.
- Keep the noise level of vehicle audible warning devices (e.g., back-up beepers or claxons) to the minimum necessary for the health and safety of employees.
- Equip the Contractor's ESHS Team with portable noise monitors to be able to verify noise levels at the sensitive receptors.
- Conduct noise monitoring in the villages of Rukma, Namase, Hema, Sibrun, Jijinkha, and Chongrak to confirm noise levels are in compliance with WB criteria, on a monthly basis and when work activities in the vicinity increase. If monitoring indicates that noise levels are exceeding WB criteria, then the Contractor will apply additional mitigation to reduce noise levels to within WB criteria.

Assuming these mitigation measures are implemented, ***Table 7.21*** presents the Project's predicted noise levels on the affected villages. ***Figures 7.11*** through ***7.14*** below show the noise contours in different project impact areas during day and night-time. The model results indicate that the Project, with appropriate mitigation, will comply with the World Bank EHS Guidelines for noise during both day light and night-time hours.

Table 7.21: Predicted Noise Levels during Hydropower Construction

Village	Predicted Noise Levels (dBA)		World Bank Criteria		Compliance	
	Day	Night	Day	Night	Day	Night
Chepuwa	50	35	55	45	Yes	Yes
Rukma	55	39	55	45	Yes	Yes
Namase	42	36	55	45	Yes	Yes
Sibrun	52	44	55	45	Yes	Yes
Hema	45	34	55	45	Yes	Yes
Barun Bazar	48	34	55	45	Yes	Yes
Jijinkha	52	39	55	45	Yes	Yes
Syaksila	50	42	55	45	Yes	Yes

Note: dBA = A-weighted decibel

Therefore, the Project's potential impact on the acoustic environment during the construction phase along the Koshi Highway would be direct, adverse, low in magnitude, local in extent, and medium term in duration, with an overall residual significance of ***Low***. The Project's potential impact on the acoustic environment during access road construction will be direct, adverse, high in magnitude, local in extent, short term in duration, with an overall residual significance of ***Substantial***. The Project's potential impact on the acoustic environment during hydropower facility construction will be direct, adverse, potentially high in magnitude, local in extent, short term in duration, with an overall residual significance of ***Substantial***. The Project's potential impact on the acoustic environment during transmission line construction will be direct, adverse, low in magnitude, local in extent, short term in duration, with an overall residual significance of ***Low*****.**

Figure 7.11: Daytime Noise Contours – Headworks

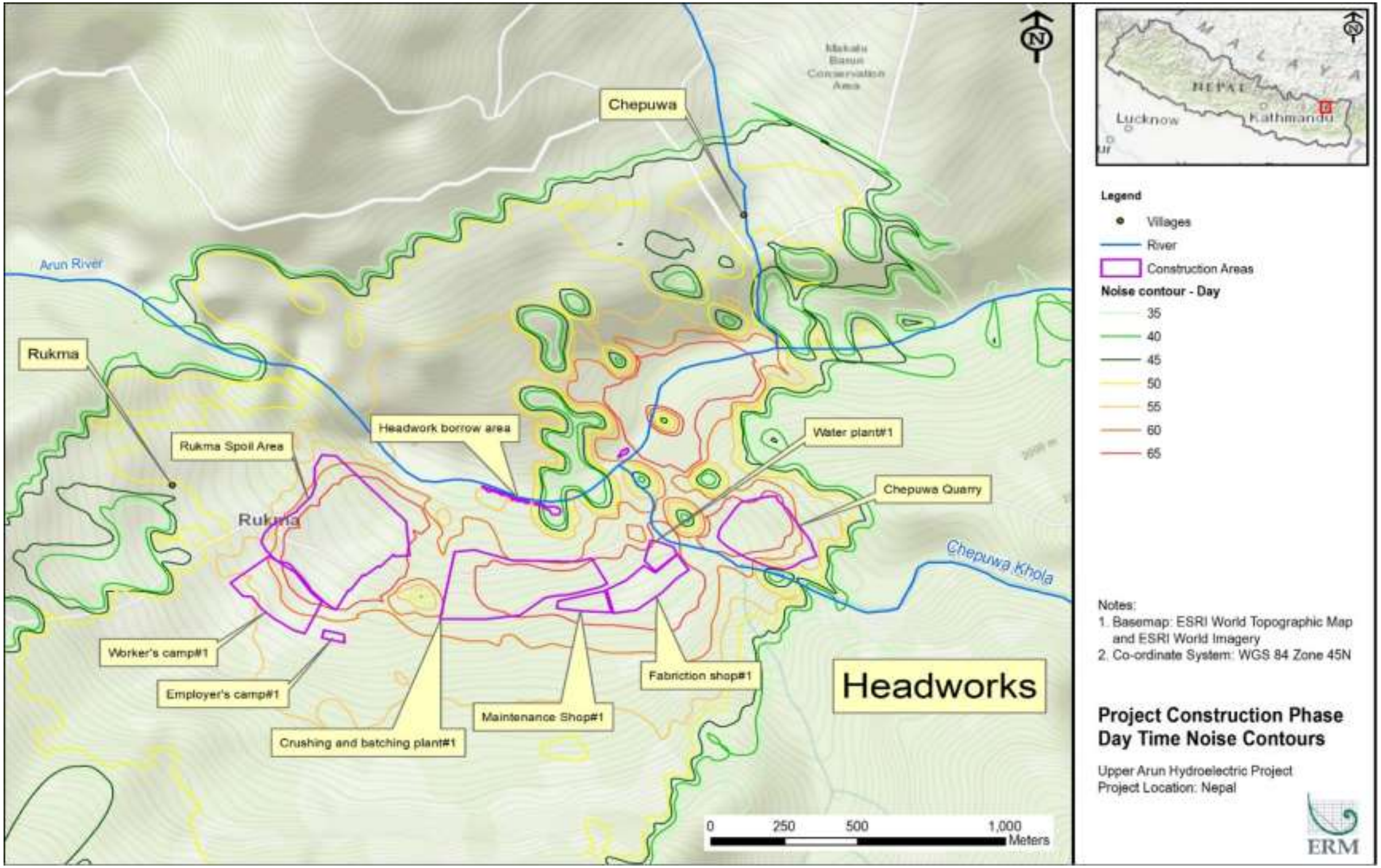


Figure 7.12: Daytime Noise Contours – Waterway Adit and Powerhouse Areas

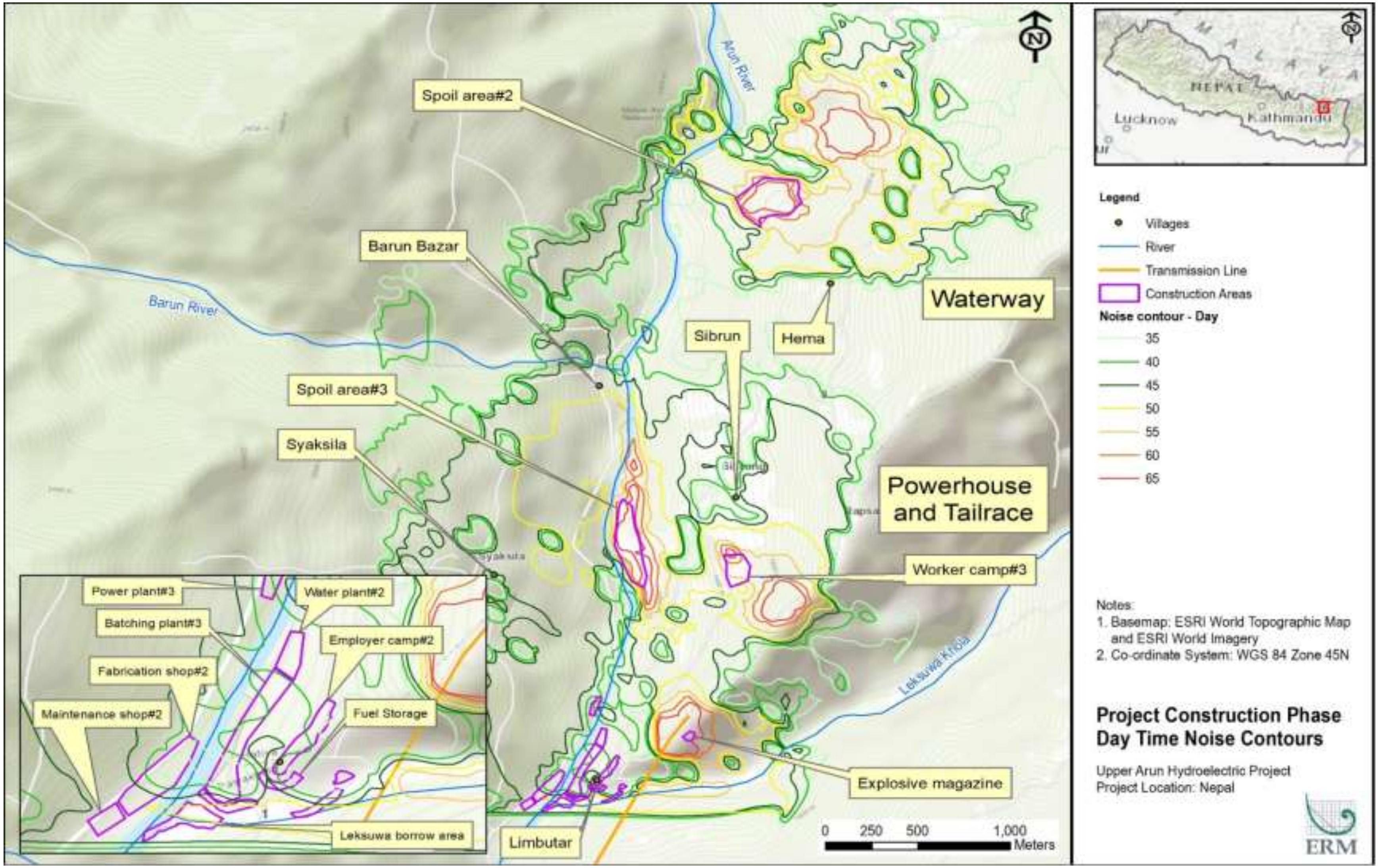


Figure 7.13: Night-time Noise Contours – Headworks Area

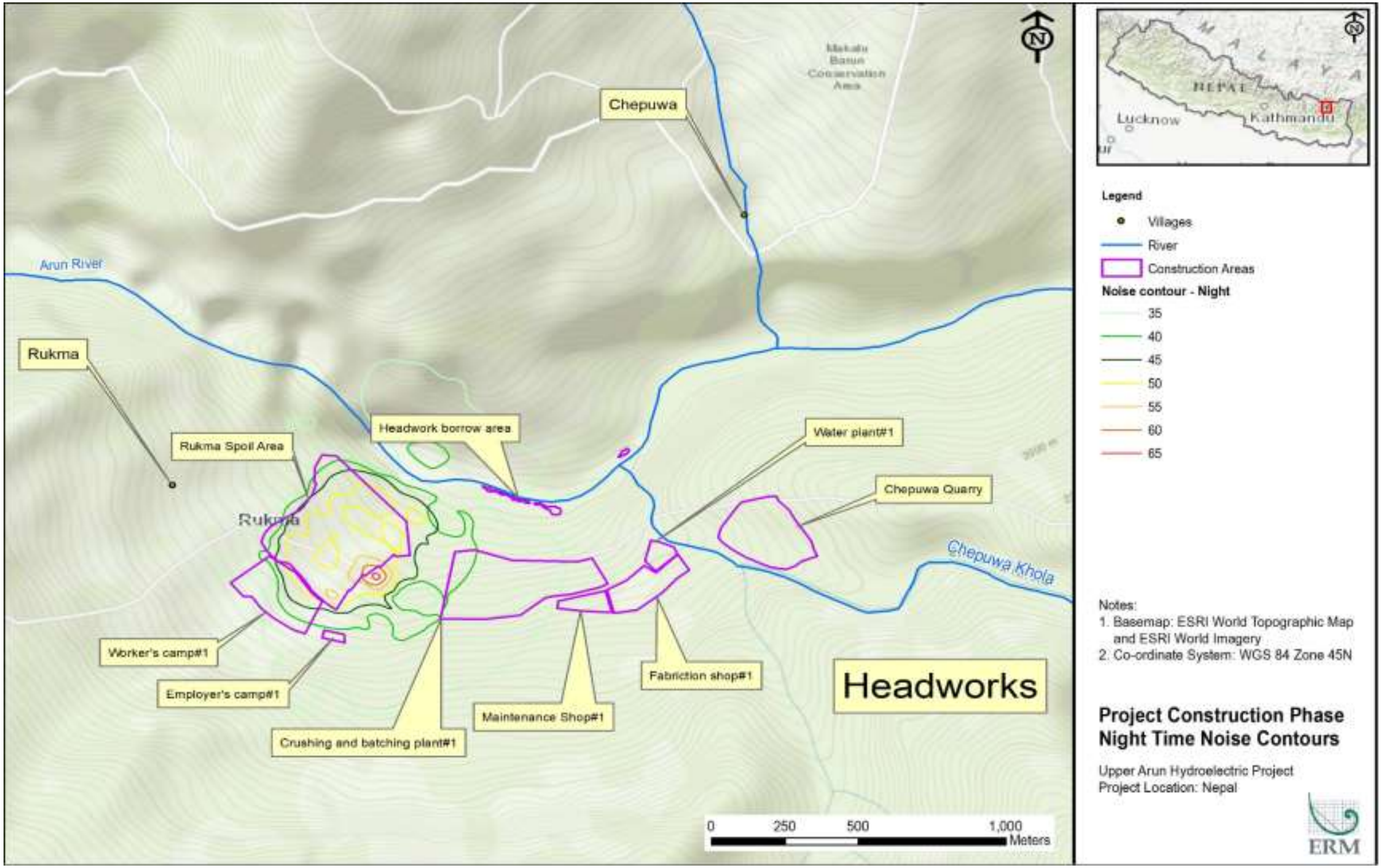
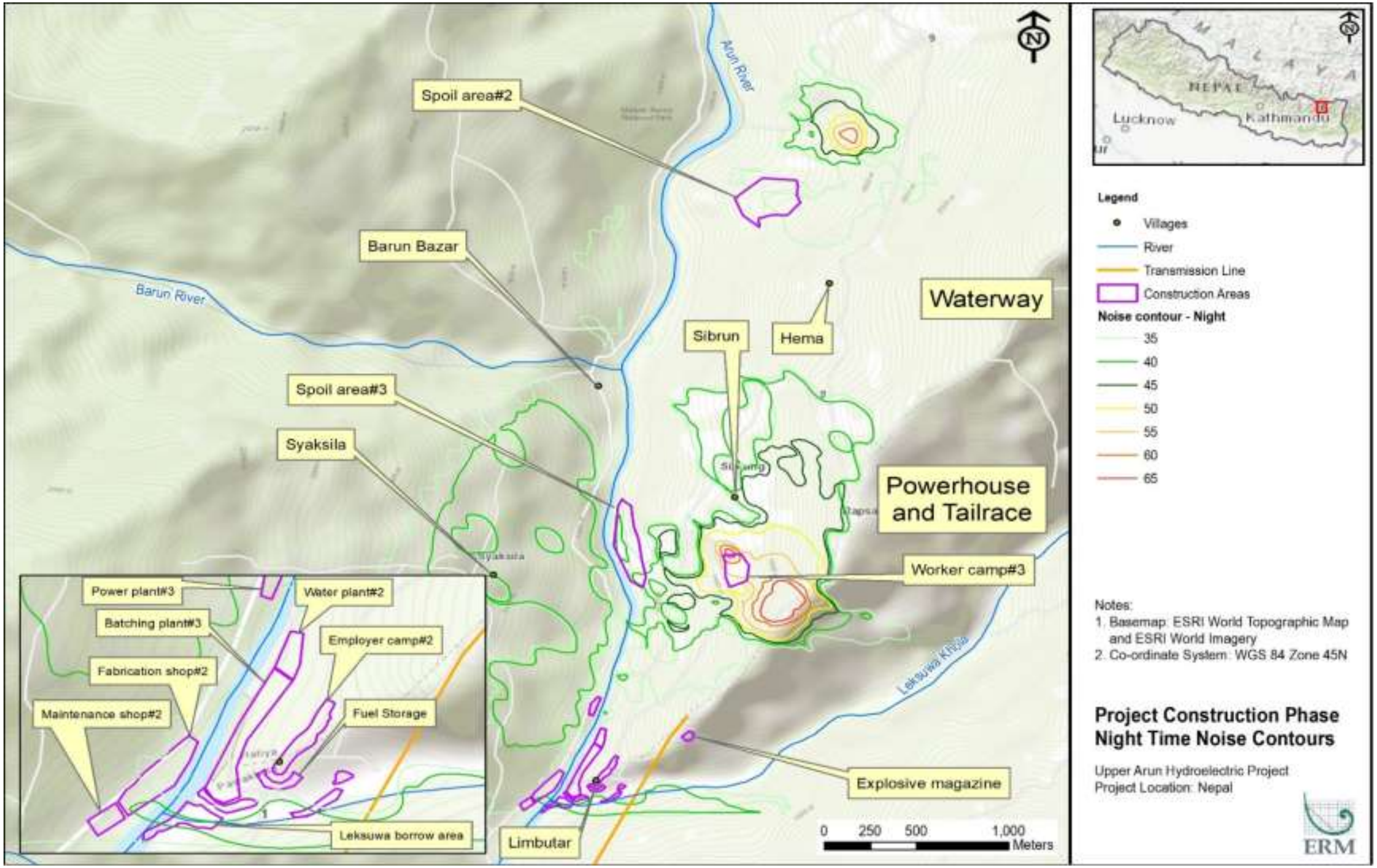


Figure 7.14: Night-time Noise Contours – Waterway Adit and Powerhouse Areas



Explosives

Project construction will require extensive use of explosives during access road construction and possibly for transmission tower construction, but especially for hydropower construction. Much of the use of explosives for hydropower construction will be for underground excavation of the various project tunnels and caverns. The noise generated from this underground blasting will be significantly attenuated by the surrounding rock, although blasting at the tunnel portal entrances will only be able to be heard by local residents. Underground blasting is the only project construction activity that will be carried out at night.

Explosives may also be used on a limited basis for road and transmission tower construction, where large intact hard bedrock or large boulders are encountered that cannot be loosened or removed by other means. Noise from blasting is instantaneous and could reach up to 140 dBA at the blast location or over 90 dBA for noise sensitive receptors within approximately 150 m, depending on the explosive charge. Although noise generated during blasting can cause concern among nearby noise sensitive receptors, blasting is a relatively short duration event, compared to other rock removal methods such as using track rig drills, rock breakers, jack hammers, rotary percussion drills, core barrels, and/or rotary rock drills, which can also generate loud noise.

The above-ground use of explosives will primarily occur during the early years of access road and hydropower construction (years 1–4). Ongoing use of explosives will occur at the quarry site and infrequently at transmission tower locations over the remaining 3 years of construction.

In addition to the use of explosives, implosive devices may also be used during transmission line stringing to make connections between conductors. Implosive charges can generate noise levels of about 120 dBA at a distance of approximately 60 m.

Use of explosives and implosives will generate noise, which may startle or disturb nearby people, livestock, and wildlife. Therefore, the Project's potential impact from noise associated with the use of explosives and implosives during the construction phase is expected to be adverse, direct, high in magnitude, local in extent, and short-term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following measures, consistent with international good practice, to reduce noise generation from the use of explosives:

- Notify nearby households of expected use of explosives and implosives and associated warning sirens.
- Limit above-ground/portal entrance explosives and implosives use to daylight hours.
- Limit the explosive charge to the minimum necessary, especially when in proximity (within 250 m) of any residential homes.

Taking these mitigation measures into consideration, the Project's potential impact from noise associated with the use of explosives and implosives during the construction phase is expected to be adverse, direct, medium in magnitude, local in extent, and short-term in duration, with an overall residual significance of ***Moderate***.

Helicopters

As a result of the Project's relatively remote location and the uncertainty regarding the condition of the Koshi Highway, which is currently under construction, it is anticipated that helicopters will likely be used to transport some construction equipment, materials, staff, and visitors to the project site. Helipad sites are planned for the three Road Contractor's camps (i.e., near the villages of Chongrak, Namase, and Rukma, which are in close proximity to the Arun River bridge, south road tunnel portal, and north road tunnel portal) and the Rukma and Sibrun Hydropower Contractor's camps. No helipad sites are proposed for the transmission line construction, but helicopters may be used to transport construction materials to more remote tower sites, where these materials will be lowered to the proposed tower pads, while the helicopter hovers above. Noise levels will increase in the vicinity of these tower pad locations when helicopters are in use.

Helicopter use is currently planned to be on an as needed basis, but will be at least seasonally limited by weather conditions (i.e., monsoon rain and low cloud cover will likely limit helicopter access to the Project for much of the period from May to September). Helicopters can generate noise up to approximately 90 dBA at approximately 150 m from the aircraft (Malcolm Hunt Associates 2017), although this varies with the size of the helicopter. Helicopter noise can startle people, livestock, and wildlife.

The Project's potential impact from noise associated from the use of helicopters during the construction phase is expected to be adverse, direct, medium in magnitude, local in extent, and short-term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following measures, consistent with international good practice, to reduce noise generation from the use of helicopters:

- Limit helicopter landings to designated landing pads at the Road Contractor and Hydropower Contractor work camps.
- Notify nearby households of expected arrival and departure of helicopters.
- Prohibit helicopters from hovering at low altitudes near residential areas other than when delivering materials or equipment to transmission tower sits where landing pads are not provided.
- Limit helicopter use to daylight hours.

Taking this mitigation measures into consideration, the Project's potential impact from noise associated with the use of helicopters during the construction phase is expected to be adverse, direct, low in magnitude, local in extent, and short-term in duration, with an overall residual significance of ***Low***.

Operation Phase

The Project will have negligible noise emissions during operations as the powerhouse will be underground and all equipment will be operated by project generated electricity. There will be some noise associated with the two owner's camps, but this will be similar to noise from any residential area. There will be some noise associated with vehicle use between the powerhouse and headworks sites, and periodic deliveries of goods and materials by truck from outside of the project impact area, but this will be similar to normal road noise as the projected traffic volumes are low.

Therefore, the Project's potential impact on the acoustic environment during operations will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project is predicted to have negligible impact on noise during operations, however, UAHEL will implement the following measures, consistent with international good practice:

- Provide manufacturer-specified maintenance of vehicles.
- Implement a grievance procedure so that local residents can submit complaints about noise.
- Limit night-time vehicle traffic between the powerhouse and headworks area.
- Prohibit night-time deliveries to the headworks area.

Taking into consideration these mitigation measures, the Project's potential impact on the acoustic environment during operations will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

7.1.10 Vibration

This section evaluates the potential impacts of project-generated vibration on structures within the project impact area.

Avoidance and Minimization Measures

There were no avoidance measures related to vibrations identified.

Construction Phase

Project construction will generate vibrations as a result of the use of explosives for underground tunnelling, at the quarry, and in some cases to remove rock to level land (e.g., for transmission towers), and due to the transport by truck of large and heavy equipment and machinery from Kathmandu and India to the project site.

Underground Blasting

The Project will be excavating several underground facilities, including the project access road tunnel, river diversion tunnel, sediment bypass tunnel, headrace tunnel, powerhouse cavern/access tunnel, and the tailrace tunnel. Most of these tunnels/caverns are distant from any villages and hundreds of meters underground, so the risk of vibration is low.

The road tunnel is the closest excavation both horizontally (about 366 m to the closest structure at the south portal and about 418 m to the closest structure at the north portal) and vertically to a village, so was evaluated as indicative of the worst case. The analysis indicates that a conservative critical vibration speed for masonry structures (0.3 cm/s) would extend about 113 m from the tunnel portals, so would not impact the nearest structures (***Figures 7.15*** and ***7.16***). Nevertheless, most local houses are built with stone or wood and are susceptible to damage from vibration.

Figure 7.15: Vibration at North Road Tunnel Portal

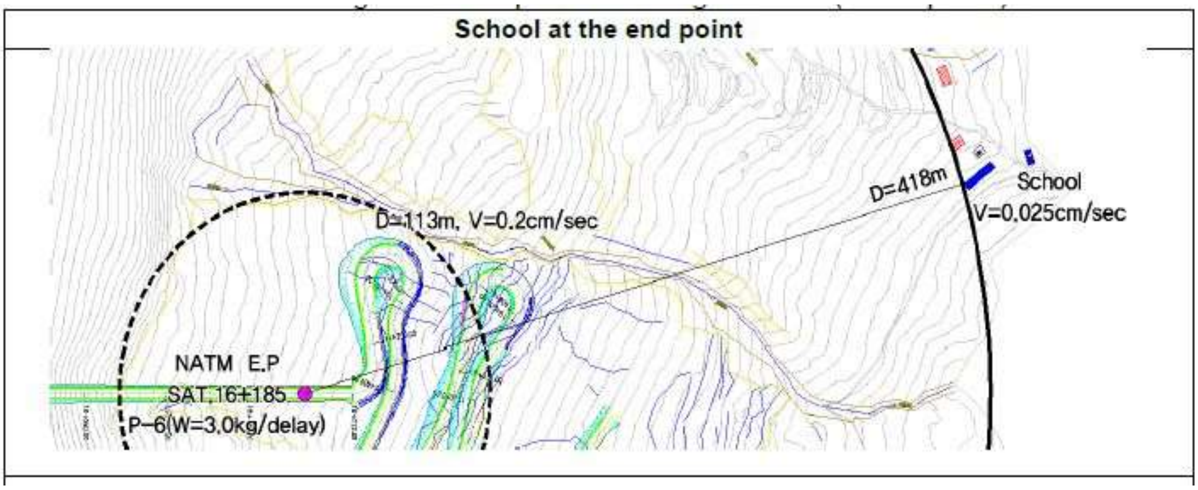
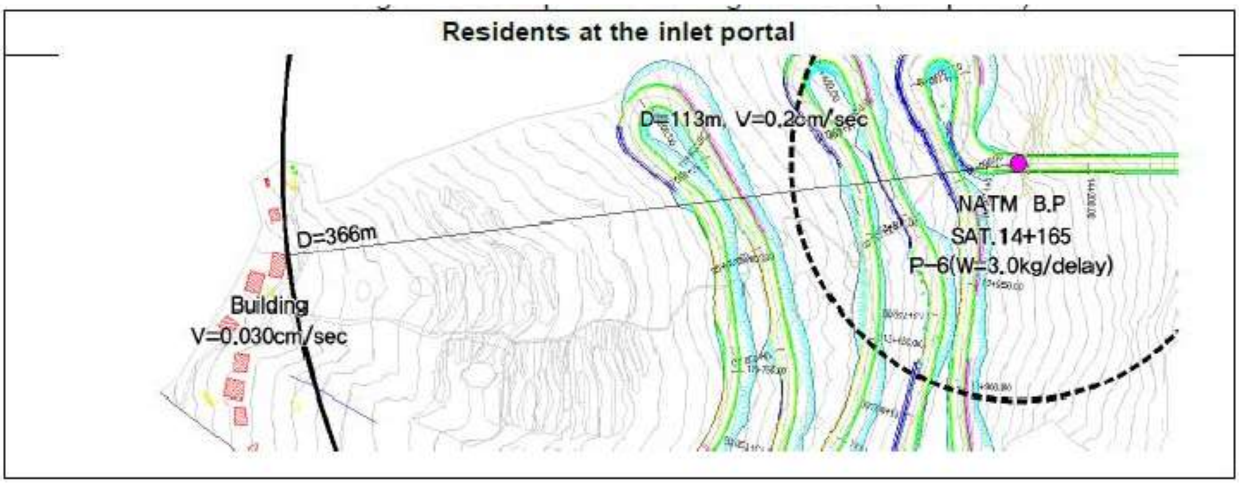


Figure 7.16: Vibration at South Road Tunnel Portal



Quarry

The proposed quarry location is relatively isolated and removed from other privately structures (~1.5 km) so should not result in any damage to these structures.

Heavy Truck Traffic

Vibration from trucks is difficult to analyze, as it is determined by many factors. The trucks hauling heavy equipment and machinery on the Koshi Highway from Khandbari to the project site pass by many houses that are located only a few feet from the road. There is potential for vibration from these trucks to cause damage.

Summary

Based on the above analysis, the Project's potential impacts resulting from vibration during construction will be direct, adverse, high in magnitude (taking into consideration the susceptibility of local residences to damage from vibration), local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

To manage vibration-related impacts from access road, hydropower facility, and transmission line construction, the Contractor will implement the following measures to mitigate the risk of damage from vibration:

- Conduct a physical inspection of all structures that could be potentially affected by construction related vibration (e.g., from blasting or heavy truck traffic) to document the pre-existing condition of the structures using photography or video. This shall include structures within 25 m of heavy truck traffic (i.e., along project transportation corridor and access road), 100 m of active construction sites, and 250 m of any blasting (including the quarry, road tunnel portals, and other locations where aboveground or below ground blasting will be used).
- Limit the explosive charge to the minimum necessary, especially when in proximity (within 250 m) to any residential houses.
- Monitor vibrations from blasting (e.g., using accelerometers) at strategic locations (e.g., near villages and landslide prone areas) to confirm the extent and magnitude of vibration impact.
- Promptly investigate any claims of damage from construction activities.
- Provide compensation at repair or replacement value for any damage caused by project-related construction activities in accordance with the GRM procedures.

- The Contractor is responsible for any damage caused by construction activities.

Taking into consideration these mitigation measures, the Project's potential impacts resulting from vibration during construction will be direct, adverse, medium in magnitude (taking into consideration the proposed compensation for any damage), local in extent, and short term in duration, with an overall residual significance of ***Moderate***.

Operation Phase

The Project should pose negligible vibration risk during operations, as no more blasting and little heavy truck traffic will occur. Therefore, the Project's potential impacts resulting from vibration during operations will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Project is predicted to have negligible vibration risk during operations, but UAHEL will implement the following measures, consistent with international good practice:

- Limit truck speeds to 20 km/hr within village or near buildings.
- Maintain a GRM procedure so that local residents can submit complaints about damage from vibration.

Taking into consideration these mitigation measures, the Project's potential impacts resulting from vibration during operations will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

7.1.11 Land Cover

Project construction and operations will result in change to existing land cover, as some forest and agricultural land will be converted to developed land used for access road, hydropower, and transmission line purposes. These project effects are quantified in this section, but the significance of the changes in forest cover is evaluated in Section 7.2.3 (Effects on Terrestrial Habitat) and Section 7.3.4 (Effects on Ecosystem Services) and agricultural land cover is evaluated in Section 7.3.2 (Impacts Associated with Land Acquisition and Physical/Economic Displacement).

Avoidance and Minimization Measures

The Project will adopt the following measures to avoid or reduce impacts on land cover, in accordance with the application of the mitigation hierarchy:

- Locate project facilities to avoid settlements and houses to the extent possible.
- Locate project facilities to minimize impacts on forest and agricultural land uses to the extent possible.
- Reduce land disturbance by locating some project facilities (e.g., powerhouse, portion of access road) underground.
- Locate transmission towers so the transmission lines can span the stream valleys without requiring forest clearing.
- Prohibit the construction of new access roads for transmission tower construction, which will significantly reduce forest clearing. Rather construction materials will be transported to tower sites by porters and pack animals.

Construction Phase

The Project will affect various land covers, which primarily includes clearance of forest and disturbance of agricultural land for various construction activities such as establishing laydown areas; constructing the substations and towers; and clearing portions of the RoW.

The entire project footprint totals 232.14 ha, including 59.5 ha for the access road RoW, 212.1 ha for the hydropower area of disturbance, and 27.7 ha for the transmission line RoW. The total area of disturbance will be 292.1 ha, as 7.2 ha of the transmission line RoW will not be disturbed as the transmission line will span over these areas. ***Table 7.22*** shows the estimated change in land cover as a result of the Project.

Table 7.22: Project Changes to Land Cover

Land Cover	Project Footprint Land Cover (ha)				
	Existing	Disturbed	Undisturbed	Net Change	Future
Forest	175.1	169.3	5.8	-158.6	16.5
Agriculture	103.6	102.4	1.2	-54.0	49.6
Grassland	4.0	4.0	0.0	+20.0	24.0
Rock/Scree	8.0	7.9	0.1	-2.0	6.0
Water	8.2	8.1	0.1	+0.0	8.2
Developed	0.4	0.4	0.0	+180.5	180.9
Maintained RoW	0.0	0.0	0.0	+14.1	14.1
Total	232.14	292.1	7.2	0	232.14

The impacts associated with changes in land use/land cover are primarily related to impacts on forest and agricultural land, which are discussed in Sections 7.2 and 7.3, respectively. Therefore, a separate significance rating is not provided for these land use and land cover impacts.

Operation Phase

There will be no additional changes to land cover during the operation phase.

7.1.12 Landscape Values and Visual Amenity

Project construction activities and the permanent civil works facilities will affect landscape values and visual amenities, which are discussed below.

Avoidance and Minimization Measures

The Project will adopt the following measures to avoid or reduce impacts on landscape values and visual amenity, in accordance with the application of the mitigation hierarchy:

- Site project dam and reservoir to avoid impacts on Chepuwa Falls.
- Locate powerhouse underground.
- Relocate powerhouse borrow areas to avoid impacts on Barun Mela.

Construction Phase

Project construction will disturb approximately 300 ha of land and introduce construction activity and forest clearing in a predominantly natural or rural agrarian landscape. Some of this disturbance will be visible from key visual amenities like Chepuwa Falls and the Barun Mela.

The Project's potential impact on landscape values and visual amenities during construction will be direct, adverse, high in magnitude, local in extent, and medium term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

There are limited opportunities to mitigate the impacts of construction activities on landscape values and visual amenities, but the following mitigation measures are proposed:

- Maintain forest cover around Chepuwa Khola waterfall to maintain the scenic integrity of this important visual feature.
- Restore disturbed areas to pre-construction conditions as soon as possible in a progressive manner.

Taking these proposed mitigation measures into consideration, the Project's potential impact on landscape values and visual amenities during construction will be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Substantial***.

Operation Phase

The Project will result in permanent on-going impacts on landscape values and visual amenities by introducing large, modern facilities into an otherwise predominantly natural and rural agrarian landscape. Many of the project facilities are underground (e.g., headrace tunnel, powerhouse), which reduces the Project's impacts on landscape values and visual amenities. The project dam, however, has to be aboveground and will be visually prominent, but only within a relatively small viewshed, which includes the village of Rukma and short portions of various trails along the Upper Arun River gorge area. The dam will not be visible to most of the households in Chepuwa, Lingum, Guthigumba, and Chyamtan, as the steep topography will block the view, although portions of the reservoir and Spoil Disposal Area #1 will be visible from some locations.

Views of the dam elsewhere up or down the river will be limited because the river meanders and the gorge setting. The dam will not be visible from the culturally significant Barun Bazar area, which hosts the Barun Mela, but from this area a person will be able to see Spoil Disposal Areas #3 and #4, which lie across the Arun River.

Further, the Barun Bazar area is located along the diversion reach and will be affected by the reduced river flow. The Mela is held every year in January when Arun River flows are typically near their annual low, but under project conditions the flow would be further reduced by 90%.

Table 7.23 evaluates project impacts on key viewpoints identified in Section 6.1.12.

Table 7.23: UAHEP Key Viewpoints

Key Viewpoints	Visible Project Features and Distance	Landscape Sensitivity	Degree of Effect
Chepuwa Khola Waterfall from both sides of the Arun River	Dam – Foreground Eco-flow powerhouse – Foreground Spoil Disposal Area #1–-Middleground	High	High
Upper Arun River Gorge from both sides of the Arun River	Diversion reach – Middleground	Medium	Medium
Cultural Sites Overlooking River	Diversion reach – Middleground Spoil Disposal Area #2 – Background	Medium	Medium
Barun River Confluence/Mela Site	Spoil Disposal Area #2 – Middleground Spoil Disposal Area #3 – Middleground Spoil Disposal Area #4 – Foreground	High	High

Crest of Namase to Rukma Trail	Spoil Disposal Area #2 – Middleground Spoil Disposal Area #4 – Background Project access road – Middleground	Medium	Low

In summary, the Project's potential impact on landscape values and visual amenities will be direct, adverse, high in magnitude (which takes into consideration both the landscape sensitivity and degree of impact), local in extent, and long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures, consistent with international good practice:

- Restore vegetative cover over Spoil Disposal Areas #1 and #2 to reduce their contribution to visual impacts on Chepuwa Khola waterfall and Arun Gorge area, respectively.
- Provide enhanced vegetative cover over Spoil Disposal Areas #3 and #4 to reduce their visual impact on Barun Bazar/Mela site.

In summary, the Project's potential impact on landscape values and visual amenities will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Substantial***.

7.1.13 Summary

Table 7.24 provides a summary of the pre-mitigation and post-mitigation (residual) impact significance for both construction and operation phases as described above.

Table 7.24: Summary of Project Construction and Operation Phase Impact Significance (on Physical Environment)

Impact	Pre-Mitigation Significance	Post-Mitigation/ Residual Significance
Construction Phase		
Project road slope failure	High	Substantial
Spoil disposal areas slope failure	High	Substantial
Transmission line slope failure	Low	Low
Natural hazards	Substantial	Moderate
Erosion and sedimentation	High	Moderate
Soil compaction and damage	Moderate	Low
Effects on Arun River flow	Low	Low
Effects of tunnelling on local springs	Substantial	Moderate
Effects of water demands	Moderate	Low
Sediment transport and deposition	Low	Low
Stormwater runoff	Substantial	Moderate
Wastewater disposal and discharge	High	Substantial
Improper solid waste disposal	High	High
Hazardous materials/waste management	Substantial	Low
Emissions from large diesel power plants	Substantial	Moderate
Emissions from aggregate crushing plant	Moderate	Low
Emissions from concrete batching plants	Substantial	Moderate

Impact	Pre-Mitigation Significance	Post-Mitigation/ Residual Significance
Emissions from road and non-road diesel engine	Moderate	Low
Emissions from small diesel generators	Low	Low
Fugitive dust emissions	Substantial	Moderate
Greenhouse gas emissions	Low	Low
Project transportation corridor traffic noise	Moderate	Low
Project access road construction noise	Substantial	Substantial
Hydropower facility construction noise	High	Substantial
Transmission line construction noise	Low	Low
Noise from explosives	Substantial	Moderate
Noise from helicopters	Moderate	Low
Vibration	Substantial	Moderate
Landscape values	Substantial	Substantial
Operation Phase		
Project roads slope failure	Substantial	Moderate
Transmission tower slope failure	Low	Low
Reservoir slope failure	Moderate	Low
Spoil disposal area slope failure	Substantial	Substantial
Natural hazards	Moderate	Moderate
Erosion and sedimentation	Moderate	Low
Effects on Arun River flow	Low	Substantial
Effects of tunnelling on local springs	Moderate	Moderate
Effects of water demands	Low	Low
Sediment transport/deposition in the reservoir	Low	Moderate
Sediment transport/deposition downstream from the dam	Low	Moderate
Stormwater runoff	Moderate	Low
Wastewater disposal and discharge	Substantial	Low
Reservoir water quality	Low	Low
Diversion reach water quality	Low	Low
Downstream from powerhouse water quality	Low	Low
Hazardous materials and waste	Low	Low
Project emissions	Substantial	Low
Greenhouse gas emissions	Low	Low
Project noise emission	Low	Low
Project vibrations	Moderate	Low
Landscape values	Substantial	Substantial

7.2 Impacts on Biological Environment

This section identifies and evaluates project risks and impacts on the biological environment, including both terrestrial and aquatic biodiversity, and recommends appropriate measures based on the mitigation hierarchy to manage these impacts to meet World Bank and European Investment Bank standards.

As required by the WB ESF ESS, the Project has applied the mitigation hierarchy (avoid, minimize, mitigate, and offset, in that order) to achieve relevant targets for biodiversity conservation. A no net loss/net gain assessment has been included in the Biodiversity Management Plan (see Appendix C, ESMP, Annex C3) prepared for the Project. This assessment identifies measures to compensate for residual impacts on biodiversity values through the implementation of biodiversity offsets.

7.2.1 Introduction

The Project will cause a range of construction and operation phase impacts, which could affect terrestrial and aquatic biodiversity values within the Project's Ecologically Appropriate Area of Analysis (EAAA), including effects on legally protected and internationally recognized areas of high biodiversity value.

Key terrestrial impacts include:

- Loss of natural and critical habitats from construction of the access road, hydropower facility (i.e., dam and reservoir), transmission line, and related ancillary facilities; and loss of natural and critical habitat from potential induced clearing of vegetation within the EAAA through access by the local community
- Disturbance and/or displacement of fauna from light, noise and vibration emissions from construction activities associated with all project components
- Barrier creation, fragmentation, and edge effects from the access road, hydropower facility (e.g., reservoir), and transmission line during construction and continuing during operation
- Natural and critical habitat degradation associated with pollution, invasive species, and induced access leading to an increase in the collection of wood and timber products in natural habitats associated with all project components, primarily during construction
- Wildlife mortality resulting from vehicle strikes, land clearing machinery, transmission line collision, hunting, and poaching incidents with all project components during construction and operation

Key aquatic impacts include:

- Loss or conversion of aquatic natural habitat associated with dam construction and the impoundment of the project reservoir
- Degradation of aquatic habitat within the diversion reach
- Degradation of aquatic habitat from peaking operations
- Limitations on fish movement and migration from dam construction and operation
- Impingement and entrainment of fish
- Potential for gas super-saturation resulting gas bubble disease in fish

Most of the potential project impacts on biodiversity will occur during construction, but are permanent and extend throughout the operation phase. Therefore, the construction and operation phase impacts are assessed together in the sections below.

7.2.2 Legally Protected and Internationally Recognized Areas of High Biodiversity Value

There are several legally protected and internationally recognized areas of high biodiversity value within the Project's EAAA, including the MBNP and IBA, the Khandbari-Num Forests IBA, and the Qomolangma UNESCO Man and the Biosphere Reserve. The EAAA does not include any Ramsar Wetlands of International Importance, Alliance for Zero Extinction Sites, or World Heritage Natural Sites.

Avoidance and Minimization Measures

Applying the mitigation hierarchy, the Project has carefully sited various project and ancillary facilities to avoid or minimize impacts on these legally protected and internationally recognized areas of high biodiversity value, including the following (also see Chapter 4: Project Alternatives):

- Avoided all direct impacts on the MBNP Core Area, Khandbari-Num Forests IBA, and Qomolangma UNESCO Man and Biosphere Reserve.
- Avoided placement of any non-essential facilities within the MBNP Buffer Zone. All proposed permanent facilities located within the MBNP Buffer Zone are unavoidable (i.e., such as the dam, reservoir and portions of the access road and Arun River bridge, which have no feasible alternative locations available – see Chapter 4: Project Alternatives); originally proposed or considered permanent facilities have been shifted out of the MBNP Buffer Zone (i.e., diversion tunnel, headworks borrow areas, Barun borrow area, Water Plant #2); and proposed temporary facilities have been minimized to the extent possible within the MBNP Buffer Zone. (i.e., including construction access roads in the headworks area, and the maintenance shop, fabrication shop, power plant, and workers camp, which were all located on disturbed land within the Buffer Zone with no reasonable practicable alternatives).
- Co-located hydropower ancillary facilities (e.g., contractor camps) to the extent possible to reduce project land requirements and habitat impacts within the MBNP Buffer Zone.
- Optimized reservoir FSL to minimize impacts on land within the MBNP Buffer Zone.

Impact Assessment

The Project will affect portions of the MBNP Buffer Zone, which is a nationally and internationally recognized protected area, and is classified as an IBA (Criteria A1, A2, A3). Terrestrial areas that maintain populations of the four critical habitat-qualifying terrestrial species also qualify as critical habitat (WB ESF ESS 6). The Project will not directly impact any of the MBNP Core Area, only the Buffer Zone. As ***Table 7.25*** indicates, the Project will disturb 35.55 ha of MBNP Buffer Zone (of which, 21.803 ha is government owned forest land and 13.751 ha is private land).

Table 7.25: Project Impacts on Protected Areas

Project Facility	Area Affected	Duration	Permanent Impacts
Dam Intake	MBNP BZ	Permanent	21.89
Reservoir	MBNP BZ	Permanent	0.28
Bridge #2	MBNP BZ	Temporary	0.08
Road #2	MBNP BZ	Permanent	1.28
Constructors Adit #6		Permanent	0.23
Road #3	MBNP BZ	Permanent	0.67
Road #4	MBNP BZ	Permanent	2.45
Extra Road #3	MBNP BZ	Permanent	0.13
Fabrication Shop #2; Maintenance Shop #2	MBNP BZ	Permanent	2.52
Construction Camp #4; UAHEP Camp #1	MBNP BZ	Permanent	1.14
Aggregate Crushing and Concrete Plant #1	MBNP BZ	Permanent	1.16
Access Road and Ancillary	MBNP BZ	Permanent	3.72
Total			**35.55 ha**

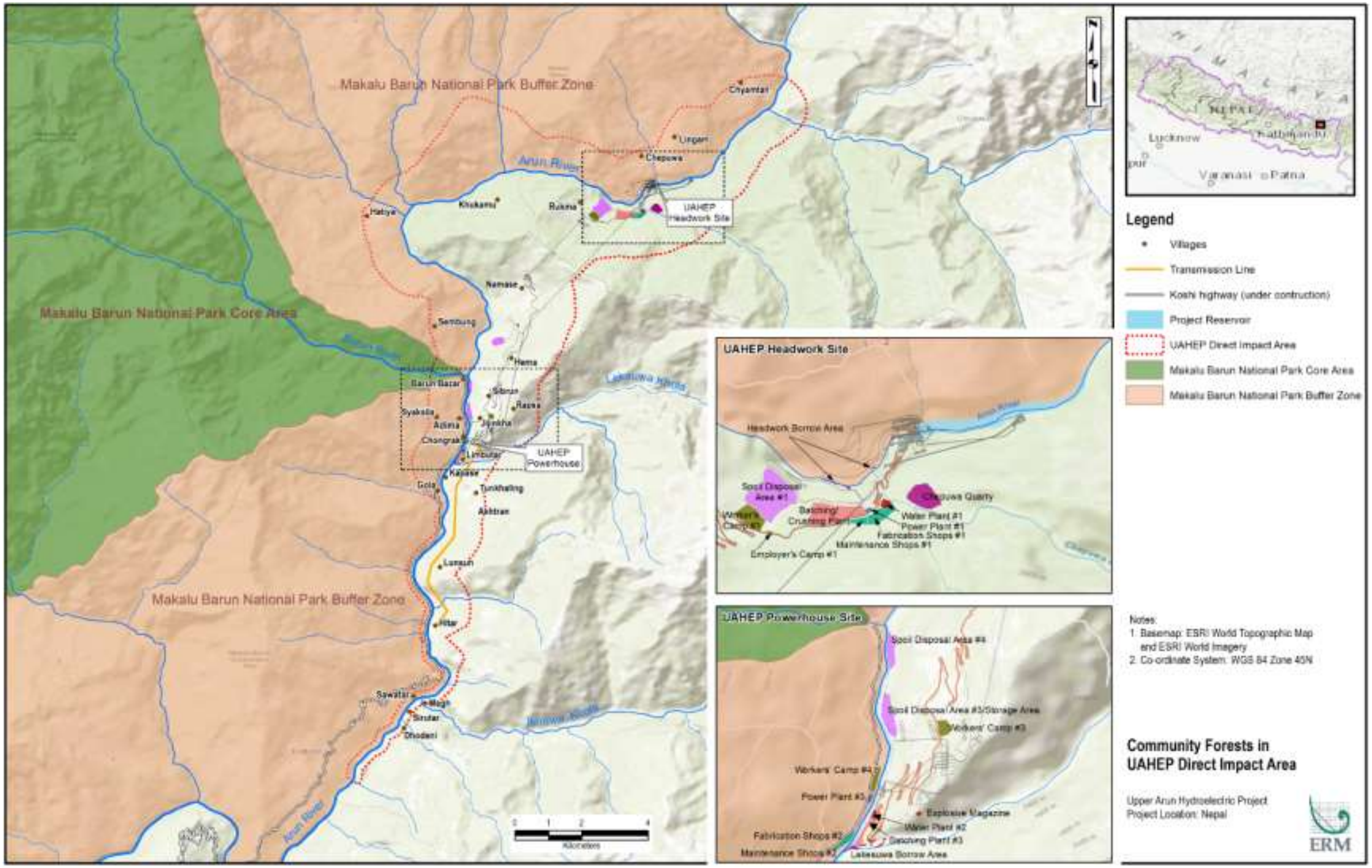
The proposed permanent facilities will unavoidably impact on the MBNP Buffer Zone, as the dam and reservoir must be located on the Arun River and the park boundary extends to the centerline of the river. The Project also requires a project road to access the site, which currently does not have vehicular access. It is impossible for any hydropower project on the Upper Arun River to avoid impacting on the MBNP, as the park Buffer Zone boundary extends along the centerline of the river from downstream from the Arun-3 HEP all the way to the China border. The proposed temporary facilities are all located on disturbed lands being used for agricultural purposes or are currently vacant land. ***Figure 7.17*** shows the location of all proposed project facilities relative to the MBNP core and buffer zone. The purpose of the Buffer Zone is to provide some degree of protection to the park core, while still allowing compatible and sustainable development.

The Project has reduced impacts on the MBNP by maximizing the use of the Koshi Highway, which is under construction, minimizing project facilities located within the MBNP, and routing the Project's transmission line on the left bank of the river outside of the park. The proximity of the Project, and its large construction workforce, to MBNP, however, creates the potential for direct and indirect impacts on the MBNP through illegal logging, clearing, hunting, poaching, and collection of animal and plant species, as well vehicle strikes.

The EAAA also encompasses the Khandbari-Num Forests IBA (Criteria A1). The Project will not directly impact this IBA, as it is located about 10 km to the south of the project site. Vehicles travelling to the UAHEP will follow the Koshi Highway, which approximately forms the eastern boundary of the Khandbari-Num Forests IBA. This vehicle traffic should have little effect on the species for which the IBA was established, which was primarily soaring birds, although an increase in project vehicles striking wildlife is likely.

The EAAA also includes portions of the Qomolangma UNESCO Man and the Biosphere Reserve in China. The Project will not directly impact this reserve, which is located approximately 10 north of the project site and upstream on the Arun River. The UAHEP dam, however, will prevent the upstream movement of mid-range migratory species like the common snow trout from reaching the reserve. This impact is evaluated in Section 7.2.4.

Figure 7.17: Location of Project Facilities Relative to the MBNP Core and Buffer Zone



The Project's impact on the MBNP legally protected area is considered to be direct, adverse, high in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***High***. The Project's impact on the other internationally recognized areas of biodiversity value is considered to be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Additional Mitigation and Residual Significance

The WB ESF ESS 6 (paragraphs 26–27) states that where a project occurs within or has the potential to adversely affect a legally protected or internationally recognized area of high biodiversity value, the Borrower must:

- Demonstrate that the proposed development in such areas is legally permitted – There are no legal restrictions on development within the MBNP Buffer Zone, as will be evidenced by the UAHEP EIA approval by the Ministry of Forests and Environment.
- Act in a manner consistent with any government recognized management plans for such areas – The MBNP does have an approved management plan, which states that the objective of Buffer Zone management is "to achieve balance between biodiversity conservation and sustainable livelihood" (MBNP and its Buffer Zone Management Plan 2076/77–20780/81, DNPWC 2020).
- Consult and involve protected area sponsors and managers, project-affected parties including indigenous people, and other interested parties in planning, designing, implementing, monitoring, and evaluating the proposed project, as appropriate – The Project has met with the Department of National Parks and Wildlife Conservation in Kathmandu and on several occasions with the MBNP Warden, to keep them informed of the Project. Consultations thus far have indicated general support for the Project as long as impacts on the MBNP are minimized. The Project has also consulted with Bird Conservation Nepal on several occasions about the Project and potential impacts on the three IBAs. Bird Conservation Nepal raised concerns about the Project's original transmission line alignment, which would have traversed both the MBNP IBA and the Khandbari-Num IBA, but those areas have now been avoided (see Stakeholder Engagement Plan). Bird Conservation Nepal has indicated its support for the proposed avoidance and mitigation measures (BCN 2021; also see Appendix F, Annex FB-4). The Project has attempted to contact the Qomolangma Nature Reserve, but no response was received.[99]
- Implement additional programs, as appropriate, to promote and enhance the conservation aims and effective management of the area – See proposed mitigation measures below, which are intended to satisfy this requirement.

The following mitigation measures will be implemented in relation to project impacts on protected areas:

- Where use of explosives is required within sensitive areas, limit the size of blast charges.
- Establish, implement, and enforce a Workers' Code of Conduct that expressly prohibits illegal logging, clearing, hunting, poaching, and collection of animal and plant species in general, but especially within the MBNP.
- Require training for drivers making deliveries to the Project so they are aware of project speed limits and know to exercise caution for wildlife crossing the Koshi Highway.
- Provide funding to MBNP to increase the number of park rangers and strengthen monitoring and enforcement of illegal activities, such as poaching and collection of animal and plant species (see Appendix C, ESMP, Annex C3, Biodiversity Management Plan).

[99] Unsuccessful attempts were made to contact Qomolangma Nature Reserve park officials for consultation. Refer to Appendix F, Annex FB-4 for a record of attempts made.

- Provide support to MBNP and the Nepal Department of National Parks and Wildlife Conservation for implementation of the MBNP Management Plan (see Appendix C, ESMP, Annex C3, Biodiversity Management Plan).
- Coordinate with MBNP to identify sites within the park to provide afforestation at a ratio of 25:1, as required by the Nepal Forest Act, for trees cut within the park.
- Restore disturbed areas within the park using native indigenous species.

These measures will meet the WB ESF ESS 6 requirements for projects affecting legally protected areas, but will still result in both direct and indirect impacts on the MBNP. The Project's impact on MBNP will be direct, adverse, high in magnitude, local in extent, long term in duration, with an overall residual significance of ***High***. The Project's impact on the other internationally recognized areas of biodiversity value is considered to be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

7.2.3 Terrestrial Habitat

Loss of Terrestrial Habitat

The Project will result in the loss of modified and natural habitats associated with construction of the access road, hydropower facility, and transmission line and ancillary facilities, and from potential clearing of vegetation through induced access by local community influx.

Avoidance and Minimization Measures

The Project has carefully sited various project and ancillary facilities to avoid or minimize impacts on terrestrial habitat, including the following:

- Co-located access road and hydropower ancillary facilities to the extent possible to reduce project land requirements and habitat impacts (e.g., spoil disposal sites, contractor camps, crusher and batch plants)
- Optimized reservoir FSL to reduce impacts on terrestrial habitat

Impact Assessment

An assessment of terrestrial natural and modified habitats was completed for the EAAA, DIA, and project footprint. This assessment identified a range of land classes including modified habitats associated with agriculture and settlements. The area of modified habitat identified within the project footprint is 137.56 ha. Regarding natural habitats, secondary forests, grasslands, rock/scree, and river habitats were identified within the project footprint, totalling 94.58 ha that will be lost for the construction of the project facilities, including the reservoir.

The area of natural and modified habitat associated with the project footprint, DIA, and EAAA are shown in ***Table 7.26***. The area of land class within the project footprint, DIA, and EAAA are detailed in ***Table 7.27***. ***Figure 6.33*** shows the distribution of natural and modified habitat within the project area. Project construction will impact on about 3.45% of the total land within the DIA, about 0.18% of the total land within the EAAA, and about 1.89% and 0.07% of the natural habitat within the DIA and EAAA, respectively.

Table 7.26: Natural and Modified Habitat Loss

Area	Natural Habitat (ha)	Modified Habitat (ha)	Total (ha)
Project footprint	94.58	137.56	232.14
Direct Impact Area	5,000	1,723	6,723
EAAA	122,298	8,518	130,816

Table 7.27: Land Cover in Project Footprint, Direct Impact Area, and EAAA

S/N	Land Class	Project Footprint (ha)	Direct Impact Area (ha)	EAAA (ha)
	Agriculture	137.401	1,486	8,210
	Grassland/shrubland, kharbari, waterbodies, river	39.57	150	36,941
	Forest	55.162	4,908	73,455
	Total	**232.14**	**6,716**	**130,816**

Habitat impacts are considered to be permanent and ongoing for all major infrastructure components following construction, with some rehabilitation of cleared areas around infrastructure components when construction finishes. These areas include workers camps, lay down areas, temporary roads and temporary infrastructure. The magnitude of the habitat loss is considered to be medium as the loss will affect only a small area of natural habitat (94.58 ha of forest, grassland, barren, and water habitat will be affected, which represents about 0.2% of the estimated natural habitat within the EAAA). Furthermore, much of the natural habitat affected is edge habitat with little overall loss of habitat functions, except for approximately 89 ha of contiguous forest in the headworks area. The 35.55 ha of land to be disturbed is within the MBNP Buffer Zone (21.803 ha of government owned forest land and 13.751 ha private land).

As described in detail in Section 7.3.3, the Project will stimulate in-migration to the project impact area in search of employment (i.e., influx), stimulated by potential business opportunities linked to the provision of goods and services to the Project, and by real or perceived opportunities arising from the general increase in economic activity in the area. This could result in the loss and/or disturbance of natural habitat due to increasing demand for natural resources such as fuelwood, and timber (see Section 7.3.4 for further information) and conversion for housing, agricultural use, or other employment-related activities.

Therefore, the Project's impact on terrestrial habitat will be direct, adverse, high in magnitude, site-specific in extent, long term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Additional Mitigation and Residual Significance

The following mitigation measures will be implemented:

- Mark all areas to be cleared prior to clearance. Clearing vegetation outside of designated areas will be prohibited.
- Provide training to all staff and contractors on the requirements to not clear outside of designated areas.
- Prohibit burning of cleared vegetation, rather, the following procedures will be used:
  - In community forests, trees shall be cut and deposited in accordance with the agreement with the community forest user groups.
  - Make any remaining cleared vegetation available for use by local residents for firewood, fodder, mulch, or other purposes.
  - Any cleared vegetation not wanted by the local residents shall be chipped, mulched, and stockpiled for use during site restoration.
  - Any invasive plant species found shall be segregated and disposed of as solid waste.

- Restrict use of the access road to construction vehicles only. Checkpoints should be used to manage access and inspect vehicles for wood and timber products taken from areas of natural habitat within the project area.
- Establish a community program with local landowners to socialize the restrictions on access to reduce the collection of timber and non-timber forest products from areas of natural habitat within the DIA.
- Monitor and report to the appropriate regulatory authority any collection of wood and timber products within the project area or areas under the control of the Sponsor.
- Rehabilitate disturbed areas using native indigenous species. A site nursery will be established to propagate flora for this purpose.
- Provide afforestation at a rate of 25:1 for trees cleared within the MBNP Buffer Zone, and 10:1 for trees cleared outside of MBNP Buffer Zone.
- Manage influx of job seekers in accordance with the measures described in Section 7.3.3.

These measures will reduce the magnitude of the impacts to low and the extent to site-specific. Therefore, the Project's impact on terrestrial habitat will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall significance of ***Moderate***. Offsets will be necessary to compensate for residual impacts and achieve a no net loss of terrestrial natural habitat. This is further discussed in Section 7.2.6 below.

Effects on Critical Habitat-qualifying Species

As described in Section 6.2, critical habitat within the Project's EAAA has been triggered for four terrestrial mammal species: Himalayan red panda (*Ailurus fulgens)*, Himalayan black bear (*Ursus thibetanus*), clouded leopard (*Neofelis nebulosa),* and spotted linsang (*Prionodon pardicolor*). The following species, formerly thought to be present in the project area, were not observed: black musk deer (*Moschus fuscus*) and Mandelli's mouse-eared myotis (*Myotis sicarius*). The Chinese pangolin (*Manis pentadactyla*) was identified as a species of stakeholder concern, a significant biodiversity value, requiring protection and requiring demonstration of no net reduction of its population, but this species was not identified in the project area.

Avoidance and Minimization Measures

The Project has adopted the following avoidance and minimization measure to reduce disturbance and/or displacement of terrestrial fauna in accordance with the application of the mitigation hierarchy:

- Located all project facilities between elevations 1,100 m to 2,200 m, which is below the elevation range of red panda and black musk deer and only includes the very upper range of the Mandelli's mouse-eared myotis, but includes the lower ranges for the clouded leopard and spotted linsang

Impact Assessment

Project impacts on these species are described below:

- **Red panda** – Red panda have been observed in the project area and it is expected that the Project will have a direct impact on this species. The Project could affect this species through increased risk of poaching, illegal trade, road kills/wildlife strikes, habitat fragmentation and loss, forest fires, increase in feral dogs, increased human pressure and presence, threats of invasive species, barriers to movement/altered use of habitat/altered behavior.
- **Himalayan black bear** – This species is found at a lower and upper elevation limit of 0 m and 4,300 m respectively. Direct impacts on the species and its habitat are expected, while indirect impacts due to human-bear conflict incidents (human casualties, increase in livestock predation, crop-raiding) may occur. The Project could affect this species through increased road kills/wildlife strikes, increased forest fires, habitat fragmentation and loss, increased poaching and snaring,

increased human presence, conduits for invasive alien species, and barriers to movement/altered use of habitat/altered behavior.

- **Clouded leopard** – Clouded leopards have been observed in the project area. It is expected that the Project will have a direct impact on this species. The Project could affect this species through increased road kills/wildlife strikes, habitat fragmentation and loss, increased poaching and snaring, loss of prey species, forest fires, increased livestock predation, increased human presence, conduits for invasive alien species, and barriers to movement/altered use of habitat/altered behavior.
- **Spotted linsang** – Spotted linsang have been observed in the project area. It is expected that the Project will have a direct impact on this species. The Project could affect this species through increased road kills/wildlife strikes, forest fires, habitat fragmentation and loss, increment of retaliatory killings, increased human presence, conduits for invasive alien species, and barriers to movement/altered use of habitat/altered in behavior killings. Proposed Additional Mitigation and Residual Significance

Mitigation measures to achieve net gain in biodiversity for these four critical habitat species and net gain for their habitats are as follows:

- The Project will mitigate the risks to these four critical habitat species and achieve net gain by minimizing terrestrial natural habitat loss and reducing natural habitat fragmentation. Without compensation measures, the Project will result in the loss of 94.58 ha of terrestrial natural habitat. The proposed natural habitat offset area should involve a mix of local tree species present in the affected vegetation types; in particular, the planting of bamboo for the red panda is essential. The afforestation areas should be similar to those impacted, with natural and modified habitat within the offset area to be clearly delineated. From this delineation, habitat condition and net gain should be achieved for each vegetation type. This net gain should be achieved after an adequate offset period of several years. The habitat hectares method is suggested for this offset.
- An afforestation program will be implemented. It is estimated that 351,648 trees will be planted to compensate the loss of trees and leasing of forest land. For this 94.58 ha of land will be purchased, as a part of land for land compensation, on which 151,328 trees will be planted, with 1,600 saplings/ha. A further 125.21 ha of government land needs to be obtained, on which 200,340 trees will be planted on a 1:10 basis (i.e., plant 10 saplings for each tree cleared), in accordance with Nepal's Forest Rules 2022. Within Sankhuwasabha, Terhathum, and Taplejung districts, a collective area of 3,932.8 hectares of barren land has been identified, out of which 125.21 ha will be used for the plantation of 200,340 saplings, in consultation with concerned authorities. The planted site will be managed for 5 years and handed over to the concerned authority after designated time.
- The afforestation area needs to be delineated into natural and modified habitat and vegetation types within. This is necessary to assess habitat condition for each vegetation type and likely gains across the afforestation period. For each vegetation type adjusted by its habitat condition, gains needs to be predicted from afforestation after a suitable afforestation period
- Afforestation measures are to achieve net gain of critical habitat in accordance with the World Bank ESF ESS 6, and will target areas of high biodiversity values. The Program is to be led by UAHEL in conjunction with the Department of Forest and Soil Conservation and Department of National Park and Wildlife Conservation. Areas to be targeted for planting are to include areas of degraded forest within the Makalu Barun National Park, its Buffer Zones and community forests within the EAAA. The plantations will need to be fenced to protect them from destruction by free roaming livestock. Dead saplings will be regularly replaced.

Offset metrics for monitoring and evaluation: The monitoring of net gain through improvement of habitat condition in each plantation, e.g., canopy cover, plant species diversity, including bamboo for red panda and fruit plants for other wildlife, will be done. The monitoring objective is to assess satisfactory progress against the net gain objective for critical habitat.

Additional mitigation measures are required to ensure net gain for the four mammal critical habitat species.

- Key measures are proposed, including the development of a number of wildlife crossing infrastructure like underpasses and arboreal bridges to be included in the design of the access road to minimize wildlife road kills. Other measures include the reduction of human-wildlife conflict and support for the preparation of biodiversity profile.
- Natural habitat restoration measures in order to compensate for the losses caused by the UAHEP encompass land acquisition for afforestation, fencing to protect the plantation from damage by livestock, the implementation of forest fire control measures by providing tools to control fires, and the provision of water sources for wildlife, if necessary, when existing water sources are damaged by construction activities. In addition, there is a need to strengthen law enforcement to control poaching and invasive species to protect the four critical habitat species and other wildlife of conservation importance.
- Biodiversity monitoring activities, involving biodiversity surveys and camera trappings, to check the effectiveness of proposed actions, will need to be carried out.
- It is also important to improve the working conditions of the rangers in the MBNP and its Buffer Zone, and the Division Forest Office, by strengthening their financial and management capacity. Actions proposed here are aimed at reducing the impact of UAHEP through multiple approaches by assisting and mobilizing the concerned authorities. These recommended measures collectively aim to conserve the four critical habitat species and their environments, while minimizing project-related impacts and are expected to achieve net gain for these four critical mammal species.

Therefore, the Project's impact on critical habitat species will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Low***.

The Project will demonstrate a net gain in biodiversity values for critical habitat species. For the four terrestrial species identified as triggering critical habitat and one stakeholder concern species, specific conservation programs are proposed to reduce key threats to the species (see Section 7.2.5 below and Appendix C, ESMP, Annex C3, Biodiversity Management Plan).

Disturbance and/or Displacement of Terrestrial Fauna

The Project has the potential to disturb and/ or displace fauna as a result of light, noise, and vibration emissions, as well as increased human activity.

Avoidance and Minimization Measures

The Project has adopted the following avoidance and minimization measures to reduce disturbance and/or displacement of terrestrial fauna in accordance with the application of the mitigation hierarchy:

- Siting project facilities away from areas of natural habitat to the extent possible
- Siting the powerhouse underground

Impact Assessment

Terrestrial fauna within and adjacent to the project area are expected to be subjected to increased light, noise, vibration, and human presence/activity, which have the potential to disturb natural breeding, roosting, and/ or foraging behavior of terrestrial fauna species and/or cause temporary or permanent movement away from project facilities, especially during construction (Van der Ree *et al.* 2015).

Noise will be the primary disturbance for resident fauna, which will be closely associated with vegetation clearing, excavation, vehicle and equipment movement, use of helicopters, drilling and blasting, aggregate crushing, and other typical construction activities. These activities will introduce noise sources that are not currently present in the EAAA. More specifically, noise can affect wildlife communication, which in turn can affect breeding potential, predator detection, and social interactions.

Lighting associated with the Project has the potential to inhibit fauna movement patterns and behavior, particularly nocturnal species (Longcore and Rich 2004). It is expected that the Project will generate vibration impacts associated with blasting activities and the movement of heavy vehicles and machinery. Wildlife species can be more sensitive to vibrations than humans. Species that rely on vibration for prey/ predator detection are likely to be negatively affected, which may in turn affect wildlife populations and distribution.

The duration of construction activities is expected to occur over seven years and cover several breeding seasons. Similarly, it should be noted that the light, noise and vibration disturbances will be continuous for the construction phase. Light, noise and vibration disturbance are unlikely to occur at all locations simultaneously. The impacts associated with noise and vibration disturbance and displacement are likely to reduce considerably during operation, however, lighting impacts will continue in close proximity to many components of project infrastructure.

Nocturnal and arboreal mammal threatened species that may be subject to potential impacts from disturbance and displacement are outlined in ***Table 7.28.*** These species are generally highly mobile and will avoid or vacate the construction area and hence impacts are considered unlikely.

The impacts due to disturbance from noise and vibration as these activities will occur only during the construction phase and are unlikely to disrupt important lifecycle functions. Lighting impacts may have ongoing localized impacts on resident species, however, including minor impacts from predation.

Table 7.28: Local Fauna Species Potentially Impacted by Disturbance and Displacement

S/N	Scientific Name	Common Name	IUCN Listing	Restricted Range	Nepal Red List
	Ailurus fulgens	Red panda	EN	No	EN
	Moschus fuscus	Black musk deer	EN	No	DD
	Myotis sicarius	Mandelli's mouse-eared myotis	VU	No	VU
	Ursus thibetanus	Himalayan black bear	VU	No	EN
	Panthera pardus	Common leopard	VU	No	VU
	Macaca assamensis	Assamese monkey	NT	No	VU
	Lutra lutra	Eurasian otter	NT	No	NT
	Muntiacus vaginalis	Barking deer	LC	No	VU
	Vulpes vulpes	Red fox	LC	No	DD
	Macaca mulatta	Rhesus monkey	LC	No	LC
	Semnopithecus schistaceus	Nepal grey langur	LC	No	LC
	Martes flavigula	Yellow throated marten	LC	No	LC
	Felis chaus	Jungle cat	LC	No	LC
	Felis bengalensis	Leopard cat	LC	No	VU
	Dremomys lokriah	Orange bellied Himalayan squirrel	LC	No	LC
	Hystrix brachyura	Malayan porcupine	LC	No	DD
	Sus scrofa	Wild boar	LC	No	LC

	Viverricula indica	Small Indian civet	LC	No	LC
	Hylopetes alboniger	Particolored flying squirrel	LC	No	LC

Notes: LC = Least Concern; VU = Vulnerable; EN = Endangered; NT = Near Threatened; DD = Data Deficient

Two habitat terrestrial species (i.e., black musk deer and Mandelli's mouse-eared myotis) are considered to be nocturnal, while the red panda is crepuscular (active at dawn and dusk) and arboreal. The black musk deer and red panda are likely to inhabit higher elevations than the area affected by the Project and, as such, are not likely to be directly impacted as they are unlikely to occur within the project footprint. If present, Mandelli's mouse-eared myotis may incur disturbances to foraging behavior within forested areas cleared for the Project. The Project does have the potential to affect some species listed above that may venture into the DIA during construction.

Therefore, the Project's potential to disturb or displace terrestrial wildlife during construction will be direct, adverse, high in magnitude, local in extent, short term in duration, with an overall pre-mitigation significance of ***Substantial,*** while the Project's potential during operations will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate.***

Proposed Additional Mitigation and Residual Significance

The Project will implement the following mitigation measures:

- Train all staff and contractors on the threatened species that may be encountered during construction and operation, including measures related to fauna rescue outlined within the *Fauna Shepherding Protocol* included in the Biodiversity Management Plan (see Appendix C, ESMP, Annex C3).
- Use timers for permanent and temporary lighting where possible to avoid unnecessary light at night-time. Cowls and directional lighting will be used to minimize lighting of natural habitat areas.
- Implement noise mitigation measures (see Section 7.1.9 – Noise) and vibration mitigation measures (see Section 7.1.10 – Vibration), including a general prohibition on noise-generating construction activities at night.

These measures will reduce the magnitude of construction noise, light, and vibration impacts to low. Therefore, the Project's potential to disturb or displace terrestrial wildlife during construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of ***Moderate***, while the impacts during operation will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

Terrestrial Barriers, Fragmentation and Edge Effects

The Project may establish barriers to wildlife movement, contribute to habitat fragmentation, and create edge impacts from forest clearance during construction and continuing through project operations.

Avoidance and Minimization Measures

The Project has adopted the following avoidance and minimization measures to reduce the creation of terrestrial barriers, habitat fragmentation, and the establishment of edge effects in accordance with the application of the mitigation hierarchy:

The Project has adopted the following avoidance measures:

- Located project facilities (e.g., workers' camps, transmission towers) away from areas of natural habitat to the extent possible to reduce edge effects and fragmentation.

- Prohibit the construction of new construction roads to access transmission tower locations. Towers will be accessed using porters and pack animals along existing or new trails.
- Clustered many project facilities to minimize the creation of habitat edges.

Impact Assessment

The impacts due to road and infrastructure construction included: barriers to fauna and flora dispersal include natural factors (e.g., rivers) and anthropogenic factors (e.g., roads) (Krisp 2004); barriers to dispersal limit the foraging, breeding and roosting potential of fauna, which can ultimately result in population scale impacts; and habitat fragmentation which involves the division of contiguous habitat, effectively creating barriers between habitat fragments, which can negatively impact fauna and flora populations (Didham 2001).

Edge effects occur when two dissimilar areas or habitat types are temporarily or permanently located immediately adjacent to one another. This phenomenon commonly occurs adjacent to cleared areas adjacent to natural habitats where changed moisture differentials can cause impacts such as increased predator and hunter access, microclimate changes, and increased erosion (Andrén and Anglestam 1988).

The proposed transmission line and roads could act as a barrier to dispersal for terrestrial species. Forest birds have been known to avoid crossing linear infrastructure that is absent of vegetation (e.g., roads) (Laurance 2004). The extent to this impact is expected to be limited as the length of the transmission line approximately 5.8 km.

Potential impacts on the critical habitat species and stakeholder concern species from barriers, fragmentation, and edge effects are likely to be low/substantial. As these species are highly threatened by the effects of habitat fragmentation, potential impacts are therefore considered to be substantial.

The Arun River already represents a barrier to wildlife movement and migration in the DIA because of the river depths and high velocities. Therefore, the creation of the project reservoir will not function as a barrier, and, in fact, may allow some wildlife to swim across the reservoir because of the lower velocities. The reduced flows in the diversion reach, and associated reduced water depths and velocities, may also similarly allow wildlife crossings that were not possible before.

Existing populations of fauna are generally resident within natural habitat patches that are currently fragmented in the landscape and are located on hillslopes away from the reservoir area. Edge effects are likely to be relatively minor along the transmission line and road corridors as they will primarily occur within modified habitats.

Therefore, the Project's impact on terrestrial habitat and species due to barriers, habitat fragmentation, and edge effects created during construction and operation will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***Substantial.***

Proposed Additional Mitigation and Residual Significance

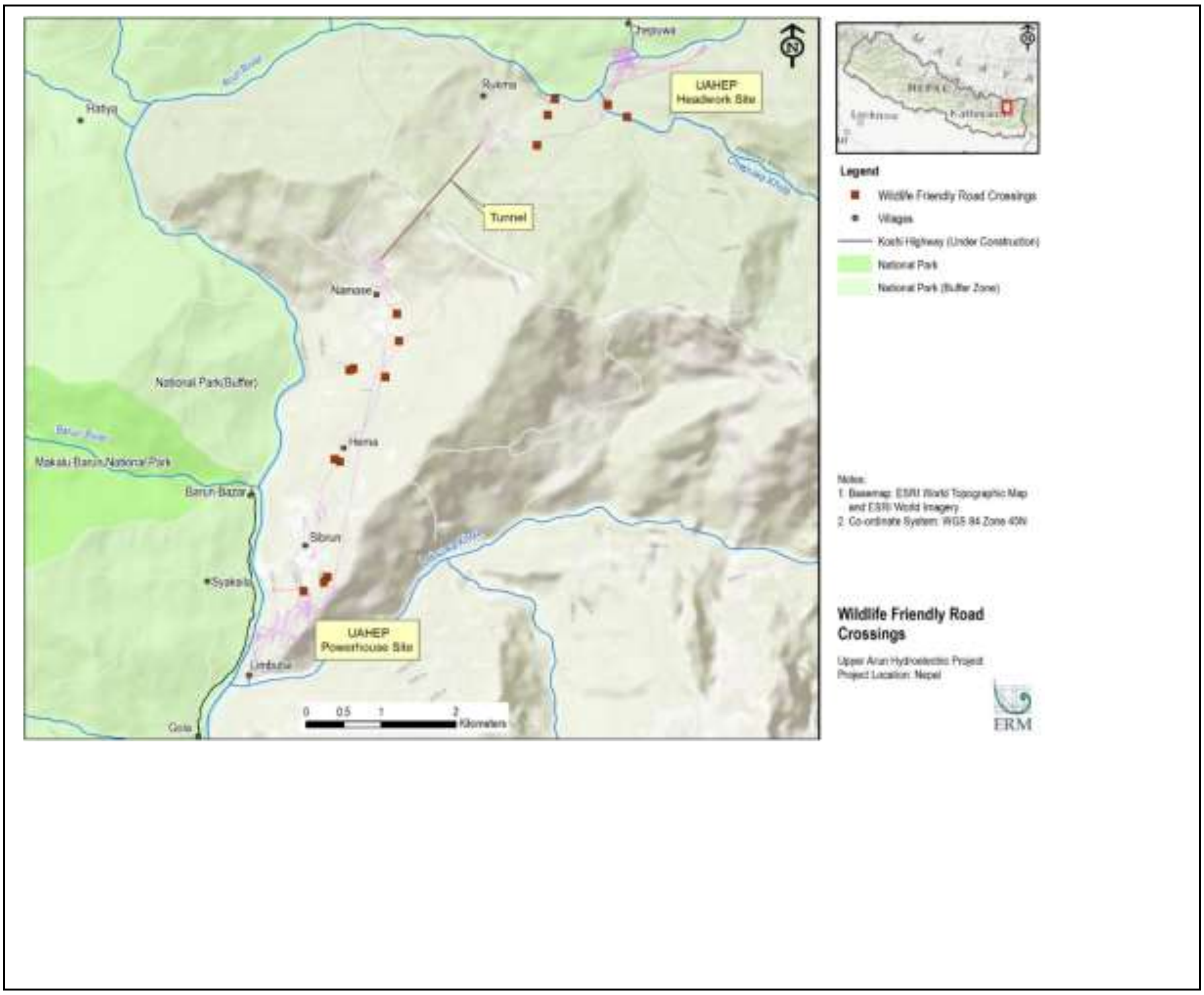
The Project will implement the following mitigation measures during construction and operation:

- Target reforestation efforts, using native species, in the areas where the project access road fragments habitat.
- Fence areas where practicable between patches of natural habitats adjacent to project areas to promote natural restoration and prevent further damage from anthropogenic impacts (e.g., walking tracks).
- Span forest to the extent possible within the transmission line RoW.
- Where possible, reduce perimeter lengths of proposed clearing areas to reduce the extent of microclimate impacts.

- Provide wildlife-friendly road crossing to facilitate the movement of small mammals, reptiles and amphibians across the access road, service roads, and other infrastructure. These wildlife-friendly road crossings will be located where the proposed roads will fragment natural riparian habitat (see ***Figure 7.18***) and be designed to allow the passage of small-medium sized mammals (e.g., marten, mongoose, squirrel, otter, small cats, wild boar, civet, fox, porcupine – see ***Table 6.30***) and herptiles. These crossing will include:
  - Open bottom box culvert with a minimum dimension of 1 m high x 1.5 m wide, regardless of hydrology requirements. These crossings will also include placing low-rise wildlife fencing (approximately 50 cm high) along both sides of the road for 25 m to direct small animals and herpetofauna to the wildlife crossing, and posting warning signage for vehicles to watch for wildlife; and
  - Overhead cableway crossings for arboreal wildlife species (e.g., monkeys).
  - Additional investigation is needed to finalize the target species, location, design (e.g., culvert dimensions; fencing length, height, and maximum mesh size; and whether electrified), and construction details (e.g., depth dug into ground) of the wildlife crossings.
- Avoid clearing of shrub and herb layers within the transmission line RoW to minimize potential barrier effects for fauna movement and retain cover for fauna.

In view of the implementation of mitigation measures, the Project's impact on terrestrial habitat and species due to barriers, habitat fragmentation, and edge effects created during construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of ***Moderate***, while the Project's potential during operations will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

Figure 7.18: Wildlife Friendly Road Crossings



Degradation of Terrestrial Habitat

The Project may degrade natural and critical habitat as a result of air and water pollution, introduction and spread of invasive species, and induced access leading to an increase in the collection of wood and timber. This impact applies to all project components during both construction and operation.

Avoidance and Minimization Measures

The Project has adopted the following avoidance and minimization measures:

- Located project facilities (e.g., workers camps, transmission towers) away from areas of natural habitat to the extent possible to reduce risks of air and water pollution, invasive species, and induced access

Impact Assessment

A range of project activities have the potential to lead to terrestrial habitat degradation during the construction phase. These activities include excavation, maintenance works, land clearing, spoil disposal, movement of vehicles and excavation and blasting. The key sources of impact to terrestrial habitat include habitat degradation from slope failures and fugitive dust emissions during construction. Impacts from the introduction and proliferation of invasive species during construction and operation is also considered. Impacts from workers and the community from the collection of timber and non-timber forest products due to induced access may also occur.

Impacts from Slope Failures

As discussed in Section 7.1.1, there is the potential for slope failures/landslides because of various project construction activities (e.g., access road, spoil disposal areas, and transmission line towers), especially considering the steep slopes and monsoon climate present within the DIA. In addition to the threats to public safety, these slope failures/landslides can also impact valuable habitat, as well, destroying or degrading potentially large swaths of forest and other natural habitats. Section 7.1.1 includes various mitigation measures intended to reduce the likelihood of slope failures/landslides.

Impacts from Fugitive Dust

During the construction phase, land preparation activities have the potential to generate dust. Dust generated from the Project could settle on vegetation adjacent to the project area. Excessive dust deposition on foliage may act to suppress growth by limiting photosynthesis, and dusted foliage and fruits may become unpalatable to foraging fauna (Farmer 1993). Construction activities will be temporary and dust generation is likely to be localized to active work areas. This impact will typically be limited to the long dry season (October to April) during the construction phase, as monsoon rains will limit dust formation and wash any accumulated dust off foliage.

Impacts from Invasive Species

Invasive species have the potential to be introduced or spread throughout the project area via increased movement of people, vehicles, machinery, vegetation and soil. An increase in the prevalence of invasive species has the potential to reduce the abundance of native species through competition. Invasive flora species can rapidly germinate in disturbed areas, which may affect the ability of native vegetation communities to re-establish (Ramula *et al.* 2008) and change species composition; this may in turn affect the composition of the faunal array these communities' support.

The proposed transmission line will increase the likelihood of invasive flora introduction and proliferation. Transmission lines require regular maintenances, and the likely frequent vehicles and machines can act as a vector for invasive species. Furthermore, areas that are subject to significant disturbance (e.g., clearance) are more vulnerable to colonization by invasive alien species (Lee 2002).

Invasive fauna may adversely impact native fauna and flora as a result of increased competition for resources, predation or habitat degradation. One invasive species was identified during the biodiversity baseline surveys in the nearby UAHEP project site, *Eupatorium adenophorum* (banmara) (see *Section* 6.2 – Terrestrial and Aquatic Biodiversity).

Impacts from Enhanced Access

Enhanced access to natural habitat patches may cause an increase in the collection of wood and timber products by workers and local people. This may result in localized reductions in ground habitats (fallen logs) or the removal of certain tree species used for building or household purposes. Additionally, hunting and poaching will also likely occur (see separate impact assessment regarding fauna mortality). A total of 178 flora species were identified during the biodiversity surveys. Flora species included trees, shrubs, herbs, lichen, climbers and orchids. Of all the 178 species, 35 are considered non-timber forest products, 16 are used for their medicinal properties and seven are used for ornamental purposes. Ten flora species are listed as CITES II species.

Summary

Therefore, the Project's potential for degrading terrestrial habitat as a result of construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall pre-mitigation significance of ***Moderate***, while the Project's potential during operations will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Additional Mitigation and Residual Significance

The following mitigation measures will be applied during construction:

- Use fencing and hoarding where minor project infrastructure (such as buildings) is adjacent to natural habitat patches, where practicable, to reduce dust impacts on adjacent flora.
- Implement a worker and sub-contractor education program to inform personnel about the prohibition of collecting timber and non-timber forest products and the importance of natural habitat for the conservation of significant species. The education program is to be conducted within one month of commencement of construction, with formal refresher training at six month intervals, with periodic reminders during daily "tailgate" meetings, until the end of the construction phase.
- Prohibit workers and sub-contractors from collecting timber and non-timber forest products from natural habitat patches. The requirement is to be included in worker contracts. Where workers are found to have undertaken collection they are to be warned and penalties (including fines and dismissal) invoked for repeat offences.
- Restrict use of the access road to construction vehicles only. Checkpoints are to be used to manage access and inspect vehicles for wood and timber products taken from areas of natural habitat within the project area.
- Establish a community program with adjacent landowners to socialize the restrictions on access to reduce the collection of timber and non-timber forest products from areas of natural habitat within the project area and other areas under the control of the Sponsor. The education program is to be conducted within one month of commencement of construction, with repeats at six month intervals until the end of the construction phase.
- Monitor and report any illegal collection of wood and timber products within the project area and other areas under the control of the Sponsor to the appropriate regulatory authority.
- Rehabilitate disturbed areas using native species of flora in areas disturbed during construction. Establish a site nursery to propagate flora for this purpose. Land rehabilitation in each disturbed area is to commence within one (1) month of the completion of construction activities associated with the project component.
- Prepare and implement an Invasive Alien Species Management Plan within the Biodiversity Management Plan (see Appendix C, ESMP, Annex C3).

- Monitor for and remove any invasive species found in areas disturbed by project construction.
- Revegetate disturbed areas using native/non-invasive species.

In view of the implementation of these mitigation measures, the Project's potential to degrade terrestrial habitat during construction will be direct, adverse, low in magnitude, local in extent, short term in duration, with an overall residual significance of ***Low***; while the Project's potential during operations will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall residual significance of ***Low***.

Wildlife Mortality Events

Project construction may result in the direct wildlife mortality because of vehicle strikes, land clearing, transmission line collision and electrocution, hunting, and poaching during construction and operation.

Avoidance and Minimization Measures

The Project has adopted the following avoidance and minimization measures to reduce the risk of wildlife mortality in accordance with the application of the mitigation hierarchy:

- Avoided areas of natural habitat to the extent possible for the access road and project ancillary facilities, which should result in reduced vehicle strikes and hunting/poaching pressures
- Routed transmission line to avoid a crossing of the Arun River, which is known as a flyway for birds of prey

Impact Assessment

Mortality events may arise from vehicle and machinery strikes, falling debris during clearing and from hunting and poaching. During the construction phase, there will be a large number of vehicle movements and construction plant within and around the project area, including along the Koshi Highway, which will be used to access the project site. This is likely to result in fauna injury and mortality events, not least in the natural and modified habitat that will be subject to land clearing for the project components.

Clearance in natural habitat is likely to affect more species that could suffer direct mortality as a result of being less mobile (e.g., reptiles, small mammals, amphibians and insects). More mobile species such as birds and large mammals may be able to avoid machinery, but will be subject to the risk of indirect mortality (e.g., tree falls, increased risk of predation). Arboreal and less mobile mammal and herpetofauna species (see ***Table 7.29***) are likely to be the most susceptible to indirect mortality.

Table 7.29: Arboreal and Less Mobile Mammals and Herpetofauna Identified Within the Project Area

S/N	Scientific Name	Common Name	IUCN Listing	Restricted Range Species	Nepal Red List
1	*Hystrix brachyuran*	Malayan porcupine	LC	No	DD
2	*Nanorana liebigii*	Spiny armed frog	LC	No	LC
3	*Amolops monticola*	Mountain cascade frog	LC	No	Not listed
4	*Ptyas mucosa*	Indian rat snake	LC	No	Not listed
5	*Orthriophis hodgsoni*	Hodgson racer	LC	No	Not listed
6	*Trimeresurus sp.*	Green pit viper	LC	No	Not listed
7	*Ovophis sp.*	Mountain pit viper	LC	No	Not listed
8	*Calotes versicolor*	Oriental garden lizard	LC	No	Not listed

Notes: LC = Least Concern; DD = Data Deficient

Fauna within the EAAA may be subject to elevated levels of hunting and poaching during the construction phase. Subsistence hunting is illegal within MBNP and is often unsustainable due to the high number of hunters and relatively low populations of target species.

In addition to hunting, the poaching of wild fauna for the wildlife trade potentially occurs within the EAAA, driven by the traditional medicine industry, the global and national exotic pet trade, and by cultural customs. The project workforce may also undertake bush meat hunting, regarding it as a culturally acceptable and habitual practice.

Thirty-six (36) CITES[100] species were identified during the biodiversity baseline surveys, with 26 of these being fauna. This highlights the vulnerability of these species to hunting and poaching pressures. These species are listed in ***Table 7.30***.

Three critical habitat-qualifying species (Himalayan red panda, Himalayan black bear, black musk deer), and one stakeholder concern species (Chinese pangolin) are listed as CITES species. Of note, the Himalayan black bear and Chinese Pangolin could potentially be subjected to intensive poaching given their likely presence within and in proximity to the project footprint. People have been arrested at Kimathanka, north of the Project, close to the border of Nepal and China, for the possession of Himalayan black bear gall bladder, paws etc. (see Appendix F, Annex FB-4, Consultation with Black Bear Expert). The Project is also located in Eastern Nepal which is considered a major national hotspot for pangolin poaching and trafficking (Ghimire *et al.* 2020). The substantial construction workforce required for the Project, and the road and infrastructure network developed by the Project will likely provide better access to new wildlife areas, increasing the risk of poaching for these critical habitat-qualifying species.

[100] The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments with the aim of protecting species threatened by the international wildlife trade. The agreement has three classifications types: Appendix I, Appendix II and Appendix III.

Table 30: CITES Listed Species Found Within the Project EAAA

S/N	Class	Scientific Name	Common Name	IUCN Listing	National Listing[1]	CITES[2]
1	Birds	*Circus cyaneus*	Hen harrier	LC	VU	II
2	Birds	*Buteo hemilasius*	Upland buzzard	LC	-	II
3	Birds	*Ictinaetus malayensis*	Black eagle	LC	-	II
4	Birds	*Falco tinnunculus*	Common kestrel	LC	-	II
5	Birds	*Accipiter nisus*	Eurasian sparrowhawk	LC	-	II
6	Birds	*Aquila nipalensis*	Steppe eagle	EN	VU	II
7	Birds	*Hieraaetus pennatus*	Booted eagle	LC	-	II
8	Birds	*Accipiter virgatus*	Besra	LC	-	II
9	Birds	*Hieraaetus fasciatus*	Bonelli's eagle	LC	-	I
10	Birds	*Milvus migrans*	Black kite	LC	-	II
11	Birds	*Gyptaetus barbatus*	Bearded vulture	NT	VU	II
12	Birds	*Gyps himalayensis*	Himalayan griffon	NT	VU	II
13	Mammals	*Manis pentadactyla*	Chinese pangolin	CR	EN	I
14	Mammals	*Moschus leucogaster*	Himalayan musk deer	EN		
15	Mammals	*Semnopithecus schistaceus*	Nepal grey langur	LC	LC	I
16	Mammals	*Macaca mulatta*	Rhesus monkey	LC	LC	II
17	Mammals	*Macaca assamensis*	Assamese monkey	NT	VU	II
18	Mammals	*Ursus thibetanus*	Himalayan black bear	VU	EN	I
19	Mammals	*Martes flavigula*	Yellow throated marten	LC	LC	III
20	Mammals	*Herpestes auropunctatus*	Small Indian mongoose	LC	LC	III
21	Mammals	*Vulpes vulpes*	Red fox	LC	DD	III
22	Mammals	*Ailurus fulgens*	Himalayan red panda	EN	EN	I
23	Mammals	*Felis chaus*	Jungle cat	LC	LC	II
24	Mammals	*Felis bengalensis*	Leopard cat	LC	LC	I/II
25	Mammals	*Panthera pardus*	Common leopard	VU	VU	I
26	Mammals	*Naemorhedus goral*	Common goral	NT	NT	I
27	Mammals	*Viverricula indica*	Small Indian civet	LC	LC	III
26	Mammals	*Lutra lutra*	Eurasian otter	NT	NT	I
27	Flora	*Coelogyne corymbosa*	n/a	-	-	II
28	Flora	*Coelogyne cristata*	n/a	-	-	II
29	Flora	*Curculigo capitulata*	n/a	-	-	II

S/N	Class	Scientific Name	Common Name	IUCN Listing	National Listing[1]	CITES[2]
30	Flora	*Cyathea chinensis*	n/a	-	-	II
31	Flora	*Dioscorea deltoidea*	n/a	-	-	II
32	Flora	*Pleione praecox*	n/a	-	-	II
33	Flora	*Pinalia stricta*	n/a	-	-	II
34	Flora	*Swerita chiryta*	Chiretta	-	-	II
35	Flora	*Taxus wallichiana*	East Himalayan yew	EN	-	II
36	Flora	*Vanda cristata*	n/a	-	-	II

Notes: LC = Least Concern; VU = Vulnerable; EN = Endangered; CR = Critically Endangered; NT = Near Threatened
[1] Nepal Red List, 2012
[2] Convention on International Trade in Endangered Species of Wild Fauna and Flora:
- CITES Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances.
- CITES Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled to avoid utilization incompatible with their survival.
- CITES Appendix III contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade.

The Project will also develop a 400 kV transmission line, which will extend for 5.8 km along the Arun River to the Arun Hub at the Village of Hitar. Considering the size and length of the transmission line, and its location along the mountain slope, there is limited potential to cause injuries or direct mortality for avifauna and bat species. The potential for electrocution of birds may exist if a circuit is created with the earth wire during flight or perching. The avifauna detected during surveys that are considered to be subject to potential collision risk with the transmission line are shown in ***Table 7.31***, however, given the placement of the transmission line in the landscape, impacts are unlikely (e.g., the transmission line will be parallel to a steep slope so the towers will be below the uphill tree line).

A targeted bat survey was not conducted, but no bats were observed within the area during surveys One species, Mandelli's mouse-eared myotis (*Myotis sicarius* – IUCN VU), has the potential to occur within 50 km of the site. This species forages on open water and may utilize the Arun River surface for this purpose. This species was also identified as a critical habitat species due to its restricted range.

Table 7.31: Species Subject to Increased Risk of Transmission Line Collision

Scientific Name	Common Name	IUCN Listing	Endemic	Nepali Law
Aquila nipalensis	Steppe eagle	EN	No	VU
Hieraaetus pennatus	Booted eagle	LC	No	Not listed
Buteo burmanicus	Himalayan buzzard	LC	No	Not listed
Tachymarptis melba	Alpine swift	LC	No	Not listed
Buteo hemilasius	Upland buzzard	LC	No	Not listed
Ictinaetus malayensis	Black eagle	LC	No	Not listed
Falco tinnunculus	Common kestrel	LC	No	Not listed
Accipiter nisus	Eurasian sparrowhawk	LC	No	Not listed
Accipiter virgatus	Besra	LC	No	Not listed
Hieraaetus fasciatus	Bonelli's eagle	LC	No	Not listed
Milvus migrans	Black kite	LC	No	Not listed
Nisaetus nipalensis	Mountain hawk eagle	LC	No	Not listed

Gyptaetus barbatus	Bearded vulture	NT	No	VU
Gyps himalayensis	Himalayan griffon	NT	No	VU
Notes: LC = Least Concern; EN = Endangered; NT = Near Threatened				

Impacts on fauna by vehicle or transmission line strikes are expected to be limited to the Koshi Highway and the project access road and along the transmission line. The project access road only affects 41 ha of natural habitat. Fauna mortality from clearing events are expected to be limited to areas of natural habitat cleared within the project area. Impacts associated with hunting and poaching for the wildlife trade and bush meat are expected to increase due to the workforce and a reduction in areas available for local people to undertake these activities. These impacts are likely to be localized and may cause reductions in local populations of the species targeted. Bird collisions with the transmission towers and lines will be limited due to the relatively short length of the transmission line (5.8 km), the fact that the alignment avoids crossing the Arun River flyway, and the placement of the line within the landscape (e.g., on relatively steep slopes, within a forested corridor parallel to the river).

Therefore, the Project's potential to increase wildlife mortality during construction will be direct, adverse, high in magnitude, local in extent, short term in duration, with an overall pre-mitigation significance of ***High***, while the Project's potential during operations will be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Additional Mitigation and Residual Significance

The Project will implement the following mitigation measures:

Vehicle strike:

- Provide training to drivers within the project footprint to inform them of speed limits and awareness of potential wildlife crossing the transportation corridor (i.e., from Khandbari to the project site) and access road, and provide procedures for avoiding and reporting wildlife strikes.
- Establish and enforce a speed limit of 20 km/hr within the project footprint to reduce the risk of fauna strikes by vehicles. Project vehicles will be fitted with speed recording devices to monitor speed use.
- Provide wildlife-friendly road crossings at designated stream crossings along the access and service roads (see Section 7.2.3 and ***Figure 7.18***).
- Require reporting of all wildlife strikes, including the location and species.

Land clearing:

- Implement a Fauna Shepherding Protocol for less mobile terrestrial species within areas to be cleared or disturbed to confirm that any resident species have vacated the area and to physically relocate individuals who remain prior to any land disturbance/forest clearance work.

Hunting and poaching:

- Establish, implement, and enforce a Workers' Code of Conduct that expressly prohibits illegal logging, clearing, hunting, poaching, and collection of animal and plant species in general, including fines and dismissal for repeat offences.
- Develop a program to train new staff and workers on the Workers' Code of Conduct, the identification of priority biodiversity values, the importance of biodiversity in maintaining ecosystem services, and to communicate the fines for non-compliance.
- Implement a worker environmental awareness program as part of worker induction, with periodic reminders during daily "tailgate" meetings, to inform/remind personnel about the prohibition of hunting and poaching and the penalties associated therewith and the importance of natural habitat for the conservation of significant species.

- Establish a community program with local villages to socialize the restrictions on access to reduce the hunting, poaching, or collection of fauna by ETP workers.
- Establish an anti-poaching patrol unit to provide enforcement against hunting, logging and other unauthorized land clearance activities within the Project area.
- Limit vehicular access within the project footprint or areas under the UAHEL's control. Conduct random vehicle inspections for CITES listed fauna and conservation significant fauna and flora. Report any violations to the DNPWC and UAHEL.
- Particular focus should be given to the Himalayan black bear and Chinese pangolin across all above listed measures to ensure strict controls are in place to ensure staff and contractors are not hunting or collecting species or are complicit in such activities.

Transmission line collisions and electrocution:

- Implement the requirements of the Avian Power Line Interaction Committee – Reducing Avian Collisions with Power Lines (APLIC 2012).
- Install visibility enhancement objects such as marker balls, bird deterrents, and bird flight diverters on the earth wire/shield wire to increase line visibility to birds and reduce bird-line collisions.
- Ensure the conductors are separated by more than the length of the wingspan of the largest bird found in the area (i.e., Himalayan griffon) to eliminate the potential for bird electrocution on the towers.
- Limit tree clearing to those required to meet safety standards between the conductors and trees.
- Monitor for bird carcasses during the first three years of project operations and provide adaptive management measures (e.g., additional targeted visibility enhancement measures) if appropriate.

In view of the implementation of these mitigation measures, the Project's potential to increase wildlife mortality during construction will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of ***Substantial***, while the Project's potential during operations will be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, with an overall residual significance of ***Low***.

7.2.4 Aquatic Biodiversity

The Project will result in the loss, conversion, and degradation of aquatic habitat associated with the inundation of the reservoir; reduction of flow in the diversion reach, and fluctuation in flow downstream from the powerhouse. It will also affect fish movement and migration within the Upper Arun River and result in loss of individual fish as a result of impingement and entrainment. Impingement occurs when the water velocity through the headrace intake screen is so high that some aquatic organisms cannot swim away and are pulled against the screen. Entrainment occurs when aquatic organisms are carried into the headrace tunnel and pass through the turbines in the powerhouse. These impacts are evaluated below.

As described in Section 6.2 (Terrestrial and Aquatic Biodiversity), the current ecological condition of aquatic habitat in the Arun River is good, with a good diversity of macroinvertebrates and zooplankton and possibly as many as 32 fish species (13 species collected, an additional 19 reported by local fishermen).

The data do indicate an ecological gradient from the upper portion of the Arun River to the downstream section below the Arun-3 HEP.

- Upper Arun River (above approximately 1100 m elevation) – Upstream from the proposed UAHEP tailrace, the physical environment in the upper Arun River is challenging for many fish species with very cold water during the winter (less than 7°C from December through February based on the headworks temperature logger data), which approaches or exceeds the physiological tolerance limit for many species, elevated turbidity, which can interfere with feeding and spawning by many fish species, and high velocities, which for many species may exceed their swimming speeds. Fish diversity and abundance are both limited in this section of the river. Only five species of fish were collected in the upper portion of the river – two cold water tolerant mid-range migratory fish species (*Schizothorax richardsonii, Schizothorax progastus)* and three benthic dwelling species that are physiologically and morphologically adapted to life in cold, turbid, high velocity rivers *(Noemacheilus botia, Psilorhynchus pseudecheneis, and Euchiloglanis hodgarti).* Although a year-round resident of the Upper Arun, the *Psilorhynchus pseduecheneis* is considered migratory. The catch per unit effort (CPUE) was low ranging from 0.03 above UAHEP dam to 0.06 near the tailwaters.

- Middle Arun River (from approximately 1,100 m to 800 m elevation) – From approximately the UAHEP tailwaters to the Arun-3 HEP dam, the river gradient is less, velocities are lower, water temperatures are marginally warmer, and turbidity levels are less. Both fish diversity and abundance increase in this section relative to the Upper Arun River, with as many as 16 species of fish either collected or reported in this segment and a CPUE ranging from 0.05 to 0.09. Based on field sampling and information reported by local fishermen, the long-range migratory species such as *Tor putitora* (IUCN EN) and *Tor tor* (IUCN DD) and possibly *Anguilla bengalensis* (IUCN NT) are found in the Arun River, but have not been collected or reported upstream from the confluence with Ikhuwa Khola (elevation ~900 m). Although the known range of at least the *Tor putitora* in Nepal can extend up to 1,200 m, they are not expected in the Arun River upstream from the confluence with Leksuwa Khola (elevation ~1,080 m), because of the cold water temperatures and lack of suitable spawning streams. The intensive aquatic biodiversity survey of the Upper Arun project site carried out by Hydrolab in 2022 also did not identify any specimen of golden mahseer up to Khandbari. According to information from local fishermen the last time this species was observed in this part of the Arun River was in 2018.
- Lower Arun River (from approximately 800 m to 400 m elevation) – From approximately the Arun-3 Dam downstream to approximately the confluence with Sankhuwa Khola, the gradient flattens, velocities decrease, sediment load is reduced, and water temperatures are warmer. In this section, the diversity and abundance of fish increases further, with 11 species collected and another 20 reported and a CPUE of 0.11, or almost four times higher than the CPUE for the Upper Arun segment. Long-range migratory species such as *Tor putitora*, *Tor tor*, and *Aguilla bengalensis* have all been collected in this segment.

In the glacial-fed waters of the Arun River, water temperature plays an especially important role in the eco-dynamic process and functionality and may act as a barrier for several species due to the physiological borders of metabolism and energy output. Even small differences in water temperature may affect population size and species diversity.

Loss and Conversion of Aquatic Habitat in the Headworks Area

The Project will result in the loss and conversion of aquatic habitat associated with the construction of the UAHEP dam and inundation of the Arun River by the UAHEP reservoir.

Avoidance and Minimization Measures

The Project has adopted the following avoidance and minimization measures to reduce the loss and conversion of aquatic habitat in accordance with the application of the mitigation hierarchy:

- Project located in the Upper Arun River where fish diversity and abundance is low because of cold water temperatures, elevated turbidity levels, and high velocities
- Optimized reservoir FSL to minimize impacts on aquatic habitat by selecting a lower reservoir elevation

Impact Assessment

This Project requires the creation of a reservoir to create head and store water that will be used for power generation. The reservoir will have a maximum depth of 94 m at the dam with a surface area of 20.1 ha. The inundation zone will extend over 2.1 km of the Upper Arun River, which is currently characterized by fast-flowing waters (lotic habitat). Based on aerial imagery interpretation and using GIS analysis, the establishment of the inundation zone (a lentic habitat), will result in the conversion of approximately 5.2 ha of existing lotic habitat and the clearing of approximately 14.9 ha of terrestrial vegetation for the development of the reservoir. The reservoir will create a sediment deposition zone at the backwaters of the reservoir as water velocities decrease and suspended sediments settle out of the water column, which will offer very limited habitat suitability, especially for benthic invertebrates, which will tend to be smothered by the sediment.

Daily water level fluctuations of up to 15 m within the reservoir as a result of peaking operations (see ***Figure 3.25***) during much of the year (October to May) will make establishment and self-propagation of macrophytic vegetation and macroinvertebrates along the margins of the reservoir unlikely. The peaking operation has the potential to result in stranding of fish.

In addition to this conversion of aquatic habitat, the Project will result in the loss of approximately 1.0 ha (0.3 sq. km) of aquatic habitat for construction of the dam.

As indicated above, the only species captured upstream from the proposed UAHEP dam were *Schizothorax richardsoni* (VU) and *Schizothorax progastus* (LC), both mid-range migrants that are known to tolerate cold water, and *Nemacheilus botia* (LC), *Psilorhynchus pseduecheneis* (LC), and *Euchiloglanis hodgarti* (LC), all resident fish. The catch per unit effort (CPUE) for these species of fish was low, suggesting that the populations of these species are relatively low, which is not surprising given the cold temperatures are near the physiological limits for most Nepal fish. Both *Schizothorax richardsoni* and *Schizothorax progastus* should be able to adapt to reservoir habitat as has occurred at other hydropower projects in Nepal. *Nemacheilus botia, Psilorhynchus pseduecheneis*, and *Euchiloglanis hodgarti,* however*,* are all small benthic species that may be able to tolerate the conversion to lentic habitat, but will not thrive because much of the reservoir will become a depositional environment that will interfere with their feeding.

Therefore, the Project's impact on the loss and conversion of aquatic natural habitat will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Additional Mitigation and Residual Significance

The following mitigation measures will be implemented:

- Require clearing and removal of trees within the reservoir's inundation area in accordance with the project's Commissioning Management Plan to reduce the reservoir's biological oxygen demand resulting from vegetation decomposition.
- Revegetate the shoreline as needed to stabilize slopes and prevent erosion.
- Implement the Sediment Management Strategy (see Section 3.6.2), which will minimize sediment deposition in the reservoir and maintain natural sediment transport processes by passing sediments through the SBT and flushing sediments through the LLO and MLO gates.
- Prohibit fishing by all construction workers for the entire construction period as part of the Workers' Code of Conduct.
- Inspect the margins of the reservoir subject to water level fluctuations from peaking operation and create channels to minimize the risk of fish stranding.
- Establish a reservoir management program to prevent the introduction of invasive fish species.

Taking into consideration these mitigation measures, the Project's impact on the loss and conversion of aquatic habitat for the dam and reservoir will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Moderate***.

Degradation of Aquatic Habitat in the Diversion Reach

The Project will significantly alter flow conditions in the 16.45 km long diversion reach between the UAHEP dam and powerhouse. This river segment is currently in good condition and provides habitat and migration connectivity for the conservation significant migratory fish species *Schizothorax richardsonii* (IUCN VU) and other migratory and resident fish species (all IUCN LC or Not Listed).

Avoidance and Minimization Measures

The Project did not identify any opportunities to avoid impacts on aquatic habitat in the diversion reach. Minimization measures are discussed below.

Impact Assessment

The Project will have negligible effects on flow or aquatic habitat in the diversion reach during construction, with impacts primarily related to the potential for increased sediment loads from construction. Therefore, the Project's impact on aquatic habitat in the diversion reach during construction would be direct, adverse, low in magnitude, local in extent, short term in duration, with an overall pre-mitigation significance of ***Low***.

The Project will significantly reduce flow conditions in the diversion reach during operation. In the absence of any Environmental Flow, the diversion reach would only receive flow as a result of spillage from the dam when river flow exceeds the hydraulic capacity of the powerhouse (i.e., 235.44 m^3/s), which only occur about 33% of the year, primarily during the monsoon season (see ***Figure 6.13***). This reduction in flow will change several characteristics of the physical habitat along the diversion reach including reductions in water depth, width, velocity, and dissolved oxygen; increases in temperature; changes in stream morphology; and potentially the loss of habitat connectivity. Further, the presence of the UAHEP dam will affect sediment transport and the influx of organic matter, which is a source of energy input for riverine habitats. Each of these changes will have effects on the species present within this segment of the Upper Arun River.

The diversion reach supports a range of fish species adapted to a fast moving and low temperature river. The gradient along this bypass is quite steep (~5%), and a reduced flow will probably not lead to dramatic changes in the river's ecological conditions. During low flow seasons, the upper section of the Arun River, upstream from its confluence with the Barun River, will be more gently flowing during the low flow season, but will still be fast flowing. Generally, there is an inverse relationship in fast flowing rivers between water velocity and biota productivity, with sections with high water velocities providing less useable habitat. Therefore, a reduction in flow and concomitant reduction in velocity may benefit some species by improving the suitability of some habitat.

Therefore, the Project's impact on aquatic habitat in the diversion reach would be direct, adverse, high in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Significance

The UAHEP diversion reach is considered natural habitat. There are no Critically Endangered, Endangered, restricted-range, or congregatory aquatic species, or highly threatened or unique ecosystems present in this river reach. There are migratory fish present, but not globally or nationally significant concentrations of those fish, especially after completion of the Arun-3 HEP dam, which is currently under construction.

The ESF establishes these criteria for potential impacts on natural habitat:

(a) There are no technically and financially feasible alternatives

(b) Appropriate mitigation measures are put in place, in accordance with the mitigation hierarchy, to achieve no net loss and, where feasible, preferably a net gain of biodiversity over the long term. When residual impacts remain despite best efforts to avoid, minimize and mitigate impacts, and where appropriate and supported by relevant stakeholders, mitigation measures may include biodiversity offsets adhering to the principle of "like-for-like or better."

Given that the UAHEP is a hydropower project and the economics of the project are dependent on the hydrology and generation potential offered by the selected project site, we believe that there are no technically and financially feasible alternatives that would avoid impacting natural habitat in the Arun River, other than to consider other rivers and, as discussed in Chapter 4 – Alternatives, there are several features of the Arun River that distinguish it as a high priority river for hydropower generation.

In the absence of a technically and financially feasible alternative, the ESF requires the Project to implement appropriate mitigation measures to be put in place to achieve no net loss.

Environmental Flow Release

As mitigation, the Project proposes to provide an Environmental Flow (EFlow) release through a proposed Eco-Flow Powerhouse to the Arun River near the downstream toe of the dam. The following EFlow assessment follows the World Bank Group's *Good Practice Handbook: Environmental Flows for Hydropower Projects* (2018). This Handbook provides an EFlow Decision Tree, using a series of Yes and No questions, for selecting the appropriate EFlow level of resolution and methodology, as identified below:

1. Low impact design and operation? – No, proposed PRoR facility
2. Significant dewatered reach between dam and tailrace? – Yes, 16.45 km
3. Ecosystems other than river affected (e.g., wetlands, estuary)? – No, few riparian wetlands exist in this highly incised gorge and the Project is far from any estuarine areas and the effects of its peaking effects will not extend downstream from Arun-3 HEP.
4. Significant social dependence on the river ecosystem? – No, most people live at higher elevations well above the river and the river is not used in any significant way for gravity-based irrigation, water supply, or transportation purposes between the UAHEP dam and the Arun-3 HEP reservoir, although the river is used for cultural purposes. For more details on social uses of the river, see Section 7.3.5 (Downstream Water Users and Uses).
5. First or most downstream in a cascade? – No, Arun-3 HEP is under construction and is located 32.0 km downstream from the UAHEP dam (about 15.5 km downstream from the UAHEP tailrace). The Lower Arun HEP and the Arun-4 HEP are also proposed downstream from the UAHEP dam.
6. Critical habitat? – No. The Project is situated in the wider landscape, i.e. EAAA, which contains a number of species that qualify as critical habitat. However, variability is expected between species in terms of whether they may be impacted directly or indirectly by the Project. The project EAAA includes critical habitat for golden mahseer (IUCN EN), but based on the field data collected to date, these habitats are found downstream from the Arun-3 HEP and the investigations done indicate that the UAHEP is not expected to impact any golden mahseer habitat. With the construction of Arun-3 HEP, golden mahseer will not be able to access potential habitat upstream from the Arun-3 dam, unless the Arun-3 HEP is to include a viable fish passage system.
7. Modified Habitat? – No. The Arun River meets definition of Natural Habitat.

According to the Handbook, this decision tree recommends a Medium Resolution Approach, which requires a Connectivity Assessment and a Sediment Assessment. ERM used the Hydrologic Engineering Center's River Analysis System (HEC-RAS) model to conduct a Connectivity Assessment. As described in Section 7.1.5 (Sediment), the Sedimentation and River Hydraulics – One Dimension

Model was used to conduct the Sediment Assessment, as described in the final subsection in this Section 7.2.4 on the Potential for Gas Bubble Disease in Fish. The World Bank had decided to conduct a high resolution Environmental Flow Assessment incorporating project peaking operations to identify flow release scenarios that minimize impacts on downstream aquatic ecology and ensure fish have access to important spawning tributaries.

UAHEP Connectivity Assessment

The connectivity/mobility assessment focused on ensuring that adequate water depths are provided to sustain fish migration and movement. Minimum depth requirements are highly influenced by body size (particularly the thickness of the body in the vertical plane including fins, known as trunk size). Adult fish typically have the largest body size of any life stage, so the EFlow assessment focused on the minimum flow needed to maintain mobility of adult fish through the affected reach under the assumption that flows sufficient to sustain adult mobility would also be sufficient for immature life stages. Mathur and Kapoor (2015) reported that snow trout prefer at least 10 cm of water above and below their trunk when swimming. The common snow trout is known to weigh up to 2.5 kg and reach 50–60 cm in length, although it is sexually mature at 18–24 cm (Sharma 1989). Mathur and Kapoor (2015) recommend EFlow water depths of approximately 0.5 m. Connectivity studies at the Upper Trishuli-1 HEP concluded that water depths of approximately 0.25 m would be sufficient to allow passage of common snow trout of <25 cm (Southern Waters draft 2018; Bhat *et. al.* 2013), which is the small end of the size for breeding stock. Common snow trout collected during the fishery study in the Upper Arun ranged in size up to 29 cm, but did not approach the maximum size of 50–60 cm referenced in the literature. Personal communication with Halvard Kaasa[101] indicates that water depths of 30 cm are adequate for most snow trout. Based on the scientific literature and the size of common snow trout found in the Upper Arun River, ERM recommends a minimum water depth of 30 cm to maintain common snow trout mobility within the diversion reach.

The Project's effects on aquatic habitat connectivity were assessed using this 30 cm water depth criterion. The Hydrologic Engineering Center's River Analysis System (HEC-RAS) was used to simulate thalweg depths at 35 cross-sections within the approximately 16.45 km long diversion reach, and another 12 cross-sections extending an additional 15.5 km downstream to approximately the Arun-3 dam). Average flows in January were used as an indicator of normal low flow conditions. The model accounted for 13.0 m^3/s of inflow, with 0.49 m^3/s from Chepuwa Khola, 9.34 m^3/s from the Barun River, and 3.17 m^3/s from other inflow, in the HEC-RAS model.

It was determined that an EFlow of 5.41 m^3/s would be required to provide the needed minimum water depth of 30 cm at all cross-sections in the diversion reach, meet Government of Nepal regulatory requirements (i.e., minimum flow of 10% of the lowest monthly average flow), and would also provide the required minimum depth of 30 cm downstream from the powerhouse while the UAHEP is not generating power (i.e., storing water during off-peak periods), which is needed to ensure spawning adults can access the important spawning tributary streams of Ikhuwa Khola and possibly to a lesser extent Leksuwa Khola. ***Table 7.4*** compares the average historic and proposed flow in the diversion reach. Even with the proposed EFlow, flow in the diversion reach will be substantially reduced from natural conditions.

Sediment Assessment

Hydropower projects, with few exceptions, will unavoidably impact sediment dynamics within their river system. The Arun River is glacial fed with a high sediment load, so proper management of sediment is critical. Ineffective sediment management can significantly impact aquatic habitat by increasing sediment deposition, thereby changing the substrate from hard rock to soft sediments, resulting in a loss of most benthic invertebrates as well as suitable habitat for benthic dwelling fish species. Benthic fish

[101] Halvard Kaasa is a Norwegian freshwater ecologist with extensive experience and knowledge of the fishes of Nepal.

species are common in the Arun River as the cobble substrate provides refuge from the high velocities in the water column.

The proposed Sediment Management Strategy (CSPDR 2020) is described in Section 3.6.2 and essentially involves passing sediment through the SBT when river flows are larger than 235 m^3/s, but less than 575 m^3/s, and using the MLO and LLO gates to lower the reservoir level and flush sediments, respectively, when river flow is equal to or greater than 575 m^3/s. As described in Section 7.1.5 (Sediment), the Sediment Management Strategy will reach an equilibrium condition with only about 19% of the reservoir's storage volume lost to sedimentation, which will primarily be found at the backwaters of the reservoir and in the deep water adjacent to the dam. This should result in relatively minor impacts on aquatic habitat within the reservoir.

Sediment transport model results indicate that the cumulative amount of sediment deposited in the diversion reach will be small, with only two areas incurring any appreciable sedimentation – just below the SBT outlet (about 0.64 m of deposition) and in a pool area just above the confluence with the Barun River (about 0.1 m of deposition). Sediment deposition in these two areas will reduce their suitability as habitat for at least the three benthic species found in the diversion reach – *Nemacheilus botia* (LC), *Psilorhynchus pseduecheneis* (LC), and *Euchiloglanis hodgarti* (LC). All of these species are relatively common, have an IUCN classification of Least Concern, the predicted deposition areas are small and these species have ample other habitat available within the diversion reach, as well as farther upstream and downstream.

Therefore, the proposed Sediment Management Strategy is considered adequate to manage potential sediment deposition in the diversion reach. The Project is not relying on EFlows to transport sediment other than the suspended sediment carried in the EFlow itself.

Social Assessment

As indicated above, the Arun River is not used to any significant degree for gravity irrigation, water supply, or transportation purposes, but is used for some cultural practices. There is one regionally significant cultural site, the Arun Dovan, which is located on the banks of the Barun River, which is considered a holy river by several different religions, near the confluence with the Project's diversion reach along the right bank of the Arun River. This site hosts an annual mela in January of each year and is also used as a cremation site by locals Dalits, Hindu Newar, and the Gurungs from several local villages. The Project should have no effect on the cremation rituals as they are practiced along the Barun River and the UAHEP will not affect flows in the Barun River. There will be an aesthetic effect on the Barun Mela as flow in the Arun River will be significantly reduced from typical January flows, but the focus of the mela is on the Barun River and not the Arun River. Although the flow will be significantly reduced, this section of the Arun River is where the river is wide and even during project operations, the river would remain at about 76 m wide, as opposed to about 100 m wide during normal January flows, so only about a 24% reduction in river width (see ***Figure 7.19***, which shows a cross-section of the Arun River just below the confluence with the Barun River). The Gurung of Sibrun also practice cremation rituals, but in an area, not a specific site, along the left bank of the Arun River. During project operations, the width of the Arun River will decrease from a typical January width of 50 m to approximately 36 m (see ***Figure 7.20***). The water widths and depths are considered sufficient to support cremation rituals.

Figure 7.19: Cross-section of the Arun River Just Downstream from the Barun River Confluence

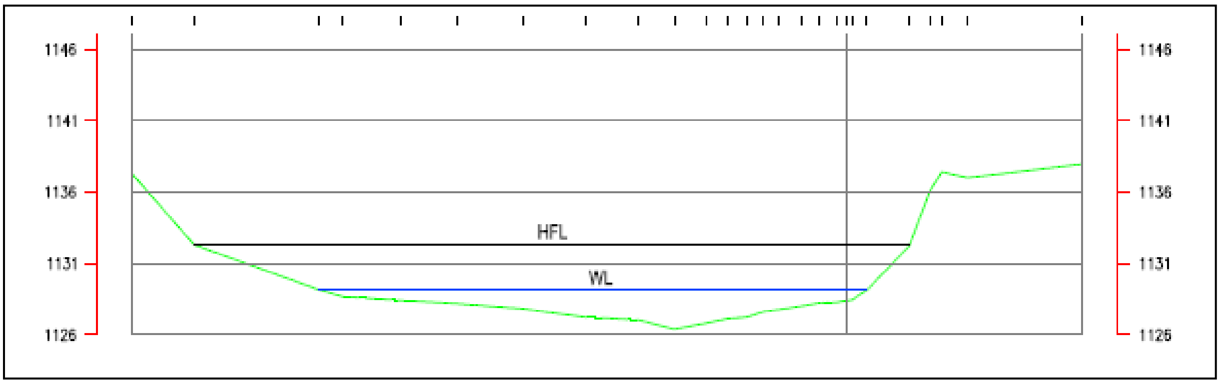
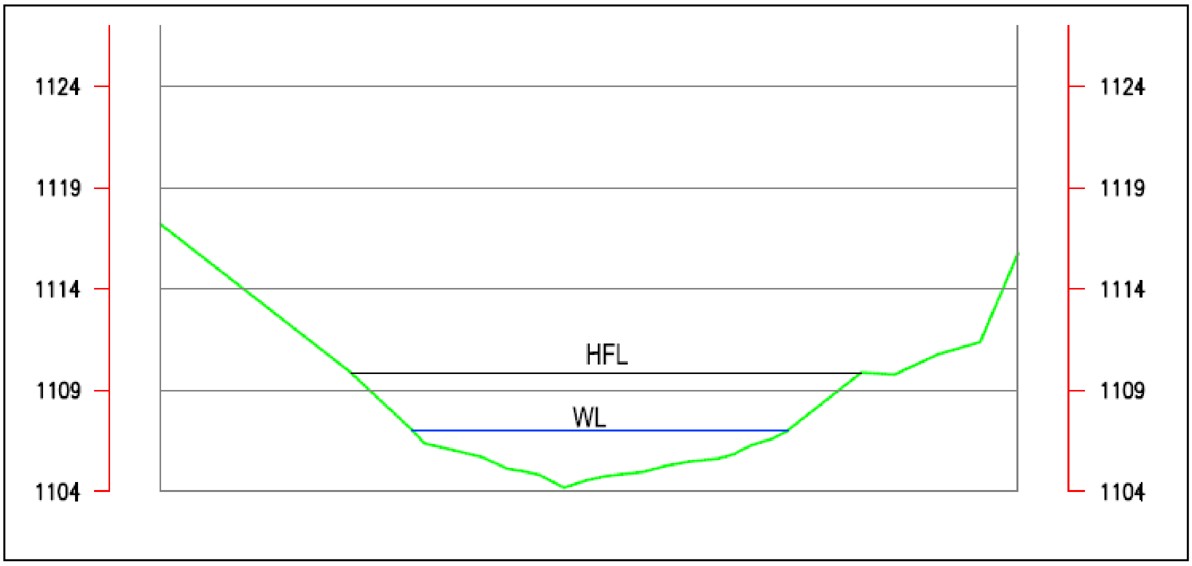


Figure 7.20: Cross-section of the Arun River Near the Sibrun Cremation Area



EFlow Summary

An EFlow of 5.41 m^3/s is recommended to maintain aquatic connectivity, address sediment transport in conjunction with the Sediment Management Strategy, and support social uses and practices along the Arun River from the dam to the Arun-3 HEP reservoir backwaters. The World Bank had decided to conduct a high resolution EFlow Assessment incorporating project peaking operations to identify flow release scenarios that minimize impacts on downstream aquatic ecology and ensure fish have access to important spawning tributaries.

The reduction In flow will reduce the Arun River's "wetted area", which is a surrogate for potential aquatic habitat, by approximately 20.8 ha in the diversion reach. As indicated previously, however, the fish population in the diversion reach is not high, as evidenced by the low CPUE. This is attributable to the rather inhospitable physical conditions in this river segment (i.e., very cold water, large sediment load, high velocities). This reduction in wetted area is unlikely to result in a net reduction in fish population, as fish abundance is more likely limited by the physical characteristics of this river segment, rather than habitat.

In addition to providing the recommended EFlow, the following mitigation measures will also be implemented:

- Monitor fish movement and migration to ensure fish are able to move along the entire length of the diversion reach. During project commissioning, inspect the diversion reach during EFlow releases to identify any barriers to fish movement and provide adaptive management measures as needed. These measures may include channel improvements and creation of pools to allow the fish to rest.
- Flush sediment in accordance with the sediment management strategy. Sediments should only be flushed during high flow periods when there is sufficient flow to transport sediment through the diversion reach.
- Monitor sediment deposition in the diversion reach for consistency with sediment transport model predictions. If sediment deposition is exceeding those predictions and impacting the suitability of aquatic habitat in the diversion reach, then the sediment management strategy will be "fine-tuned" to improve sediment transport and reduce sediment deposition in the diversion reach.
- Consult with local stakeholders regarding any residual impacts on social/cultural uses of the diversion reach.

The provision of the proposed EFlow and the other mitigation measures will reduce the magnitude of the impact to medium. Therefore, the Project's impact on aquatic habitat in the diversion reach will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Substantial***.

Degradation of Aquatic Habitat Downstream from the Powerhouse

The Project will have negligible effects on flow or aquatic habitat in the Arun River downstream from the powerhouse during construction, with impacts primarily related to the potential for increased sediment loads from construction. Therefore, the Project's impact on aquatic habitat downstream from the powerhouse during construction would be direct, adverse, low in magnitude, local in extent, short term in duration, with an overall pre-mitigation significance of ***Low***.

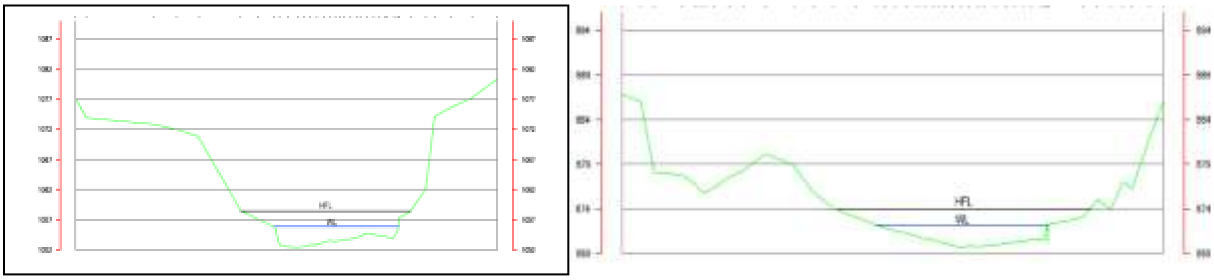
The Project will operate in a PRoR mode, which will result in water level fluctuations in the 11.8 km long river segment between the UAHEP tailrace and the Arun-3 HEP reservoir backwaters that may affect the approximately 40 ha of aquatic habitat present in this segment. During the monsoon season (June to September, 4 months), the Project will operate in a RoR mode and there should be negligible change in flow downstream from the tailrace. For the rest of the year (October to May, 8 months), the Project will operate in a PRoR mode with daily water level fluctuations occurring downstream from the tailrace depending on whether the Project is or is not peaking. The magnitude of these fluctuations will vary depending on the inflow into the reservoir. January has the lowest monthly average flows and will be expected to be the month with the most significant downstream flow modification from project operations. As described in Section 7.1.4 (Hydrology – subsection on Operation Phase), and using average January flows as indicative of the near worst case conditions, on an average daily basis during peaking operations, water depths will vary from 0.6 to 1.8 m, water velocities will vary from 2.0 to 4.3 m/s, and mean wetted area (a surrogate for aquatic habitat) will vary from 24.9 to 43.4 ha (see ***Table 7.5***).

Once a day, water depths will increase quickly, on average by over a meter in 15 minutes, and about six hours later decrease quickly by over a meter. This pattern of daily fluctuations in flow is not one to which most aquatic species are adapted; thus, such conditions can reduce the abundance, diversity, and productivity of these species. Rapid decreases in water depths can strand adult, juvenile, fry fish in shallow pools with no access to the main river channel and subject them to desiccation, predation, and collection by humans. Juvenile fish may be especially subject to stranding as they tend to concentrate in shallow water along the edge of the river, which are the areas most vulnerable to water level fluctuations, to avoid predation. Peaking operations can also degrade aquatic habitat for macroinvertebrates and macrophytes in the zone subject to water level fluctuations, including exposing them to potential desiccation (i.e., drying) when water levels decline.

Further, there is the potential for the peaking operation to affect fish connectivity and access to tributary streams (i.e., Ikhuwa Khola and Leksuwa Khola), as a result of lower water levels in the Arun River. The World Bank had decided to conduct a high resolution Environmental Flow Assessment incorporating project peaking operations to identify flow release scenarios that minimize impacts on downstream aquatic ecology and ensure fish have access to important spawning tributaries.

The geomorphology of the Arun River between the tailrace and the Arun-3 HEP backwaters, however, is a steep, moderately to deeply entrenched and confined stream channel. This channel morphology is less susceptible to fish stranding as the channel is typically narrow and relatively deep with few side channels, as is evidenced in the representative cross-sections shown in ***Figure 7.21***, which show water levels during average January peaking (HFL) and non-peaking (WL) conditions. Appendix F, Annex FB shows the peaking and non-peaking water levels for all cross-sections between the UAHEP tailrace and Arun-3 reservoir backwaters.

Figure 7.21: Representative Arun River Cross-Sections Downstream from the Tailrace



Cross-section below Leksuwa Khola **Cross-section below Ikhuwa Khola**

The daily fluctuations in flow, and particularly the sudden increase in flow during peaking, can retard upstream migrating fish.

Although golden mahseer (*Tor putitora* – IUCN EN) are known to migrate to approximately elevation 1,200 m on rivers in Nepal, no individuals were collected as part of the aquatic baseline surveys for this project, nor for the Arun-3 HEP EIA. One fisherman reported catching a golden mahseer about 15 years ago near the confluence with Ikhuwa Khola (elevation 900 m). It is reasonable to assume that golden mahseer may migrate farther upstream, perhaps to the confluence with Leksuwa Khola (elevation 1,080 m), but there is little if any suitable spawning habitat for golden mahseer farther upstream on the Arun River. Once the Arun-3 HEP closes its diversion tunnel, however, upstream migration of fish will no longer occur past the dam, and even the occasional golden mahseer will no longer be able to access any portion of the Arun River upstream from the Arun-3 HEP dam. Even if some individuals were trapped upstream from Arun-3 HEP when they close their diversion tunnel and commence operation, the water temperatures in this segment of the Arun River would likely be too cold for a sustainable population of golden mahseer to survive over winter.

Therefore, the Project's impact on the degradation of aquatic habitat downstream from the UAHEP tailrace will be direct, adverse, high in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Significance

The following mitigation measure will be applied by UAHEL:

- Monitor the downstream reach for fish, fry, and macroinvertebrate stranding for the first year of operations, especially during fish upstream (March to May) and downstream (September to November) migration periods. If fish stranding is determined to be having a population level impact, adaptive management measures will be implemented, such as channel improvements (e.g., remove rock to allow connectivity between pools and the river channel) or establishment of ramping rates to allow fish to escape from isolated pools.
- Ensure tributary streams maintain habitat connectivity with the Arun River during project peaking, especially during the critical spring spawning period. Provide adaptive management measures such as channel improvements or ramping rates to maintain fish access to important spawning tributaries like Ikhuwa Khola and Leksuwa Khola.

The proposed mitigation should reduce the potential magnitude of the impact to low and the extent of the impact to site-specific areas. Therefore, the Project's impact on the degradation of aquatic habitat downstream from the UAHEP tailrace will be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Substantial***.

Degradation of Aquatic Habitat in Small Streams

In addition to the loss, conversion, and degradation of aquatic habitat in the Arun River discussed above because of project structures and operation, there are other potential impacts on aquatic habitat in smaller streams in the DIA because of various construction activities. These impacts include degradation of water quality, reductions in flow in local streams and springs, and loss of habitat connectivity. These potential effects are discussed below.

Degradation of Water Quality

Degradation of water quality in local streams and the Arun River may result from erosion and sedimentation, stormwater runoff, wastewater discharges, and hazardous material spills, the physical impacts of which are evaluated in Section 7.1. These physical changes in water quality can also affect the biological environment as well, making some of these water bodies less suitable as aquatic habitat. Section 7.1 proposes a variety of mitigation measures to protect water quality, which in turn would also protect aquatic habitat and species.

Reduction in Flow

As described in ***Section 7.1.4***, the Project requires extensive tunnelling, which has the potential to intercept faults and fractures through which groundwater moves, resulting in a lowering of the water table and a reduction in or elimination of flow in affected springs and streams. Clearly a significant reduction or elimination of water would adversely impact the aquatic habitat and species found in those streams. ***Section 7.1.4*** includes a several mitigation measures to prevent or limit the extent of dewatering from tunnel construction, including the use of grouting and reinforced concrete in the tunnels.

Project construction will withdraw water from local waterbodies to meet the project's water demands. As discussed in Section 7.1.4, access road construction will withdraw water from local streams along the road route, but these withdrawals are relatively small in magnitude, short term in duration (i.e., only sporadic withdraws over the up to two years of road construction), and limited to a few larger streams with sufficient year-round flow to support these withdrawals without substantially affecting stream flow or aquatic habitat. Hydropower facility construction will require significantly more water, but proposes to construct water treatment plants that will withdraw water from Leksuwa Khola and Chepuwa Khola, which are large streams that can accommodate the proposed level of withdrawal without significant adverse impacts on aquatic habitat. Again, Section 7.1.4 proposes several mitigation measures to minimize project impacts on stream flow, which in turn would also protect the aquatic habitat present in these streams.

Loss of Habitat Connectivity

Construction of the project access road and service roads can fragment aquatic habitat connectivity along these small streams. If not designed properly, road culverts may allow the passage of water, but can be an obstacle to fish and wildlife movement.

Summary

Therefore, the Project's impact on the degradation of aquatic habitat in small streams during construction would be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

In addition to the proposed mitigation measures described in Section 7.1.4, the Project will also implement the following measures:

- Prohibit the washing of vehicles in local streams.
- Avoid the disturbance of riparian vegetation within 25 m of any streams when withdrawing water.
- Provide wildlife friendly road crossing (see Section 7.2.3 and ***Figure 7.18***).

The Project's impact on the degradation of aquatic habitat in these small streams during construction will be direct, adverse, low in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Low***.

These activities affecting stream water quality and flow primarily relate to the construction phase of the Project. During project operations, the Project's impact on the degradation of aquatic habitat in these small streams will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Low***.

Effects on Fish Movement and Migration

The flow in the Arun River will be diverted into the diversion tunnel during the third year of construction, at which point upstream fish migration and movement past the dam will be obstructed because of the high water velocities in the tunnel. Downstream fish passage can still occur through the diversion tunnel. Nearly natural river flow will continue through the diversion reach, so aquatic habitat integrity will be maintained and fish movement through the diversion reach will not be interrupted.

As project construction is completed, the diversion tunnel will be plugged and the reservoir filled, which is scheduled to occur in late February of the seventh year of construction. The Project will be required to maintain the EFlow release during reservoir filling, which will provide sufficient flow to maintain aquatic habitat integrity and allow uninterrupted fish movement through the diversion reach.

Once the diversion tunnel is plugged, the UAHEP dam will function as a barrier to fish movement and upstream fish migration. There are several species of fish that may be present in the Arun River upstream from Arun-3 HEP that are migratory, as indicated in ***Table 7.32***.

Table 7.32: Migratory Fish Likely Present in the Arun River

Scientific Name	Local/Common Name	IUCN Listing	Migratory Status
Anguilla bengalensis	Bengal eel	Not listed	Long-range migrant
Neolissochilus hexagonolepis	Katle/copper mahseer	Not listed	Mid-range migrant
Psilorhynchus pseudecheneis	Stone carp	LC	Mid-range migrant
Schizothorax progastus	Chunche asala/Dinnawah snow trout	LC	Mid-range migrant
Schizothorax richardsonii	Buche asala/common snow trout	VU	Mid-range migrant
Tor tor	Sahar	DD	Long-range migrant

Notes: LC = Least Concern; VU = Vulnerable; DD = Data Deficient

The UAHEP dam is located near the upstream limit of most migrating fish. The common snow trout and Dinnawah snow trout, both mid-range migrants, are the only species that are known to migrate upstream past the UAHEP dam site, but even then are only found in low numbers. The UAHEP dam will serve as a barrier to these two fish species. The other mid-range and long-range migratory species present within the Arun River (i.e., Bengal eel, copper mahseer) are only found downstream from the UAHEP dam site, so the UAHEP dam will not function as a barrier for the migration of these species.

The ecological corridor for long- and mid-range migrating fish will be impacted substantially by the Arun-3 HEP, which is currently being constructed and is scheduled to become operational between 2023 and 2025. The Arun-3 HEP will create a barrier for all fish migration at the dam site (approximately 800 m elevation), unless the project is retrofitted to include a viable fish passage system. Based on field data, reports from local fishermen, and the scientific literature, the long-range migrants found in the Arun River, including *Tor putitora* (IUCN EN), *Tor tor* (IUCN DD) and *Anguilla bengalensis* (IUCN NT), may infrequently migrate upstream from the Arun-3 dam. With completion of the Arun-3 dam, these species will no longer be able to migrate upstream beyond the dam. Although eels are known to be able to climb nearly vertical dam faces, given the height of the Arun-3 HEP dam (approximately 68 m), it is unlikely that *A. bengalensis* will be able to traverse the dam and access the Arun River upstream.

In the upper section of Arun River (i.e., upstream from the UAHEP dam), the fish population reflects a healthy aquatic ecosystem. It is composed of a relatively low number of species and with low fish densities, which would be expected for a relatively high elevation, cold water, turbid river. Based on the baseline survey data, the fish population is composed of mid-range migrants and resident species.

Based on this analysis, the magnitude of the Project's impact on fish movement and migration is considered medium, as relatively few species of fish and relatively few number of fish actually migrate pass the UAHEP dam, and none of these species need to migrate pass the UAHEP dam to complete their life cycles. Therefore, the UAHEP effects on fish movement and migration will be direct, adverse, medium in magnitude, regional in extent, and long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact

Various options were evaluated to mitigate the effect of the UAHEP dam as a barrier to fish movement and migration and allow for upstream fish passage. The provision of any of the several types of fish passage is challenging for the following reasons:

- Nature-like fishway – This is a man-made fishway the design of which is based on simulating natural stream characteristics, using natural materials, and providing suitable passage conditions over a range of flows for fish and other aquatic organisms, typically in the form of a bypass channel or a rock ramp (Wildman *et al.* 2005). In this case, because of the height of the dam (91 m) and the narrow gorge setting, there is not sufficient area available to create a nature-like fishway, so this is not a technically feasible option.
- Fish ladder – This can take several forms, such as a Denil/baffle fishway, pool type or a vertical-slot fish ladder. Fish ladders have a mixed record of effectiveness globally, but a particularly poor record in Nepal. Where fish ladders have had some degree of success, it is usually attributable to a long period of trial and error in terms of fish ladder design, and a detailed understanding of the targeted fish behavior and swimming characteristics, which is lacking for most fish in Nepal. Further, the lack of regulatory monitoring and ineffective fish ladder operations (Kaasa, undated) contribute to the poor performance of fish ladders in Nepal. It is considered likely, however, given the cold water of the Upper Arun, the many migrating fish may not have the energy to climb a 91 m +/- high fish ladder. Although fish ladders greater than 91 m exist, this would be a very high fish ladder and the highest in Nepal and, as for the nature-like fishway described above, the dam height and gorge setting limit the technical feasibility of even a fish ladder.
- Fish lift – This is an elevator-like structure that directs migrating fish into a hopper that carries them over the dam and dumps them into flume that empties into the river upstream from the dam. This fishway needs to be adjusted to fish migrating periods and often requires frequent support by skilled technical staff and has never been constructed in Nepal.
- Fish cannon – This is a new technology being developed in the United States by Whooshh Innovations, but may not be practical as it would require significant energy to pump water and fish over a 91 m high dam.
- Trap and haul – This technique is often used at dams where it is not practical or feasible to install a fish passage facility. This technique involves attracting fish to an area where they can be collected with nets and transported by buckets or tubs above the dam and releasing them into the river above the dam. There has been little if any experience with this option in Nepal, it is labor-intensive and difficult to monitor for compliance.

In addition to these technical challenges, other factors were considered in evaluating mitigation options:

- Presence of a downstream barrier to fish migration – The downstream Arun-3 HEP, which is currently under construction, was not required to provide a fish ladder as part of its approval by MoFE. Therefore, unless the Arun-3 HEP is retrofitted to include a viable fish passage system, long-range migratory fish will no longer be able to migrate upstream past the Arun-3 HEP dam. Common snow trout, Dinnawah snow trout, and the stone carp can tolerate the cold water of the Upper Arun River and will likely be able to form a small, but self-sustaining population in the Arun River between the Arun-3 HEP dam and the UAHEP dam. Some of these fish are likely genetically inclined to migrate upstream and would migrate past the UAHEP dam site. These are the only fish that are likely to be impacted by the UAHEP. No other mid-or long-range migratory fish species is likely to survive over winter in the Arun River upstream from Arun-3 HEP dam.
- Fish genetics – The Arun-3 HEP has been required by MoFE to develop a fish hatchery to raise fingerlings to be released in the reservoir to sustain “endemic” fisheries, primarily common snow trout. Over time, hatchery fish genetics will likely come to dominate the common snow trout population in the Arun River between Arun-3 HEP and the UAHEP dams as hatchery fingerlings will be added to the reservoir regularly, whereas the existing native fish population appears to be small and will not be supplemented other than by natural reproduction. In addition, there is the potential for interbreeding between hatchery and native individuals, which would further dilute the native fish genetics. This has the potential to weaken the common snow trout stock and is an argument against providing fish passage above UAHEP dam, which would likely be introducing hatchery fish into an otherwise native common snow trout population.
- Potential for more fish migration barriers in the future – There are other large dams proposed along the Upper Arun River (e.g., Lower Arun, Arun-4, and Kimathanka), which are all large projects with high dams with the potential to further segment fish populations. The potential impacts associated with these other proposed dams is evaluated in the UAHEP CIA (see Appendix E).
- If effective upstream fish passage could be established, then safe downstream fish passage would be needed. Upstream passage alone would probably lead to an increase in mortality as the only downstream passage options for much of the year would be entrainment through the powerhouse turbines, which, given the pressure head of the project, would likely result in near complete mortality. Some fish will be flushed through the dam as part of the sediment management strategy via the sediment bypass tunnel or the LLO and MLO gates, but these releases are only planned during high flows in the monsoon season, which does not coincide with the timing of downstream fish migration.

Given that the downstream Arun-3 HEP will not have a fish ladder, the fish population within the river segment between Arun-3 HEP and UAHEP will likely over time become dominated by hatchery fish. Due to the technical/engineering challenges of constructing a 91 m high fish ladder in a gorge setting, it was concluded that a fish ladder or other form of fish passage is not appropriate for UAHEP. Rather, the following mitigation measures are proposed:

- Try to postpone the establishment of the Arun-3 HEP fish hatchery – As indicated above, it is likely that hatchery fish will soon dominate the common snow trout population in the reach between Arun-3 HEP and UAHEP dams, which could damage the genetic robustness of this population. The common snow trout population does not appear to be large in this reach to start with, and the local villages do not appear to rely on fish for protein. There are likely sufficient spawning areas between these two dams (e.g., Ikhuwa Khola, Leksuwa Khola, the lower portion of the Barun River) to maintain the existing population and allow a self-sustaining, naturally reproducing population.

  Further, the common snow trout species appears to be quite opportunistic and able to adapt to a wide range of environmental conditions. For these reasons, and in the context of an adaptive management approach, it would be preferred to see if natural reproduction of native fish would be sufficient in this reach to maintain the population and support the local subsistence fishery, before establishing the fish hatchery. If the natural population is maintained, the hatchery may not be needed. At a minimum, it is recommended that the release of hatchery fish not occur until the

UAHEP dam is in place to prevent hatchery fish from accessing these natural waters upstream from UAHEP dam.

If the Arun-3 HEP fish hatchery is not implemented, then the UAHEP should test a trap and haul option at the discharge from the Eco-flow Power Station. During the upstream fish migration period of March to May, the Project would typically not be spilling any water, so the only release at the dam would be the EFlow from the Eco-flow Power Station. Migrating fish should be attracted to this flow, and, if they congregate near this discharge, some of the fish should be able to be captured by net, placed in a container, transported by the elevator in the dam to the dam crest, and released upstream. A key benefit of this approach would be the introduction of some genetic variability into the fish stock isolated upstream from UAHEP dam.

- Preserve the integrity of existing warm water tributaries between Arun-3 HEP dam and UAHEP dam to support a naturally reproducing and sustainable population of these migratory fish in this river segment – *Schizothorax richardsoni* (IUCN VU) is the dominant species found in the Arun River upstream from the proposed Arun-3 dam. This species is a migratory species with the ability to form resident populations. With the construction of Arun-3 HEP and UAHEP dams, a local resident population of *Schizothorax richardsoni,* as well as the other native species found in this segment of the Arun River, will likely form in the river segment between these two dams. In order to maintain a naturally reproducing population of *Schizothorax richardsoni,* it will be critical that suitable spawning and nursery habitat is preserved in this segment. The tributaries of the Arun River in this segment, primarily the Ikhuwa Khola and the Leksuwa Khola, are the only clean, warm water tributaries (i.e., not glacial fed) where *Schizothorax richardsoni* spawning and nurseries have been documented. The Hydrolab (2022) Aquatic Biodiversity Survey observed that the common snow trout spawns mostly in the main Arun River. The other Arun River tributaries in this segment either do not have enough flow to support spawning or have impassable waterfalls (i.e., Chepuwa Khola and Barun River) at, or shortly upstream from, the confluence with the Arun River, which limit their suitability to provide the required spawning and nursery habitat. Ikhuwa Khola is the preferred stream for preservation, as it has a larger drainage area than Leksuwa Khola and provides more suitable spawning habitat. As discussed in the CIA (Appendix E), if the Arun-4 HEP is built, then both Ikhuwa and Leksuwa kholas would be need to be preserved to maintain natural reproducing and sustainable populations in each of these river segments (i.e., from Arun-3 HEP to Arun-4 HEP, and from Arun-4 HEP to UAHEP) and to meet the WB ESF ESS 6 requirement of no net loss of natural habitat and a net gain of biodiversity values for critical habitats.
- Monitor populations of common snow trout upstream from the UAHEP dam as part of an adaptive management program to ensure a naturally reproducing and sustainable population of this IUCN Vulnerable migratory fish in this river segment – If upstream populations do not appear to be sustainable after construction of the UAHEP dam, then implement a trap and haul fish passage program, but this should only be done as a last resort given the likely introduction of hatchery fish in otherwise native fish waters.
- Introduce allochthonous matter or nutrients to the diversion reach to maintain the river’s productivity and enhance fish populations.

Taking into consideration these proposed mitigation measures, the Project effects on fish movement and migration will be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Substantial***.

Effects from Fish Impingement and Entrainment

Fish are susceptible to impingement and entrainment mortality at all hydropower projects. Impingement occurs when the intake velocity exceeds the fish’s burst swimming speed and the fish are pinned against a barrier, such as an intake screen or trash rack. Entrainment occurs when fish enter the headrace tunnel and are eventually flushed through the turbines, where they are subject to large pressure changes and the potential for being injured or killed by turbine blade strikes.

Avoidance Measures

The Project is located in an area with relatively low fish diversity and abundance, which reduces the number of individual fish susceptible to impingement and entrainment.

Impact Assessment

Given the high head of the UAHEP, it is reasonable to assume nearly 100% mortality for all entrained fish, including adults, juveniles, and fry. Some larger fish, such as the common snow trout and Dinnawah snow trout, could be impinged against the trash racks protecting the headrace tunnel intake, with a high mortality rate. As indicated above, however, the relative abundance of fish likely to be present in the reservoir is expected to be relatively low and the three resident fish are all benthic dwellers and less susceptible to impingement and entrainment at the intake structure, as they are less mobile and less likely to be found at the intake elevation (1,606 m). The mortality associated with impingement and entrainment is not expected to be large, but given the relatively low abundance of fish upstream from the dam, it could be important.

Therefore, the Project-related risk of fish impingement and entrainment will be direct, adverse, high in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Additional Mitigation and Residual Significance

The Project will implement the following mitigation measure:

- Install a trashrack/screens at the headrace intake with a clear spacing between the bars of 2.5 cm and ensure the intake approach velocities are below 0.5 m/s to reduce entrainment and impingement risk.

This mitigation measures should reduce the magnitude of the impact to low, which in turn should reduce the extent of the impact to site-specific. Therefore, the Project-related risk of fish impingement and entrainment will be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

Potential for Gas Bubble Disease in Fish

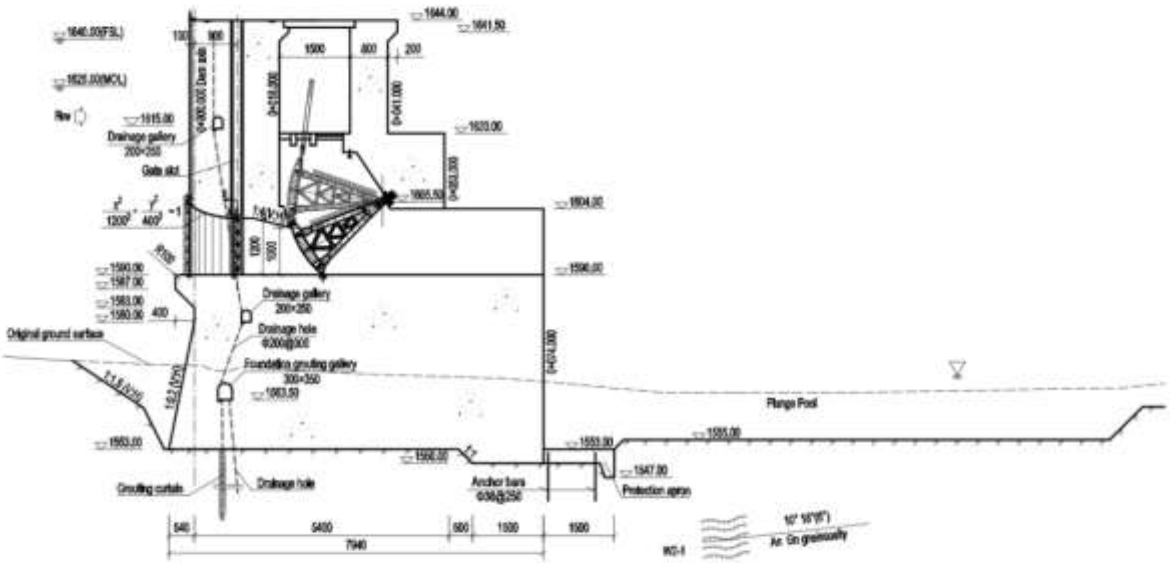
Gas bubble disease is a condition that affects aquatic organisms living in waters that are super-saturated (>115% saturation) with atmospheric gases (Weitkamp and Katz 1980). The gas super-saturation results in bubbles developing in fish, frequently behind the cornea, and to a lesser extent in the gills, causing a loss of equilibrium, the formation of lesions, and ultimately death under prolonged exposure, which can vary from hours to weeks. Gas super-saturation is known to occur below the spillways of some high head hydroelectric projects where air and water are mixed (Weitkamp and Katz 1980). The UAHEP is a high head project (91 m high dam), so the risk of gas super-saturation needs to be evaluated.

Gas super-saturation occurs when: (1) there is spillage at the dam where the water is mixed with air, and (2) this water is then carried to substantial depths in a plunge pool where the hydrostatic pressure is sufficient to greatly increase the solubility of atmospheric gases, which produces the super-saturation (Weitkamp and Katz 1980). The applicability of each of these two gas super-saturation requirements to the Project is discussed below:

- Spillage – At the UAHEP, spillage is effectively limited to the monsoon period (late May to early October), as for most of the rest of the year flows are below the Project's discharge capacity of 235 m^3/s and all water is routed to the powerhouse. In accordance with the Project's proposed mode of operation and sediment management strategy, flows above 235 m^3/s up to 575 m^3/s will be routed through the SBT and not spilled, so this water should not become super-saturated with gases. When Arun River flow is above 575 m^3/s, the Project will open the MLO and LLO gates for a controlled release of reservoir water. Flows above 575 m^3/s only occur about 10% of the time (see ***Figure 6.13***: UAHEP Dam Site Flow Duration Curve). Therefore, on average, the Project will only spill water about 10% of the time, and when it does, except under extreme flood events, the water will be released from the MLO sill elevation of 1,596 m and the LLO sill elevation of 1,590 m, rather than from the dam crest elevation of 1,644 m, which greatly reduces the water's exposure to air.

- Plunge pool – The UAHEP will have a plunge pool for energy dissipation. Most dams that have experienced gas super-saturation problems have powerhouses that are integral with the dam such that there is no diversion reach and tailwaters below the dam can be quite deep, promoting gas super-saturation. In the case of UAHEP, however, the powerhouse is 16 km downstream, and when the Project spills water, it will be to the diversion reach, with a relatively shallow water depth. The Project's plunge pool will have a floor elevation of 1,555 m (see ***Figure 7.22***).

Figure 7.22: Plunge Pool Typical Section



In summary, the Project is expected to spill water about 10% of the time. Except under flood conditions, most of the spillage will occur at the LLO at 54 m below the dam crest, and a deep plunge pool will not be present to create the conditions conducive to forming gas super-saturation. Therefore, the risk of gas super-saturation and gas bubble disease is direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Low.***

Proposed Mitigation and Residual Significance

Although the risk of gas super-saturation is believed to be low, the Project will:

- Measure gas saturation in the tailwaters after spill events for the first year of project operations to determine if super-saturation is occurring.
- Monitor fish populations in the tailwaters during the first year of project operations for evidence of gas bubble disease.
- If gas bubble disease is found to be occurring, the Project will evaluate alternatives to mitigate this impact (e.g., spillway deflectors).

Taking into consideration these mitigation measures, the Project's risk of gas bubble disease is considered to be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Low***.

7.2.5 Ecosystem Services

The WB (ESS 1) defines ecosystem services as benefits that people derive from ecosystem, which are organized into the following four major categories:

- Provisioning services, which are the products people obtain from ecosystems and which may include food, freshwater, timbers, fibers, medicinal plants;
- Regulating services, which are the benefits people obtain from the regulation of ecosystem processes and which may include surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards
- Cultural services, which are the nonmaterial benefits people obtain from ecosystems and which may include natural areas that are sacred sites and areas of importance for recreations and aesthetic enjoyment
- Supporting services, which are the natural processes that maintain the other services and which may include soil formation, nutrient cycling, and primary production

This section focuses on the effects the Project will have on the supporting services category listed above. The provisioning, regulating, and cultural services categories are evaluated in Section 7.3.

Avoidance and Minimization Measures

There were no avoidance or minimization measures related to ecosystem supporting services identified.

Construction and Operation Phases

Impact Assessment

The Project will impact on the natural processes that help maintain soil formation, nutrient cycling, and primary production. The Project will result in the disturbance of 292.1 ha of land, which will involve the removal of topsoil.

In terms of nutrient cycling, the UAHEP dam and reservoir will trap some nutrients flowing down the Arun River. These nutrients, most of which are absorbed to suspended sediment particles, will settle out with the sediment as river velocities slow when they reach the UAHEP reservoir.

In terms of primary production, the Project will promote an increase in primary production as the UAHEP reservoir provides better conditions for primary production than the Arun River itself, but this production will be retained within the reservoir or will flow through the Project's powerhouse, thereby bypassing the diversion reach. So the diversion reach may be impacted more than other river segments.

In summary, the Project's potential impact on ecosystem supporting services would be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Significance

The Project will implement the following mitigation measures to address project impacts on ecosystem supporting services:

- Implement the Soil Erosion and Sediment Control Management Plan – Some of the land to be disturbed during project construction will be restored to its pre-construction use, and the Contractor will be required to remove and stockpile topsoil to aid in site restoration. Nevertheless, there will be a slight reduction in soil formation processes, but this represents only about 0.2% of the land where soil formation may be occurring within the EAAA.
- Implement the Sediment Management Strategy – The Project has a sediment management strategy that will bypass or flush much of the sediment deposition out of the reservoir when river flows exceed 235 m^3/s. Therefore, the nutrient cycling within the Arun River will continue, but will be slightly temporarily affected.
- Organic material passage through the headworks – The Project will help ensure that organic material, which plankton requires for photosynthesis and primary production, will be passed through

the reservoir, as much of this material is carried with the monsoon flows and, therefore, will be released as part of the planned sediment flushing where the LLO gates are opened.

Taking into consideration these mitigation measures, the Project's potential impact on ecosystem supporting services would be direct, adverse, low in magnitude, site specific in extent, and long term in duration, with an overall residual significance of ***Low***.

7.2.6 No Net Loss and Net Gain of Terrestrial Biodiversity

No Net Loss Requirements for the Project

The Project will impact approximately 94.58 ha of terrestrial natural habitat within the Direct Impact Area.

The WB ESF ESS 6 (paragraph 22) states that a Borrower will not implement any project-related activities that adversely impact natural habitat unless:

- There are no technically and financially feasible alternatives:
  - As described in Chapters 2 and 4, it is not technically feasible to develop a project of this magnitude in this relatively remote area of Nepal without affecting natural habitat. Chapter 4 evaluates a "No Forest Clearing" alternative, but concludes this is not technically feasible. Impacts on terrestrial natural habitat have been minimized.
- Appropriate mitigation measures are put in place, in accordance with the mitigation hierarchy, to achieve no net loss and, where feasible, preferably a net gain of biodiversity over the long term. When residual impacts remain despite best efforts to avoid, minimize, and mitigate impacts, biodiversity offsets adhering to the principle of "like-for-like or better" can be applied.

No net loss is defined "as the point at which the project-related biodiversity losses are balanced by gains resulting from measures taken to avoid and minimize these impacts, to undertake on-site restoration, and finally to offset significant residual impacts, if any, on an appropriate geographic scale" (WB ESF ESS 6, footnote 8).

Net Gain Requirements for the Project

An additional biodiversity survey carried out by the Red Panda Network in 2022 did not find the presence of Chinese pangolin, black musk deer or Mandelli's mouse-eared myotis in the wider project area, but established the presence of red panda, Himalayan black bear, clouded leopard, and spotted linsang, all four of which are Endangered species according to Nepal's Red List (Red Panda Network Nepal 2023). The Project will directly impact on red panda, Himalayan black bear, clouded leopard, and spotted linsang and areas within the MBNP that maintain populations of these species, as well as community forest areas in the MBNP Buffer Zone and community forests outside the park. Indirect impacts on the Himalayan red panda, Himalayan black bear, clouded leopard, and spotted linsang will occur as a result of poaching or animal collection.

The WB ESF ESS 6 (paragraph 24) states that a Borrower will not implement any project-related activities that adversely impact critical habitat unless:

- No other viable alternatives within the region exist for development of the Project in habitats of lesser biodiversity value:
  - The Project will impact on 35.55 ha of MBNP Buffer Zone (21.803 ha government owned forest land and 13.751 ha private land) (see ***Table 7.25***), which is treated as critical habitat. As described in Chapter 4 (Project Alternatives), the MBNP and its Buffer Zone extend along the centerline of the Arun River from the China border all the way to the Arun-3 HEP. So any hydroelectric project on the Upper Arun would unavoidably impact on portions of the MBNP. Although critical habitat for the four identified terrestrial species exists within the UAHEP EAAA, the Project itself will not directly impact on any terrestrial critical habitat, so there are no other alternatives that could affect less critical habitat.

- All due processes required under international obligations or national law that is a prerequisite to a country granting approval for project activities in or adjacent to a critical habitat have been complied with:
  - This will be documented by the Ministry of Forests and Environment with approval of the EIA.
- The potential adverse impacts, or likelihood of such, on the habitat will not lead to measurable net reduction or negative change in those biodiversity values for which the critical habitat was designated:
  - The UAHEP will not have an adverse impacts on the critical habitat such that it would lead to measurable net reductions or negative changes in its biodiversity values. The habitat affected within MBNP is a mix of forest and agricultural land within the Buffer Zone.
- The Project is not anticipated to lead to a net reduction in the population of any recognized Critically Endangered, Endangered, or restricted-range species over a reasonable time period:
  - The UAHEP is anticipated to result in the direct mortality of the Himalayan black bear. There remains a risk that the Project could indirectly result in poaching or animal collection of Himalayan red panda, Himalayan black bear, clouded leopard, and spotted linsang, but mitigation measures are proposed to manage this risk and offsets are proposed below.
- The Project will not involve significant conversion or significant degradation of critical habitats –
  - The UAHEP will result in the permanent conversion of approximate 35.55 ha of land within the MBNP Buffer Zone, part of which is treated at critical habitat. This conversion is not considered significant as it only represents very a small fraction (0.026%) of the total Buffer Zone.
- The Project's mitigation strategy will be designed to achieve net gains in those biodiversity values for which the critical habitat was designated:
  - The UAHEP's proposed strategy for achieving net gains is described below.
- A robust and appropriately designed, long-term biodiversity monitoring and evaluation program aimed at assessing the status of the critical habitat is integrated into the Borrower's management program:
  - The UAHEP's proposed terrestrial biodiversity monitoring and evaluation program is described below.

Net gains are defined as "additional conservation outcomes that can be achieved for the biodiversity values for which the natural or critical habitat was designated. Net gain may be achieved through full application of the mitigation hierarchy that may include the development of a biodiversity offset and/or through the implementation of additional programs in situ to enhance habitat, and protect and conserve biodiversity" (WB ESF ESS 6).

High-level strategy for Achieving No Net Loss and Net Gain of Terrestrial Biodiversity

In light of the above, biodiversity offsets will be necessary to compensate for residual impacts and achieve a no net loss for Natural Habitat and net gain for critical habitat.

No Net Loss and Net Gain of Terrestrial Natural and Critical Habitat

A number of broad actions to support the Project to achieve no net loss and net gain of terrestrial natural and critical habitat are given as follows:

- Avoid and minimize disturbance of natural habitat to the extent possible.
- Restore temporarily disturbed natural habitat that will not support permanent facilities by planting native species.

- Compensate for the permanent loss of natural habitat by coordinating with the Nepal Division of Forests to provide the required 25:1 (saplings planted per tree cut) afforestation by planting native species found in the project footprint (i.e., “like for like”), ideally on government-owned land that will be permanently maintained as natural habitat. Compensation programs can be proposed to enable forest restoration within the MBNP as well as afforestation programs as stipulated by Nepal’s Forest Clearance Guidelines. Dependent on the requirements of the Nepal Government, the afforestation programs would occur at ratios of 25:1 of the trees lost and based on the forest inventory results. The afforestation programs would occur using native forest species and targeting degraded areas of the landscape. Additionally, community forest programs would reduce the need for community members to collect timber within the broader landscape. Such measures will compensate for habitat losses.
- Mitigation measures are recommended to ensure net gains for critical habitat species and their habitats, including: the development of wildlife crossing infrastructure like some wildlife underpasses and arboreal bridges; human-wildlife conflict management; and habitat restoration efforts encompass land acquisition, planting of local trees, such as bamboo for red panda, fencing of planted plantations, fire control, control of invasive species, and water management of water sources for wildlife. Additionally, the monitoring of wildlife to identify the effect on the four critical habitat species, strengthening of law enforcement to control poaching by anti-poaching units, feral dog control, which attack wildlife, and limited rescue and rehabilitation programs are emphasized. Wildlife research and monitoring activities involve camera traps, species monitoring to check the effectiveness of proposed actions, patrols of anti-poaching units. These recommended measures collectively aim to conserve critical habitat species and their environments while minimizing project-related impacts and are expected to achieve net gains of these species.
- Additional Conservation Actions (ACAs) for the MBNP are:
  - Coordinate with the Nepal Department of National Parks and Wildlife Conservation and the MBNP staff to determine additional conservation measures to achieve no net loss of the MBNP protected area, which could involve proportionally expanding the MBNP, support implementation of management measures identified in the MBNP Management Plan, or provide financial support to allow for more effective management and enforcement of the park.
  - Coordinate with the Nepal Department of National Parks and Wildlife Conservation and the MBNP staff to manage potential cumulative impacts on the MBNP as identified in the Arun River Basin CIA (Appendix E).

Biodiversity Monitoring and Evaluation Program for Terrestrial Biodiversity

The UAHEP’s proposed terrestrial biodiversity monitoring and evaluation program includes the following elements (see Appendix C, ESMP, Annex C3, Biodiversity Management Plan):

- Wildlife shepherding protocol
- Biodiversity induction training procedure
- Soil erosion and sediment control Procedure
- Biodiversity community engagement procedure
- Injured wildlife protocol
- Biomass removal procedure
- Site Rehabilitation Plan
- Invasive Species Management Plan
- Biodiversity and Ecosystem Services Policy
- Transmission line engineering design

- Avoidance of natural habitat
- Lighting strategy
- Soil erosion and stabilization engineering
- Construction phase fishing ban
- Worker employment agreements
- Livelihood Restoration Program, incorporating biodiversity-related actions
- Access control requirements
- Coordinate with, and provide funding to, the MBNP to track poaching and vehicle strikes animals and other species of concern.

7.2.7 No Net Loss and Net Gain of Aquatic Biodiversity

No Net Loss Requirements for the Project

The Project will result in the loss of aquatic natural habitat because of dam construction (1.0 ha), conversion of riverine to lacustrine habitat (5.2 ha), and potential degradation of aquatic habitat (20.8 ha in the diversion reach and approximately 40 ha downstream from the powerhouse subject to fluctuating water levels due to seasonal peaking operation). The project dam will also prevent fish migration and restrict aquatic connectivity up and down river. The dam will contribute to segmenting the Arun River between dams and limiting connectivity between the Arun River and its important tributaries to just those fish found within each segment (i.e., the segments between the Arun-3 and UAHEP dams and between the UAHEP and Kimathanka dams). No net loss for fish biodiversity in the dewatered section can be achieved when the year-long EFlow of 5.41 m^3/s is released and a minimal depth of 30 cm is guaranteed, which is has been assessed to be sufficient for the common snow trout to reach its spawning grounds and breed and maintain a viable natural population.

Minimum Flow Requirements

The table below was set up during the Building Block Methodology Workshop after discussions between all experts. It describes the required characteristics of hydraulic parameters to reach acceptable conditions to minimize the impacts of flow reduction on environmental and social values:

Table 7.33. Hydraulic Parameters Required to Minimize Impacts of Flow Reduction

Parameter		Component	Constraint Factor	Location	Requirement
Depth	Value	Biological	Fish must be able to migrate laterally and longitudinally. Requirement is based on the size of the largest fish encountered + extra margin	Along dewatered and hydropeaking reaches	30 cm
Depth	Value	Biological	Some pools need to be preserved as distinct habitats	Main existing pools, particular	> 2 m
Depth	Value	Human	Waist deep water is required for performing ceremonies.	At cultural sites	ca. 1 m
Wetted perimeter	Value	Biological	A wide wetted perimeter, particularly in sunlit shallow, low velocity depths, helps support more periphyton (primary	Dewatered reach	50% of pre-project

		productivity) on rocky substrate and higher invertebrate populations on gravel / sand.		
Seasonal pattern	Biological	Hydraulic cues are needed for organisms to trigger their various life cycle phases. This is particularly important at the start of the monsoon.	Dewatered reach	Proportional to natural variation during key spawning period of the common snow-trout

Hydraulic modelling interpretation helped the experts to assess and establish flow requirements corresponding to the different requirements. It appeared during the analysis that maintaining waist deep water at key cultural sites would not be compatible with project concept and additional specific measures were defined to overcome this issue (See Cultural Heritage Management Plan from EFlow Management Plan). Moreover, the proposed concept does not yet allow for variable EFlow and provision of hydraulics cues potentially triggering migration and spawning. Having the design of the EFlow powerplant to allow for an increased EFlow would widen the options to address potential residual impacts.

The table below presents the required environmental flow to minimize the impacts of flow reduction on environmental values. It is noted that this is the minimum flow to be released and that it will be supplemented by the several tributaries located in the dewatered stretch.

Table 7.34. Environmental Flow to Minimize Impacts of Flow Reduction

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.41 m^3/s	5.41 m^3/s	5.41 m^3/s	5.41 m^3/s	5.41 m^3/s	5.41 m^3/s or Over-flow/ SBT	Over-flow/ SBT	Over-flow /SBT	Over-flow/ SBT	Over-flow/ SBT or 5.41 m^3/s	5.41 m^3/s	5.41 m^3/s

Hydropeaking and SBT Management

For the 11.8 km section downstream of the powerhouse to the Arun-3 HEPP the high resolution EFlow Assessment recommended a ramping up and down as presented in the table below in order allow juvenile common snow trout not to get washed away and to reach a safe location and during ramping down not get stranded. This mitigation measure will allow a viable fish population to be maintained in this section of the Arun River and will lead to no net loss for the common snow trout the most common species in the part of the river. The effectiveness of these two mitigation measures need be closely monitored and adapted when needed as presented below.

The table below was set up during the Building Block Methodology Workshop after discussions between all experts (geomorphology, hydrology, aquatic ecology, hydraulics, environmental and social experts). It describes the required characteristics of hydraulic parameters to reach acceptable conditions to minimize the impacts of hydropeaking on environmental and social values.

Table 7.35. Hydraulic Parameters Required to Minimize the Impacts of Hydropeaking

Parameter		Component	Constraint Factor	Location	Requirement
Depth	Rate of change (decrease)	Biological	Stranding of fish is expected if depth drops too rapidly for them to find shelter. The effect is amplified for younger life stages that have not reached monsoon size.	Hydropeaking reach, especially near confluences Dewatered reach (end of SBT use)	Max. 1 cm/min on majority of sections, Max. 10 cm/min for all sections
Width of river	Rate of change (decrease)	Biological	Stranding of fish is expected if width narrows too rapidly for them to find shelter. The effect is amplified for younger life stages that have not reached monsoon size.	Hydropeaking reach, especially near confluences Dewatered reach (end of SBT use)	5 m/min
Depth	Rate of change (increase)	Human	A fast rise in water level increases the risk of drowning, particularly considering the poor escape routes in narrow gorges and enhanced opportunities for visiting them.	Hydropeaking reach	20 cm/min
Velocity	Rate of change (increase)	Biology	Sudden increases to un-swimmable conditions for fish do not provide enough time for reaching shelter such as counter currents	All reaches	15 min escape time
Shear Stress	Rate of change (increase)	Biological	Fast rates of change in shear stress may exceed ability of invertebrates to dig in for shelter	Hydropeaking reach	> 10 min for doubling shear stress

Hydraulic modelling interpretation helped the experts to assess and establish the limiting factor. The table below shows the limiting factor and corresponding maximum flowrate variation for bringing the impacts of hydropeaking to acceptable values during a ramp up and a ramp down.

Table 7.36. Limiting Factor and Corresponding Maximum Flowrate Variation for Reducing the Impacts of Hydropeaking

Parameter		Water Level Variation Constraint	Corresponding Maximum Flowrate Variation	Limiting Factor
Ramp up	First unit	20 cm/min	1.33 m^3/s per min	Human safety Entrainment of macroinvertebrates
	Additional units	*No requirement*	*No requirement*	*Not Applicable*
Ramp down	All units excluding the last one	*No requirement*	*No requirement*	*Not Applicable*
	Last unit	1 cm/min in majority of sections	1 m^3/s per min	Fish stranding

It is noted that these constraints also apply to:

- Opening of the Sediment By Pass Tunnel for the first 50 m3/s
- Closing of the Sediment By Pass Tunnel for the last 50 m^3/s

Net Gain Requirements for the Project

The Project is not expected to result in any direct impacts on aquatic critical habitat. The Hydrolab Aquatic Biodiversity Survey in 2022 confirmed that golden mahseer are not present in the parts of the Arun River affected by the UAHEP thus the net gain requirement is not needed (Hydrolab 2022).

High-level Strategy for Achieving No Net Loss of Aquatic Habitat and Biodiversity

In light of the above, other mitigation measures could be necessary to compensate for potential residual impacts and achieve a no net loss in the case that monitoring indicates that the two above mentioned mitigation measures are not adequate for the common snow trout to maintain a viable population.

No Net Loss of Aquatic Habitat and Biodiversity

UAHEL will prepare a Biodiversity Offset Management Plan prior to bidding the construction contracts (see Appendix C, ESMP, Annex C3) to achieve no net loss of aquatic habitat, which may include the following provisions:

- UAHEL has conducted a high resolution EFlow Assessment, which incorporated project peaking operations to identify peaking flow release scenarios that minimize impacts on downstream aquatic ecology, maintain habitat connectivity, and ensure fish have access to important spawning tributaries such as Ikhuwa Khola and Leksuwa Khola.

- Conduct monitoring and implement adaptive management measures to ensure connectivity in the reach downstream from the powerhouse subject to fluctuating flows from seasonal peaking operations, which may include channel improvements and possibly adaptation of ramping rates if stranding proves to be a significant issue.
- Take action to ensure a sustainable, naturally reproducing common snow trout population in the approximately 32 km long reach of the Arun River between the Arun-3 dam and the UAHEP dam. This will require preservation of key common snow trout spawning habitat in this reach, including Ikhuwa and Leksuwa kholas.
- Conduct monitoring of the diversion reach and identify opportunities for habitat enhancements that take advantage of the reduced river velocities and turbidity. For example, the Arun River may become suitable for common snow trout and other native species for spawning. The Hydrolab Aquatic Biodiversity Survey has already confirmed that the Arun River is a suitable spawning habitat for common snow trout (Hydrolab 2022).
- Conduct monitoring of the reservoir and identify opportunities for habitat enhancements that take advantage of the increased water depths and incrementally warmer water. The reservoir could serve as a refuge for some fish from cold winter water temperatures.
- Implement a trap and haul program at the UAHEP dam if the Arun-3 HEP does not introduce hatchery fish into the segment of the Arun River between the Arun-3 and UAHEP dams.

Biodiversity Monitoring and Evaluation Program for Aquatic Biodiversity

The UAHEP's proposed aquatic biodiversity monitoring and evaluation program includes the following elements:

- Biodiversity induction training procedure
- Biodiversity community engagement procedure
- Invasive Species Management Plan
- Construction phase fishing ban
- Worker employment agreements
- Livelihood Restoration Program, incorporating biodiversity-related actions

Potential Residual Impacts and Mitigation Measures: Biodiversity and No Net Loss Approach

The proposed operating rules (EFR and ramping rates) minimize the potential negative impacts of reduced flow and hydropeaking on fish populations and support the overall ecological integrity of the Arun River system. However, residual impacts on aquatic habitats may remain. In this case, restoration and offset measures may be necessary.

This section summarizes the proposed approach and measures developed in the EFMP to achieve no net loss for common snow-trout if residual impacts are confirmed through monitoring after commissioning of the powerplant. Indeed, common snow trout is an umbrella species and protective measures implemented for this species will also safeguard a broader range of other species.

The proposed approach is a stepped approach based on adaptive management. If monitoring shows that initially proposed measures result in significant residual impacts, the Project should implement additional measures. The commissioning period will be key period for the assessment of the residual impacts and the implementation of the adaptive management. An exhaustive list of all points to check during the commissioning phase will have to be prepared, in conjunction with Contractor and UAHEL E&S teams. For example, the first hydropeaking cycles need to be performed in the daytime, starting with slow ramping rates to ensure a successful monitoring of the impacts. Moreover, staffing arrangements and logistics requirements for the implementation of the different measures must be anticipated so that potential residual impacts can be addressed in due time. More specifically, the team in charge of the measures needs to be trained before they start working so that they can be operational at the time of commissioning.

UAHEL and the Contractor will be responsible for the monitoring and the analysis of monitoring data and the resources of the Contractor may be mobilized if habitat restoration and river morphology management measures appear to be necessary.

STEP 0: Monitoring and Spawning Ground Protection

Monitoring and Evaluation:

- Implement a rigorous monitoring program to track the effectiveness of habitat connectivity measures. After commissioning of the project, assess connectivity and channel conditions in key tributaries and identify potential barriers to fish movement. As common snowtrout and numerous other species preferentially spawn in warmer, clear water tributaries rather than the Arun River itself, the maintenance of adequate spawning habitat is critical to minimize the residual impacts on aquatic biodiversity. Tributary streams such as the Ikhuwa Khola and Leksuwa Khola are essential for the spawning of various fish species like the common snow-trout. These streams must therefore remain accessible to fish from the Arun River, especially during critical periods like the spring spawning season.
- Use ecological indicators such as fish population surveys, spawning success rates, and juvenile recruitment to evaluate the health of fish communities.

Stakeholder Engagement:

- Establish a feedback mechanism for stakeholders to report observations and concerns related to fish movements and spawning activities.

Reporting and Adaptation:

- Have the design of the Eflow powerplant to allow for an increased Eflow would widen the options to address potential residual impacts.
- Regularly report on the status and outcomes of habitat connectivity measures to relevant environmental authorities and stakeholders.
- Be prepared to adapt management actions based on monitoring results, new scientific information, or changing environmental conditions.

***Fish Stock and Spawning Grounds Protection*:**

- Work with the GoN to permanently conserve one or more clean water streams used for spawning common snowtrout.
- Liaise with neighbouring hydropower companies and stakeholders on this issue, particularly other hydropower projects and taking a proactive role in the cross-organizational aspects of fish stock management.

If monitoring indicates significant residual impacts, actions listed under step 1 should be envisaged.

STEP 1: Fine-tuning of Operation Rules

Adaptive E-Flow Management:

- Fine-tune ramping rates that simulate natural flow conditions during spawning periods to facilitate fish movement into tributaries.
- Fine-tune discharge volumes to ensure sufficient water depth and velocity for fish passage, particularly during critical spawning times (upstream (March to May) and downstream (September to November) migration periods).
- Assess the need to adapt Eflow to mimic natural hydrological variation in the dewatered stretch during key spawning period of the common snow-trout.

If monitoring indicates significant residual impacts, actions listed under step 2 should be envisaged.

STEP 2: Habitat restoration and river morphology management

Channel Modifications:

- Implement structural improvements to remove or modify barriers, such as creating fish passes using nature-based solutions or training the river to allow for fish passage.

Habitat Enhancement:

- Enhance spawning habitats within tributaries by adding substrates suitable for egg deposition and larval development.
- Restore riparian zones along tributaries to improve water quality and provide necessary shelter and food resources for juvenile fish.

Stakeholder Engagement:

- Involve local communities and fishery experts in the design and implementation of connectivity measures to incorporate traditional knowledge and ensure community support.

If monitoring indicates significant residual impacts, actions listed under step 3 should be envisaged.

STEP 3: Offsets

Native Fish Stock Management:

- Implement a catch and release programme to facilitate the recovery of the fish populations. The catch and release programme should include a clearly defined success metric, with goals set in numerical terms and related to the number of returning adults that are progeny of previous spawners. Population replacement rates should be greater than 1.0 and monitored using genetic parentage analysis in exploratory programs or modelled for programs under consideration.

If monitoring indicates significant residual impacts, actions listed under step 4 should be envisaged.

STEP 4: Offsets

***Native Fish Stock Management*:**

- Develop a hatchery / breeding programme for common snow trout, and if needed other species in the Upper Arun area. It is important that this offset solution is part of an integrated approach to river basin management. The commitment to an offset management period of 30 years aligns with the concession agreement period for the project, emphasizing the long-term perspective for environmental conservation.

In line with the requirements of the Biodiversity Management Plan (ERM, 2022), the confirmation of achievement of No Net Loss for the common snow trout through the above measures will require the definition of appropriate metrics. These metrics (e.g., Catch per Unit Effort) will be developed under the responsibility of UAHEL with a fish expert and baseline data in the metrics selected should be defined prior to the construction of the project.

7.3 Community Safety

In order to minimize the impacts of the project on community safety, the following measures should be implemented:

- Set up a **flood monitoring system** upstream of the dam and in the Barun watershed capable of detecting sudden unplannable events such as GLOFs.
- Set up two-way **communication channels with the local authorities** for updating the population on scheduled operations such as hydropeaking hours (hydropeaking hours will be varying all along

the course of the dry season), probability of forecast unplanned undesirable events, and the current e-flow. This communication channels should also be mobilized during flushing events.

- Develop a **smartphone service and application** that provides real time and forecast information on flow-conditions. Constantly bear in mind that cell phone information will only inform part of the population.
- Establish an **alarm system** using sirens and SMS cell broadcast messages. Test the sirens once per month at a well-established time outside of the usual hydropeaking hours. Alarms should be sounded at the start of events such as hydropeaking or flushing. The alarms should be both part of an interconnected system, in addition to having some redundant autonomous capability using local sensors in order to improve resilience.
- Carry out a **study of escape capacity**. This will involve identifying all the existing escape routes on each bank of the river. This should consider:
  - Existing accesses to the river as well as future accesses and crossing points created by the lowering of the water level in the river (continuously in the dewatered section and daily in the downstream section).
  - The various anticipated flow levels (access to certain escape routes may vary depending on the water level).
  - Areas that are too deep with no existing escape routes should be identified. The creation of escape routes and/or safety platforms may then be studied for these sections (considering the different flow levels) if required considering risk of being swept away by the flow.
  - Basics for spending a night out in the refuge will need to be discussed with the communities.
  - The timing of the alarms must be set to at least 30 minutes before the start of the flushing operations (times to be adjusted according to the results of the escapement assessment).
- Implement extensive **signage** along the river, informing people of the risks incurred in the vicinity of the river, the nearest escape routes or safety platforms and their direction, the times of the main water level variations expected, a reminder of the alarm signals, their meaning and the behavior to follow.
- Define location **reference points** along the river such as landmarks and / or additional visible markers. Disseminate maps of these (including posting up at administration offices, along the river and on the web site) so that everyone has the same reference points for warnings / rescue. From these, it should be made easy to know where the closes refuge area is located.
- Provide community **education and awareness** training/seminars on project related safety risks.
- Conduct periodic stakeholder engagement and closely monitor **grievances** during first two years of project operations to document any unanticipated project impacts/risks on downstream water uses and users and implement an adaptive management program to mitigate these impacts/risks if necessary.

This list is a summary of proposed measures and additional information is available in the Community Safety Management Plan (See Eflow Management Plan).

7.4 Cultural Heritage

In order to minimize the impacts of the project on cultural heritage, the following measures should be implemented in addition to ramping rates and minimum flow requirements:

- **Community-Centric Festival and Ritual Planning:** schedule operational activities, especially those that might alter river flow, to accommodate important local festivals, rituals, and community gatherings. This planning will be done through active dialogue with community leaders to ensure minimal interference with cultural practices, including river-related worship services and swimming traditions.
- **Adaptive Management for Cultural Continuity:** incorporate an adaptive management approach to EFlows that considers social and cultural aspects, ensuring that adjustments can be made to flow regimes as necessary to preserve the cultural and religious practices that depend on the river. If necessary, bathing areas with at least 50 cm of water can be created. The most suitable location(s) will be defined in consultation with the local authorities and the communities. At this stage, it is recommended to install at least 3 bathing areas near the confluences of the main tributaries (Barun, Lexuwa and Ikhuwa). The design of these areas should allow for water renewal and therefore avoid stagnant water.
- **Cultural Sensitivity Training: i**mplement a comprehensive training program for all operating personnel on local customs and cultural sensitivities. This will be a part of the induction process for new employees and an ongoing program for all staff to reinforce the importance of respecting local traditions.
- **Open Communication Channels:** establish a consistent and transparent communication framework for ongoing dialogue with the local communities. This includes pre-announcement of project activities that may affect river use, ensuring that the communities can adjust their activities and rituals accordingly.
- **Cultural Heritage Inventory Management:** maintain an up-to-date inventory of cultural heritage sites within the project influence area. This register will be used to ensure that project operations do not inadvertently damage sites of cultural significance. This inventory will be a public document, available to the community for updates and verifications.
- **Impact Mitigation and Enhancement:** where impacts on cultural practices are unavoidable, develop and implement mitigation strategies that may include the creation of alternative sites for worship and swimming that are acceptable to the community.

This list is a summary of proposed measures and additional information is available in the Cultural Heritage Management Plan (See Eflow Management Plan).

Metrics to assess no net loss of the common snow trout population will need to be developed in more detail as part of a Biodiversity Monitoring Plan. These metrics (e.g., CPUE for native species) will be developed in consultation with a fish expert. Summary

Table 7.37 provides a summary of the pre-mitigation and post-mitigation (residual) impact significance for both construction and operation phases for the biological environment, as described above.

Table 7.37: Summary of Project Construction and Operation Phase Biological Environment Impact Significance (Biological Environment)

Impact	Pre-mitigation Significance	Post-mitigation/ Residual Significance
Construction Phase		
Effects on legally protected areas (MBNP)	High	Low
Effects on internationally recognized areas of high biodiversity Value	Moderate	Low
Loss of terrestrial habitat	Substantial	Low
Effects on critical habitat species	High	Low
Disturbance and/or displacement of terrestrial fauna	Substantial	Moderate
Terrestrial barriers, fragmentation and edge effects	Substantial	Moderate
Degradation of terrestrial habitat	Moderate	Low
Wildlife mortality events	High	Low
Loss and conversion of aquatic habitat in the headworks area	Moderate	Moderate
Degradation of aquatic habitat in the diversion reach	Low	Low
Degradation of aquatic habitat downstream from powerhouse	Low	Low
Degradation of aquatic habitat in small streams	Substantial	Low
Effects on fish movement and migration	High	Substantial
Effects on ecosystem services	Moderate	Low
Operations Phase		
Effects on legally protected areas (MBNP)	Low	Positive
Effects on internationally recognized areas of high biodiversity value	Low	Positive
Loss of terrestrial habitat	Low	Positive
Effects on critical habitat species	Low	Positive
Disturbance and/or displacement of terrestrial fauna	Moderate	Low
Terrestrial barriers, fragmentation and edge effects	Moderate	Moderate
Degradation of terrestrial habitat	Low	Low
Wildlife mortality events	Low	Low
Loss and conversion of aquatic habitat at headworks	Moderate	Moderate
Degradation of aquatic habitat in the diversion reach	Low	Substantial
Degradation of aquatic habitat downstream from powerhouse	Low	Substantial
Degradation of aquatic habitat in small streams	Low	Low
Effects on fish movement and migration	Substantial	Substantial
Effects from fish impingement and entrainment	High	Low
Risk of gas bubble disease	Low	Low
Effects on ecosystem services	Low	Low

7.5 Social Environment Risks, Impacts, and Mitigation

7.5.1 Introduction

This section identifies and evaluates potential project risks and impacts on the social environment, recommends appropriate measures to avoid, minimize and mitigate these impacts, and identifies the significance of the remaining residual impacts in accordance with the rating system described in Chapter 5. In addition, this section describes means of avoiding, reducing, mitigating and managing social impacts e consistent with the applicable standards discussed in Chapter 2. It also assesses the predicted social environment impacts (both positive and negative) associated with the Project. These include impacts associated with the following:

- Land acquisition and physical/economic displacement, which are covered in detail in the RAP
- Project-induced in-migration and population influx
- Ecosystem services (see Section 7.2.5 for supporting ecosystem services pertaining to biodiversity)
- Downstream water users and uses
- Transmission of food and water borne communicable diseases
- Transmission of sexually transmitted diseases
- Health infrastructure
- Gender, gender-based violence (GBV), and trafficking in persons (TIP)
- Nuisances
- Emergencies and public safety
- Use of security personnel
- Labor and working conditions (including child labor)
- Employment creation, skills enhancement, and local business opportunities
- Cultural heritage
- Differential impacts on vulnerable people

The Project will cause a range of pre-construction, construction, and operation phase impacts that will affect people living in the project impact area, which includes both the Direct and Indirect Impact Areas, and beyond (i.e., at the regional level). A Stakeholder Engagement Plan (SEP) including a grievance redress mechanism (GRM) was prepared for the Project and publicly disclosed in September 2019.[102] The Project is located in an area where approximately 98% of the local population belongs to aadibasi/janajati (indigenous) communities. The Project will result in adverse impacts on land and natural resources subject to traditional ownership and customary use; therefore, as per WB ESS 7 (paragraph 24), free prior and informed consent (FPIC) is required. Therefore, an FPIC process is being carried out, and details on the process and agreements are provided in a standalone Indigenous Peoples Plan (IPP).

The key potential social impacts of the Project and the stage of the Project during which these impacts are predicted to be most impactful/relevant are provided in ***Table 7.38*** below. This table shows the impacts' pre-mitigation significance and is not meant to imply that impacts primarily occurring in the construction phase do not have legacy/residual impacts during operations; rather, it is designed to indicate when the impacts will emerge and be most prominent (and, thus, when most mitigation

[102] Details pertaining to the GRM, including how information will be tracked and managed, are available in the SEP. Such details are beyond the scope of this chapter.

measures will be implemented). This document, therefore, distinguishes, where appropriate, between the pre-construction/construction phase and the operation phase. Women and other vulnerable groups within the affected population are expected to experience these social impacts differently. These are discussed at the end of this section.

Before moving on to the impact assessment, it is important to note some modifications to the impact/ risk assessment methodology laid out in Chapter 5 to accommodate two particular considerations about the prominence of specific social risks and the feasibility of successful implementation of proposed mitigation measures within the Nepal context.

- The first such consideration is the **normative context of Nepal** – specifically, the presence of prevailing norms that may complicate the implementation of mitigation measures (e.g., lack of a stringent health and safety (culture; normalization by many of the practice of child marriage).
- The second such consideration pertains to the **institutional/organizational capacity** of the Government of Nepal and its related operational arms to implement the mitigation measures proposed in the following sections. This consideration is most important in instances where the proposed mitigation measures are particularly arduous/demanding.[103]

To address these considerations, the residual rating for certain indicators have been adjusted where the mitigation measures were assessed to be particularly arduous and/or historically not well-implemented by governmental bodies. These areas are clearly indicated and the reason for the final adjustment rating explicitly noted. In some cases, this returns the significance down to the pre-mitigation level. In others, where the mitigation measures are more straightforward – such as sharing health information, etc. – the residual significance remains unchanged. This nuanced approach recognizes the existence of capacity issues and more accurately represents for each impact the implications of government bodies' potential limitations in implementing the proposed mitigation measures effectively (thus, highlighting where capacity building may be required, without discounting the potential efficacy of the proposed mitigation measures – if done well – to reduce the impact significance to the stated levels).

A third consideration, which does not require alteration of the evaluative approach, but nevertheless warrants mentioning pertains to the relationship between vulnerable people and the impact significant rating approach. The concern here relates to the fact that the evaluative matrix employed in this document is based on the *overall effect* of particular impacts on the communities in the project DIA. Thus, in instances where there is a very small minority sub-group of the population for whom a given project risk is particularly high, it is possible that the impact significance on that specific sub-group does not align with (and is not accurately represented by) that of the *overall* population. Rather than increase the overall impact significance for every impact for which there is a particularly vulnerable segment of the population (which would be the majority of them), a detailed discussion of the potential for certain impacts to have disproportionate impacts on specific vulnerable groups is provided (see Section 7.4).

[103] In addition to adjusting the ratings to account for these considerations, this ESIA also includes the following measures to address capacity issues: 1) Institutional Capacity Assessment and Strengthening Plan (see Annex C4 of Appendix C – ESMP) – implement the recommendations of the plan, and; 2) Independent third-party monitoring and auditing – conduct robust monitoring and auditing of key project risks and where the lack of capacity is especially acute.

Table 7.38: Key Potential Social Impacts and Stage of Occurrence

Potential Impact	Pre-Construction and Construction	Operation
Land acquisition and physical/economic displacement	High	Moderate
Project-induced in-migration and population influx	High	Moderate
Ecosystem services	Substantial	Moderate
Impacts on downstream water users and uses	Low	High
Transmission of food/water borne communicable Diseases	Substantial	Low
Transmission of sexually transmitted diseases	Substantial	Moderate
Impacts on health infrastructure	Substantial	Low
SEA/SH, gender-based violence, and trafficking in persons	High	Substantial
Nuisances (e.g., noise, dust, vibration)	Substantial	Low
Natural disasters	High	High
Traffic accidents	High	High
Landslides	High	High
Dam failure	High	High
Emergencies and public safety	NA	High
Use of security personnel	Substantial	Low
Labor and working conditions	High	Moderate
Employment creation, skills enhancement, and local business opportunities	Positive	Positive
Tangible cultural heritage	Substantial	Low
Intangible cultural heritage	High	Substantial
Differential impacts on vulnerable people		

7.5.2 Land Acquisition and Physical/Economic Displacement

Development projects, which displace people involuntarily, generally give rise to severe economic, social, and environmental problems. Involuntary and voluntary resettlement may cause long-term hardship, impoverishment, and environmental damage, unless appropriate measures are carefully planned and carried out.

The Project has made considerable efforts to minimize the scope of physical and economic displacement. Specific efforts include the following:

- Project facilities have been sited to minimize physical and economic displacement to the extent possible.
- Project facilities have been carefully designed to reduce the need for land acquisition to the extent possible.

Construction Phase

Project construction will require acquisition of at least 195.8 ha of land for the hydropower and access road, which will affect all or portions of at least 699 privately owned land parcels (totaling 119.47 ha) and 92 publicly owned land parcels (at least 76.33 ha).[104] A minor amount of additional land acquisition may be required where the parcel residual is too small for economic use and the property owner prefers to have it acquired. The Project will also acquire 1.1 ha for transmission line towers; however, the nature of these lands (private/public) is not yet known, as the exact location of the transmission towers has not been confirmed (see RAP).

Table 7.39: Land Acquisition by Land Type (Private or Public)

Land Category	# Affected Parcels	Area (m^2)	Area (ha)
Private land	699	1,194,777	119.5
Public land	92	763,206	76.3
Unknown (transmission line towers)	Not available yet	11,250	1.1
Total	**Not available yet**	**1,957,983**	**196.9**

The Project will also require execution of temporary land access agreements for approximately 76.9 ha of land to allow for temporary construction access and disturbance (e.g., grading, temporary access road). Permanent land use restrictions for the transmission line RoW will be required for 25.5 ha of land (detailed information pertaining to the transmission line will be addressed in a supplementary appendix to the Project RAP. This RAP's appendix will be prepared and implemented in advance of the transmission line construction).

The potential project impacts during the pre-construction phase, resulting in the physical displacement of approximately 22 households and economic displacement of 335 households, are assessed to be direct, adverse, high in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***High***.

Based on the implementation of the proposed mitigation measures detailed in the RAP, the Project's impacts related to land acquisition and physical and economic displacement during the (pre-) construction phase will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Substantial***.

However, as per Section 7.3.1, this ESIA has identified this Project impact as one in which the Project proponent's institutional capacity to implement the proposed mitigation measures must be more explicitly considered. In view of this, a capacity development program to enhance the UAHEP's capacity to implement the RAP and manage the mitigation measures has been included in the ESMP.[105]

Operation Phase

No additional physical or economic displacement associated with planned land acquisition is expected as part of the operation phase. Activities under the Livelihood Restoration Plan (LRP) will continue during this phase, and permanent land use restrictions will continue throughout the operation phase. The Project's potential impacts from land acquisition and physical/economic displacement during the

[104] Please note that final information on public versus private land ownership and number of affected parcels for the transmission line is not yet available, as the precise location of the towers has not yet been decided. Information pertaining to the transmission line will be included as a supplementary appendix to the Project RAP.

[105] It is critical to note, once again, that this ESIA proposes that the Project mitigate such capacity-related issues through the following measures: 1) Institutional Capacity Assessment and Strengthening Plan (see Annex C4 of Appendix C – ESMP) – by implementing the recommendations of the plan, and; 2) Independent third-party monitoring and auditing – conducting robust monitoring and auditing of key project risks and where the lack of capacity is especially acute. These efforts, if successfully implemented, will be important contributors to reducing the risk associated with this, and other, project impacts identified as highly dependent on a particular level of capacity to implement the proposed mitigation measures.

operation phase will be direct, adverse, medium in magnitude, local in extent, and medium term in duration, with an overall pre-mitigation significance of ***Moderate****.*

Mitigation measures outlined in the RAP will reduce the magnitude of the impact, but given the challenges with the project location and the Project's potential impact from land acquisition and physical/economic displacement during the operation phase is assessed to be direct, adverse, medium in magnitude, local in extent, and medium term in duration, with an overall residual significance of ***Moderate***.

7.5.3 Project-induced In-Migration and Population Influx

The Project will stimulate in-migration to the project impact area. This may include workers contracted to the Project, or job-seekers entering the area in the hope of securing employment with the Project. Population influx may also be stimulated by the possibility of business opportunities linked to the provision of goods and services to the Project, and by real or perceived opportunities arising from the general increase in economic activity in the area. The following sections address the impacts that this in-migration and population influx could have on the project impact area, absent any mitigation.

Construction Phase

During its peak construction (year 5), the Project will employ approximately 4,500 workers. Although steps will be taken to maximize local employment, many of the skilled and semi-skilled roles will likely be filled by workers from outside the project districts, given the low local skill base in the area. Therefore, it is estimated that over 70% of jobs will go to non-local (i.e., migrant) workers, both Nepali and third-party nationals brought into the project DIA through a managed process of recruitment and transportation. The Construction Contractor will be encouraged to hire women, but the vast majority of these jobs will likely be filled by men. Typically, an infrastructure project of this size will attract economic migrants seeking either direct or indirect employment associated with the Project – this is referred to as the influx population. The Project is located in a remote location not well connected by road and transportation services, which may deter some of this ancillary population influx. The Project will provide skills training in construction to enhance possibilities for employment by the Project. Accordingly, the Project will give preference to local workers to the extent possible and will ensure that the documentation of the Construction Contractor includes the measures required to realize this.

Workers will be concentrated in seven workers' camps – three for access road construction, and four for the hydropower construction – consisting of anywhere from 45 to 2,500 workers each. This represents a significant increase in population, given that the entire DIA of the Project consists of 24 small villages with approximately 1,350 households and a total population of approximately 8,000 people. Villages in the DIA – particularly those located near workers' camps – will, therefore, be significantly outnumbered by workers and any project-related population influx. Local police are deployed mostly on the right bank of the Arun River. As project components are primarily located on the left bank of Arun River, the villages on the left bank such as Sibrun, Hema, Namase, and Rukma do not have any police post. Even where police posts exist, they do not have the authority to act against any influx, or the capacity to act against the illegal occupation of government land, and the rural municipalities have limited staff and capability to deal with these issues.[106]

A number of Impacts associated with this in-migration and, to a lesser extent, population influx of economic migrants looking for employment opportunities, are explored in other sections. These include:

- Increased demand on natural resources (water and firewood) (see Section 7.3.4)
- Increased spread communicable diseases, including food and water borne diseases and STDs/STIs (see Sections 7.3.6 and 7.3.7)
- Increased pressure on the health care system (see Section 7.3.8)

[106] The influx hot-spots will likely develop along the road between Hedengana and Arun Bazar. This will involve other rural municipalities (Makalu and Num) along with Bhotkhola.

- Increased risk of emergencies (Section 7.3.11)
- Impacts on local culture and tradition (see Sections 7.3.15)
- Impact on women and girls who may be exposed to potential SEA/SH and GBV risks

Beyond these topics addressed elsewhere, the in-migration of workers and influx of those hoping for employment, to offer other services, or families of workers, may have the following impacts:

- **Increased demand and competition for local public services:** In addition to pressure on health care and housing (discussed below), in-migration could increase demands on water, power, sanitation and waste facilities, and telecommunications, placing strain on the already limited services currently available to residents. Some of these needs would be immediate (like health), while others (like banking) would emerge more gradually, as people enter the cash economy or participate at a greater level than at present. While workers' camps will have their own medical facilities, waste management system, power system, and will house all workers, there would still be potential for spill-over into local communities.
- **Increased pressure on accommodation and rents:** As shown in the project social baseline (Chapter 6.3), residential structures in the DIA tend to be small (54% are single story) and, therefore, do not have any extra space for renting. There are a few households that are used as homestays by mostly local people, as the area receives only a few tourists. Additionally, there is very little additional land in the DIA. which community members could use to host additions to the local population, whether through in-migration or population influx. Therefore, locals might choose to free up some of their current, limited, living space or build additional structures around their existing homestead to accommodate the population influx. While this can have positive income-generating impacts on the local population (see Section 7.3.14), it also may result in crowding and unhygienic conditions. Alternatively, the poor economic conditions in the DIA (19% living under Nepal's poverty line, and 60% living under the internationally defined poverty line) may even encourage local people to sell or rent land to outsiders interested in establishing homestays or other businesses, thus contributing to the social dislocation explored in Section 7.3.2 in relation to physical and economic displacement. However, the requirement for non-local workers to live in the contractor's camps and the prohibition on bringing their families to the DIA will help to limit the inflation of local housing prices.
- **Local inflation of prices and crowding out of local consumers:** As a result of the above, the prices for homestay arrangements and meals would increase and the local people who previously used these services would have to pay more. Demand for other local goods and services would also increase prices, potentially beyond the spending power of the local population. See Section 7.3.14 for a full discussion of project impacts on local businesses. However, the provision of self-sufficient worker accommodation may help to limit the inflation of the cost of basic goods.
- **Gender-based violence, including sexual harassment, child abuse and exploitation:** As the population increases and more cash and material wealth emerges in the area from an increase in the presence of salaried workers, the likelihood of anti-social behaviors, such as trafficking, child marriage, sexual abuse and exploitation and harassment, and prostitution, may also increase (see Section 7.3.9). Most workers – and likely a large percentage of job-seeking economic migrants – will be men, which may exacerbate these impacts.
- **Substance abuse and criminal behavior:** Increased levels of disposable income could exacerbate levels of substance abuse. The abuse of alcohol (and drugs, should this occur) often correlates with increased levels of criminal behavior and violence (e.g., domestic violence), both while under the influence of the substance, or as a desperate measure to find the financial or material means with which to support the habit. Such behavior would increase the number of people indirectly affected by, or vulnerable to, alcohol and drug abuse.
- **Increased stress on public protective services:** Currently there is variable police presence in the DIA and reportedly very low levels of crime, drug, and alcohol abuse, and social order is

maintained largely via traditional authority mechanisms. The effects of the presence of project workforce and a growing in-migrant population would create a need for more substantial and formal policing and judicial infrastructure than currently in place.

- **Increased incidences of prostitution and casual sexual relations:** Increased disposable income can lead to an increase in prostitution and casual sexual relations between workers and local women. These sexual relations could lead to an increased incidences of STDs/STIs (see Section 7.3.7 for further discussion of STD/STI transmission). Women and young girls in the area would be particularly vulnerable to STDs/STIs due to their limited education, limited ability to negotiate safe sex practices for cultural and religious reasons, and the higher risk that women have of contracting STDs/STIs through unprotected sexual intercourse compared to men (see Section 7.3.7).
- **Conflict between local community and migrant workers:** The presence of migrants or "outsiders" in the project impact area may not be viewed as a positive impact by all community members. Issues that often cause conflict between migrant workers and host communities relate to competition for job opportunities, natural resources (including land), women, different cultural beliefs, and general project benefits. For instance, the distribution of employment opportunities between locals and migrants often leads to social tension and conflict, especially when locals perceive the migrants to be taking their jobs. This perception could lead to tension between the two groups.
- **Conflict between local community and the Project:** There is also a high degree of expectation that the Project will bring local and regional benefits. The main expectation for benefits is access to employment opportunities, improvements to infrastructure, and the delivery of corporate social responsibility (CSR) projects (see Section 7.3.14). Due to the extent of these expectations, there is potential for unmet expectations and conflict with local communities, especially if workers from other parts of Nepal are perceived to be benefiting more than locals (see above). There is also a risk of conflict between the community and project security personnel. This is explored in Section 7.3.12 and, therefore, not addressed further in this section.

Based on the analysis provided above, the risk of project-related in-migration and influx during the construction phase could be direct, adverse, high in magnitude, local in extent, medium term in duration (spanning the six to seven-year construction period and potentially beyond), with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

Measures Aimed at Mitigating Population Influx

- Prepare an **Influx Management Plan** (see Appendix C, ESMP) to minimize the influx of employment-seekers into the project impact area. This plan will be prepared in consultation with district, municipal, and ward officials, and will include the following measures, among other things:
  - Enforce the Code of Conduct (see Appendix C, ESMP), which will include language prohibiting workers from bringing their families to the DIA and will include language pertaining to zero tolerance to GBV/SEA/SH behaviors.
  - Advertise widely (e.g., at the regional level) the employment requirements and approach to employment (including no "at the gate" hiring) early on as a means of managing the expectations of potential job-seekers.
  - Ensure gender neutral hiring advertisements (i.e., avoid terms such as workmen, line men) and state that women are encouraged to apply).
  - Source as much unskilled labor as possible from Bhotkhola and Makalu rural municipalities.

  - Maximize local content in procurement (i.e., from local people and towns) whenever possible, and whenever project requirements are met.
  - Establish project employment offices in Kathmandu and Khandbari for most workforce hiring. Establish a local employment office in Gola for residents of Bhotkhola and Makalu rural municipalities who can prove their local residency to discourage influx of job-seekers. Avoid any "at the gate" hiring.
  - Set up security checkpoints at each of the project road and pedestrian bridge crossings of the Arun River (one of each near Limbutar and between Chepuwa and Rukma) to discourage people seeking employment from entering the construction area. Ensure Construction Contractors enforce no trespassing into construction areas, both for safety and security reasons and to further discourage influx.
  - Provide transportation to Khandbari for workers on leave to avoid entry into villages and intermingling with local people (especially women).
  - Plan for the controlled return of workers to the place where they were recruited or to their place of domicile as soon as their employment in the Project ends to discourage their remaining in the project impact area.
  - Hold information meetings with local authorities to explain the negative impacts of population influx, harnessing their support to reduce the influx of workers and opportunity seekers.
- Support local governments in monitoring and mitigating influx through the following activities:
  - Provide training and capacity building for local officials at the district and affected rural municipality and ward levels regarding monitoring and managing influx.
  - Establish an UAHEP Intergovernmental Coordination Committee with UAHEL, as well as district, rural municipality, and ward level representatives, to monitor influx and growth of any illegal and unsafe settlements and address these and other local issues. UAHEL shall ensure that this committee has an appropriate gender balance.
  - Help the rural municipalities to issue an advisory to local residents for the orderly development of accommodation facilities, ensuring the safety of the structure, sanitation, and environmental hygiene.
  - Assist the rural municipalities to issue advisory notices on lease/rent amounts and to regulate the growth of illegal settlements or commercial establishments.

Measures Aimed at Reducing Impact on Surrounding Communities/Local Economy

The above measures will help to manage the movement and settlement of economic migrants in the DIA. However, acknowledging that it will not be possible to avoid all in-migration, the following mitigation measures can help reduce the impact of population influx. These are primarily drawn from the Project's Influx Management Plan.

- Require non-local workers (i.e., those from locations other than Bhotkhola and Makalu Rural Municipalities) to live in the designated workers' camps and prohibit non-local workers from moving their families to the project impact area as a condition of employment.
- Ensure workers' camps are relatively autonomous and do not rely on local/public facilities for accommodation, healthcare, sanitation, cooking, recreation, and other infrastructure or services. The provision of self-sufficient worker accommodation will limit the negative economic impacts associated with construction projects, such as the inflation of local housing prices or the cost of basic goods.
- Implement an Occupational Health and Safety Plan (see Appendix C, ESMP) to reduce the impacts of workers and workers' camps on the surrounding communities and local economy. This plan will

be consistent with the requirements of WB ESS 4, the WB General EHS Guidelines, and the EIB Standard 9, and include the following measures:

- Provide ongoing and regular training to all workers and staff on sexual exploitation, abuse, and harassment, and adopt a code of conduct that prohibits them from engaging in any form of sexual activity with members of the local community, except in case of pre-existing marriages. Ensure that an effective monitoring system is in place to ensure compliance.
- Conduct basic sociocultural induction with all migrants working on the Project. The community liaison officers (CLOs) will also develop a brochure (containing basic sociocultural information) and distribute it to all new arrivals in the DIA.
- Incorporate penalties for non-compliance by the Contractor with the above provisions.

- Implement a Community Health and Safety Management Plan (see Appendix C, ESMP) that mandates the Contractor to:
  - Restrict workers to workers' camps during night-time hours unless working a night shift. No worker access to villages during night-time hours and establish penalties for failure to comply.
  - Adopt a policy on GBV, TIP, and sexual exploitation and abuse and collaborate with law enforcement agencies in the investigation of any violations of the law.
  - Fund the establishment of police posts at locations where large workers' camps are located (Sibrun and Rukma) and deploy female police personnel at these posts to help monitor interactions between project workers and local residents, specifically GBV, TIP, and sexual exploitation and abuse.[107] The hiring of local residents for these positions is encouraged.
- Implement a Workers' Code of Conduct that demonstrates respect for local customs and traditions and prohibits behaviors that could be damaging to the local communities, such as fighting, use of ecosystem services (e.g., hunting, fishing, logging, collection of NTFP), possession of illegal substances or firearms, consorting with prostitutes, abuse of alcohol, and defecating in open areas/bodies of water.

Measures Aimed at Mitigating Community Conflict

- Involve local leaders such as municipal officials and ward chairs in aforementioned UAHEP Intergovernmental Coordination Committee to find ways to ensure that social cohesion is maintained, to ensure that all affected villages receive equal access to opportunities in terms of local recruitment, training, small business development, procurement, and community outreach programs, and to manage influx-related issues. Ensure appropriate gender balance on this committee.
- Encourage realistic expectations about the Project's developmental contributions by maintaining close communication with community leaders and residents.
- Appoint permanent community liaison officer(s) (CLOs), including at least one female, to actively interact with the communities.
- Widely advertise and promote use of the Project's established GRM, associated procedure, and recording/tracking tool for addressing social, environmental, technical, and operational issues.108 Such a grievance procedure should be easily available to local communities, giving them a transparent and anonymous (if desired) means by which to report concerns about contractor or worker behavior.

These measures will prevent some of these impacts and reduce the magnitude of the impacts. Therefore, the Project's impacts resulting from influx during the construction phase will be direct,

[107] Given the potential complexity of this intergovernmental arrangement, consultations between UAHEL and the relevant authorities will need to occur to design a feasible plan for implementing this component.

[108] This GRM is outlined in the Stakeholder Engagement Plan.

adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of ***Moderate***.

However, as per Section 7.3.1, this ESIA has identified this impact as one in which the Project proponent's institutional capacity to implement the proposed mitigation measures and local normative context must be more explicitly considered and a determination made as to whether gaps in this capacity warrant a manual adjustment of the residual significance rating. This is because several of the measures proposed to mitigate the effect of this particular impact rely heavily on the capacity of the Project to remain rigorous and consistent in the application of proposed mitigation measures. Historically, the capacity of relevant actors to robustly implement such mitigation measures has been limited. Moreover, local normative characteristics are unlikely to be conducive to understanding of, or respect for, proposed measures. As a result of this limited capacity and cultural context, this ESIA concludes that a manual adjustment of the residual risk rating to ***Substantial*** is warranted. This is reflected in the summary of social impacts provided in Section 7.3.16.[109]

Operation Phase

Following the construction phase of the Project, it is unlikely that any further job-seekers will move into the area, given the limited employment opportunities available during the operation phase. Although the existence of a new road may encourage some continued economic migration, the lack of direct/ formal jobs in the area will limit this dynamic. Some of the Nepali in-migrants who arrived for both direct and indirect employment during the construction phase may remain in the area in search of new employment opportunities, or to pursue other livelihood activities. The presence of the access road may make it more attractive for other workers to move to this area.

Therefore, the Project's impacts resulting from influx during the operation phase could be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measure:

- Transport all non-Nepali workers out of the country at the end of their employment term. The impacts of this are, however, expected to be limited, given the limited amount of employment opportunities that will remain.

This mitigation measure will reduce the risk of foreign workers remaining in the project impact area, but Nepali workers may still decide to stay in the project impact area or be attracted to the area because of its improved vehicular access; so the magnitude of the impact remains medium. Therefore, the Project's impact resulting from influx during the operation phase will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall pre-mitigation significance of ***Moderate***. No further mitigation measures are proposed.

7.5.4 Ecosystem Services

This section addresses the potential impacts of the Project on ecosystem services, which include:

- Regulating ecosystem services (addressed in Section 7.2.5)
- Cultural services (addressed in Section 7.3.15)
- Supporting services (addressed in Section 7.2.5)

[109] Once again, however, this ESIA has proposed a number of capacity-building measures that could reduce these affects, including: 1) Institutional Capacity Assessment and Strengthening Plan (see Annex C4 of Appendix C – ESMP) – implement the recommendations of the plan, and; 2) Independent third-party monitoring and auditing – conduct robust monitoring and auditing of key project risks and where the lack of capacity is especially acute.

- Provisioning services (including edible wild plants, timber, fuelwood/biomass, medicinal plants, and other NTFPs), which are the focus of this present section

Avoidance and Minimization Measures

The Project has adopted the following measure to avoid or reduce impacts on ecosystem services, in accordance with the application of the mitigation hierarchy:

- The location of project facilities has been shifted and area of disturbance associated with construction of these facilities reduced to minimize impacts on forests, especially community forests (CF).

Construction Phase

Local residents access many of the ecosystem provisioning services in nearby forests, especially CFs. ***Table 7.40*** shows the project construction impacts on CFs used by local residents. As this table indicates, the only CF with any significant impacts is Pari Parkha, which is primarily because it is small. There are only two villages that use this CF – Sibrun and Limbutar. Sibrun also has access to the much larger Him Shikhar CF so is not reliant on Pari Parkha CF. The entire village of Limbutar is being physically relocated, so locals from this village will no longer use this CF. While population influx and worker in-migration can also cause increased pressure on CFs, these are not expected to be significant due to the mitigation measures designed to control influx/in-migration and its effects (listed in Section 7.3.3).

Table 7.41 outlines the main provisioning services of relevance to the Project. It assigns each ecosystem service a “degree of impact” rating from *low to hig*h based on scope and scale of the impact. It also assigns each an “importance” rating from *low to hig*h based on:

- Intensity of use – e.g., estimated daily, weekly or seasonal use; quantitative data will be used if available and relevant
- Scope of use – e.g., household versus village level, commercial use only, subsistence only or both
- Degree of dependence – e.g., contribution of wild fish to total protein in the diet; contribution of fishing to employment in the community
- Importance expressed by beneficiaries, including cultural/historical importance

Table 7.40: Project Effects on Community Forests

Community Forest	Villages Using Community Forest	Number of Community Forest Users	Community Forest Area (ha)	Community Forest Impacts (ha)	Community Forest Impacts (% of total CF)
Him Shikhar	Namase, Hema, Sibrun	157	481	0.1	~0
Mak Palung	Rukma	27	731	19.6	2.7
Rupsali	Rapsa	55	3.5	0	0
Pari Parkha	Sibrun, Limbutar	54	3.9	1.9	48.7
Gorujure	Tunkhaling, Kapase	120	312	0	0
Pejung Danda	Chepuwa, Lingam, Gumba	145	495	14.4	2.9
Mahavir Thansingh	Hitar, Obak	93	500	0	0
Xulungma	Chyamtan	~135	90	0	0
Total			2,616.4	36.0	1.4

Finally, it assigns a “replaceability” rating of *low to high* considering the following criteria:

- Existence of spatial alternatives, including both natural replacements (e.g., the replacement of one type of wild food with another) and man-made substitutes (e.g., availability of man-made drugs as an alternative to medicinal plants)
- Accessibility, cost and sustainability of potential alternatives, including a consideration of other users and the existing status and threats to the resource(s) providing natural alternatives to the service
- Preference and cultural appropriateness of alternative services

As this analysis indicates, while these ecosystem provisioning services are very important to the local residents, Project impacts on the community forests that provide these services are small. As discussed in Section 7.1.4, the greatest project risks to these provisioning services may be to freshwater, as there is the potential that the project activities that may affect flow in some springs and streams that local villages rely on, and to non-timber forest products, as a result of the improved access to the DIA.

Table 7.41: Project Effects on Ecosystem Provisioning Services

Relevant Ecosystem Service	Degree of Impact	Importance of the Service to Affected Communities	Replaceability of the Service	Overall Impact Significance
Edible wild plants	The project footprint and surrounding forests are a source for wild edible fruit, tubers, rhizomes, and vegetables. The community collects green leafy vegetables (*niuro* and others), bamboo shoot, asparagus, mushroom, walnuts, *katus tamarilo* (rukh tomato), and yams for self-consumption, as well as for selling. The Project only affects approximately 2–3% of community forests, meaning that the communities will still have access to nearly all of the community forest areas and other non-community forests for these products. The in-migration of workers and influx of others could increase the demand for harvesting these wild plants, which could lead to a reduction in their abundance. **Significance: High**	Intensity of use: The frequency of collecting edible plants depends on the location of the settlement vis-à-vis the community forest. Some of the ethnic groups, for example Bhote, collect edible plants more than other groups. The intensity of the use varies with seasonal availability of these products as well. Scope of use: Some products are collected for self-consumption, and the products that have higher market value are generally sold. Degree of dependence: In general, all households collect these resources, but only 8% of them sell them for generating cash income. Opinion of communities: In general, the community considers community forests to be an important source, if not an exclusive source, of these resources. **Significance: Moderate**	Existence of spatial alternatives: Many of the households source these products both from the private forest as well as from community forest. The decision on the source location depends on the distance. Accessibility, cost and sustainability of potential alternatives: As the decision to access the source location depends on the distance, the production of these items on private forest land, which is more convenient to access, can be promoted. The socioeconomic survey also found that most households prefer to grow them on their own land if they can receive guidance and support. Preference and cultural appropriateness: Some of the communities, such as Bhote, Tamang and Rai, consider the collection of edible plants as part of their traditional diet and culture. Hence, promoting the production and use of these items will be a boost to their traditional cultural practices. **Significance: Moderate**	**Substantial**

Relevant Ecosystem Service	Degree of Impact	Importance of the Service to Affected Communities	Replaceability of the Service	Overall Impact Significance
Timber	Timber is a major construction material used for building residential structures, as well as ancillary structures such as grain stores, and livestock sheds. The timber trees are grown in private forests and can also be sourced from community forest by paying a nominal fee. The Project only affects approximately 2–3% of community forests, meaning that the community will still have access to remaining community forest areas for sourcing timber. **Significance: Moderate**	Intensity of use: Timber is used for superstructures, walls, and floors of houses. The use of timber in the construction of houses along with modern materials such as zinc-coated (galvanized) steel sheets is common. Scope of use: The timber is mostly locally used and is not sold commercially. Degree of dependence: Timber is easily available and is the most affordable construction material. Poor households build their houses only using timber. Hence, dependence on timber for many household is high. Opinion of communities: The community considers community forests to have adequate timber trees to meet their requirements. **Significance: Moderate**	Existence of spatial alternatives: The community forests have adequate timber trees to meet the requirements of the local community. Accessibility, cost and sustainability of potential alternatives: Timber is an affordable and locally available construction material, which is also suitable to the weather conditions. As road connectivity and transportation services improve, the cost of modern alternative construction materials will be reduced and more people will be able to afford them. Preference and cultural appropriateness: Timber is part of the local architecture and communities have traditional skills for building houses and household items using wood or timber. **Significance: Moderate**	**Moderate**
Fuelwood	Fuelwood is sourced by households from their private forest, as well as from community forests. The Project only affects approximately 1% of the community forests, meaning that the community will still have access to remaining community forest areas for sourcing firewood. The workers' camp, which will accommodate most of the in-migrant worker population, will use LPG and other non-biomass fuel. However,	Intensity of use: Fuelwood is the most commonly used cooking fuel for 97% of the households. In the cold winter months, fuelwood is also used for heating. Scope of use: The fuelwood is sourced from community forests by paying a nominal fee for self-consumption. Degree of dependence: Due to lack of roads and transport services, the use of LPG is limited. Electricity is supplied by micro-hydroelectric plants, which only meet households' requirement for lighting. Hence, there is a high dependence on fuelwood for cooking and heating.	Existence of spatial alternatives: As only a small part of the community forest area is impacted by the Project, alternative locations for sourcing fuelwood are available. The fuelwood can be sourced from other rural municipalities as well, for meeting additional demands. Accessibility, cost and sustainability of potential alternatives: As the Project is located near the MBNP Buffer Zone, over-exploitation of community and buffer zone forests will have a wide impact. Hence, sourcing additional fuelwood requirements from adjacent rural municipalities should not be encouraged.	**Moderate**

Relevant Ecosystem Service	Degree of Impact	Importance of the Service to Affected Communities	Replaceability of the Service	Overall Impact Significance
	there will be additional consumption of firewood by the influx population. **Significance: Moderate**	Opinion of communities: The community at present does not face any shortage of fuelwood. Each household stores the fuelwood it requires for the wet and winter months during summer. As this is adequately available, the community is not alarmed by this. **Significance: Moderate**	Preference and cultural appropriateness: The dependence of the local community on fuelwood for cooking and heating is high. However, they aspire to use LPG and electricity as alternative fuels. **Significance: Moderate**	
Other NTFPs	In general, the Himalayan region has an exotic range of natural resources, which are used by the local community as well as in high demand elsewhere. Some of the important products include mountain rocks, white *siljit*, *bikhama* (*Aconitum palmatum*), wild-honey, *sarpagandha* (*Rauvolfia serpentina*), and various types of *dhup* (incense). The Project, however, only affects approximately 2–3% of community forests, meaning that the community will still have access to remaining community forest areas for these products. The In-migration of workers and influx of others could increase the demand for harvesting these wild plants, which could lead to a reduction in their abundance. **Significance: Low**	Intensity of use: Most of the households in the socioeconomic survey reported collecting a range of NTFPs for self-consumption. Scope of use: Only 8% of households sell part of the NTFPs collected to generate cash income. Weaving, basket making, and manufacturing household articles from local raw materials, which are common skills, will be affected, as the new generation will have less leisure time and readymade materials will become more easily available in local market. Degree of dependence: The collection of NTFPs is a general practice by all ethnic groups. Bhote, Rai, and Tamang are engaged in selling part of the NTFPs for cash income. More Bhote families sell NTFPs than Tamang and Rai. Opinion of communities: The Bhote community is at the forefront in expressing concern over the impact of the Project on NTFP collection. **Significance: Moderate**	Existence of spatial alternatives: As only a small part of the community forest area is impacted by the Project, alternative locations for sourcing NTFPs are available. The exotic items are mostly found at higher altitudes and are not impacted by the Project. Accessibility, cost and sustainability of potential alternatives: It is expected that the local population will have the opportunity to work as unskilled labor during the construction phase. The practice of collecting NTFPs, therefore, is expected to decline. Preference and cultural appropriateness: Bhote consider knowledge of Himalayan herbs and other NTFPs as an inherent part of their culture and identity. **Significance: Low**	**Low**

Relevant Ecosystem Service	Degree of Impact	Importance of the Service to Affected Communities	Replaceability of the Service	Overall Impact Significance
Herbs and medicinal plants	The key medicinal herbs collected by villagers in the project impact area include *hadchur* (viscom), *satuwa* (love apple, Paris), *thulo okhati* (*Astilbe rivularis*), *chiraito* (Swertia), *padamchal* (Rheum), *pakhanbed* (Bergenia), *dhupi* (black juniper), *allo* (Himalayan nettle, *Girardinia diversifolia*), *timur* (Nepali pepper, *Zanthoxylum armatum DC*), *lokta* (*Daphne bhoula* or *Daphne papyracea*), *panch aunle* (*Dactylorhiza hatagirea*), *lauthsalla* (*Taxus wallichiana*), *bikhama*, yarchagumba (*Ophiocordyceps sinensis*), *kutaki, bhairab pati*, *sunpati*, *mahaguru*, and so on. The Project, however, only affects approximately 2–3% of community forests, meaning that the community will still have access to remaining community forest areas for these products. The in-migration of workers and influx of others could increase the demand for the harvesting these wild plants, which could lead to a reduction in their abundance. **Significance: Moderate**	Intensity of use: Most of the households in the project impact area collect medicinal plants, which are sold in Terai region of Nepal, India and China (Tibet Autonomous Region) markets. Scope of use: Bhote women from the project impact area collect and wild nutritious food and support their family about 2 months in a year from their income from selling herbs. In and average, an individual involved in collection and sale of medicinal herbs earn income in the range of 25,000 to 100,000 annually. Degree of dependence: Bhote villages located in higher elevations at the dam site practice a cycle of seasonal migration. As the winter progresses, they migrate to lower altitude locations. They carry herbs collected by them in summer months and sell them in the towns and cities they visit during these days. Thus, collection and selling of herbs is part of their seasonal cycle of migration. A good part of their stay in town and cities in winter is covered from the income from herbs. Opinion of communities: The Bhote community is at the forefront in expressing concern over the potential impact of the Project on their traditional practice of trade in herbs. **Significance: Moderate**	Existence of spatial alternatives: As only a small part of the community forest area is impacted by the Project, alternative locations for sourcing herbs are available. The exotic items are mostly found in higher altitudes and are not impacted by the project. Accessibility, cost and sustainability of potential alternatives: It is expected that local population will have the opportunity to work as unskilled labor during the construction phase. The practice of collecting herbs may decline in the medium term (i.e., for the duration of the construction phase), but will likely return to pre-project levels in the long term. Preference and cultural appropriateness: Significance: Bhote consider knowledge of Himalayan herbs and other herbs as an inherent part of their culture and identity. **Significance: Moderate**	**Moderate**

Relevant Ecosystem Service	Degree of Impact	Importance of the Service to Affected Communities	Replaceability of the Service	Overall Impact Significance
Freshwater	The UAHEP will impact on the Arun River, especially the reach from Chepuwa to Gola and further downstream to the Arun-3 HEP. In the DIA, water from the Arun River is not used for drinking water or irrigation purposes. Instead, households get their drinking and limited irrigation water from streams and springs flowing down the hillsides near their villages. The construction of the headrace tunnel may impact on the flow of Chudachumbuk Khola (Namase), Hema Khola, Darlekha Khola, and Jijinkha Khola, which are used for drinking water supply. **Significance: High**	Intensity of use: Less than 2% of households use the Arun River for fishing, bathing, livestock, and washing clothes. Thus, direct use of fresh water from the Arun River is negligible. But, the fresh water from perennial and seasonal streams is used for irrigation as well as drinking water supply. Scope of use: Some streams are used to supply drinking water. They are also used to operate *ghatta* (water mills), which are a popular device for grinding, grains such as maize, millet, and wheat. There are micro hydroelectric plants on Khabuwa Khola at Namase (8 kW) and on Mangpung Khola at Hema (16 kW), which supply electricity to Namase, Rapsa, Sibrun and Hema. Apart from this the seasonal streams are the only source of irrigation. Degree of dependence: The community dependence on these seasonal and perennial streams is very high. Opinion of communities: Local communities have a strong expectation that the Project will not draw water from the streams they depend on. Impact on the flow of streams due to tunnelling, in their view, will impact on farming (particularly cardamom growing) to a great extent. **Significance: High**	Existence of spatial alternatives: Most of the perennial streams are used by local communities, apart from Chudachumbuk Khola located in Himshikhar Community Forest near Namase. There are a number of seasonal streams such as Yorim Khola, Takchen Mul, Lumchen Mul, Yaklem Khola, Gurungsis Khola, Hesluks Khola around Namase that are not used by the community. Accessibility, cost and sustainability of potential alternatives: The unused springs are farther from the villages and farmland. To tap these waters would be expensive and, as most of them are seasonal, they are of limited use. Preference and cultural appropriateness: The fresh water from natural streams is used by communities and they protect the catchment of these streams to ensure that the quality of the water is maintained. **Significance: Moderate**	**Substantial**

Based on the analysis above, the Project's potential impact on ecosystem services during the construction phase is assessed to be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Implement a Workers' Code of Conduct that prohibits behaviors that could be damaging to local communities, such as use of ecosystem services (e.g., hunting, fishing, logging, collection of NTFP). This Code will incorporate clear consequences for workers and Contractors found to be in violation.
- Implement a Spring Management Plan (see Appendix C, ESMP) aligned with the WB's ESS 3 (Resource Efficiency and Pollution Prevention and Management – Water Use) to minimize impacts on the local springs on which local residents rely for their water supply and to commit to providing an alternative reliable water supply if project construction does affect the flow or water quality of these springs.
- Implement an Air Quality Management Plan (see Appendix C, ESMP) that mandates Contractors to provide alternative fuel for heating and cooking to avoid competing with local residents for use of forest related products.
- Implement a Soil Erosion and Sediment Control Management Plan (see Appendix C, ESMP) that states that cleared vegetation shall not be burned, but rather:
  - In CFs, trees shall be cut and deposited in accordance with the agreement with community forest user groups.
  - Make any remaining cleared vegetation available for use by local residents for firewood, fodder, mulch, or other purposes.
  - Any cleared vegetation not wanted by the local residents shall be chipped, mulched, and stockpiled for use during site restoration.
  - Any invasive plant species found shall be segregated and disposed of as solid waste.
- Implement a Cultural Heritage Management Plan that requires measures to be put in place to protect both tangible and intangible cultural heritage (see Section 7.3.15 for more details)

Taking into consideration these mitigation and monitoring measures, the Project's potential impact on ecosystem provisioning services during the construction phase is assessed to be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Moderate***.

Operation Phase

Note that during the operation phase there will be ongoing impacts due to forest removal that occurred during the construction phase; however, no additional impacts are anticipated in this regard. Further, as discussed in Section 7.3.3 (Project-induced In-migration and Population Influx), most workers who in-migrated to the area for employment will leave following the end of construction (either to seek economic opportunity elsewhere, or because of the project requirement that foreign workers be returned to their place of origin following the end of their contract). Therefore, no new impacts associated with population in-migration are anticipate. Mitigation measures are proposed to control population influx, but these measures will not prevent some influx from occurring, although at the end of construction and the departure of the Project's construction workforce, many people who came to the area may also leave. The Project will create about 130 new jobs, of which about half are expected to be local and half non-local. The roughly 65 non-local employees are likely to bring their families to the project impact area, although these families are not expected to have the same dependence on ecosystem services as native households as they will have an alternative source of income.

Therefore, the Project's potential impact on ecosystem provisioning services during the operation phase is assessed to be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Implement a Biodiversity Management Plan (see Appendix C, ESMP, Annex C3), which will require replanting of cleared trees on a 25 new saplings planted per 1 tree removed basis. The afforestation will use native species and be targeted within affected community forests or unused project lands to the extent possible to mitigate the impacts of lost forest land on local residents. It will take a decade or more for these trees, as well as shrubs and herbs, to become established and to start providing provisioning services
- Provide potable water to any villages where project activities have resulted in a meaningful reduction in flow or degradation of water quality.

There will still be the potential for additional demand associated with influx, so the magnitude of the impact is considered to remain medium. Therefore, the Project's potential impact on ecosystem provisioning services during the operation phase is assessed to be direct, adverse, low in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

7.5.5 Downstream Water Users and Uses

As discussed in Section 7.1.4 (Hydrology), the Project will affect flow conditions in the Arun River upstream from the dam, in the 16.5 km long diversion reach, and downstream from the powerhouse. Within the DIA, the Arun River is not used to any meaningful extent for transportation, water supply, recreational boating, sand mining, recreational or commercial fishing, irrigation, operating water mills, watering livestock, or industrial/employment purposes. It is used for cremations by several ethnic groups, for various other cultural and religious purposes, especially near Barun Dovan, and, to a lesser degree, subsistence fishing and washing/bathing. These changes in flow conditions could affect local resident's use of the river for these purposes, which are evaluated in this section.

Avoidance and Minimization Measures

There were no avoidance or minimization measures related to downstream water users and uses identified.

Construction Phase

During project construction, the Project will have little effect on flow in the Arun River as a diversion tunnel will direct nearly all river flow around the dam construction, so there will be no meaningful change in flow downstream from the dam, although some increase in turbidity is expected, especially during the monsoon season, as a result erosion and sedimentation. These minor changes in flow and water quality are not expected to affect use of the river for cremations, cultural/religious uses, subsistence fishing, or washing/bathing, as the Arun River has naturally high turbidity levels.

Therefore, the Project's potential impact on downstream water users and uses during the construction phase is assessed to be direct, adverse, low in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Develop and implement a Soil Erosion and Sediment Control Plan to minimize the delivery of sediment to the Arun River.

- Maintain local resident access to cremation, cultural, and religious locations along the river, or consult with the community to identify alternative safe locations for these activities.

Taking into consideration these mitigation measures, the Project's potential impacts on downstream water users and uses during the construction phase will be direct, adverse, low in magnitude, site-specific in extent, and short term in duration, with an overall residual significance of ***Low***.

Operation Phase

The UAHEP will have its most significant effects on flow during the operation phase (see Section 7.1.4). The changes in flow differ by segment of the river, and these in turn have different effects on water users and uses.

Upstream from the project dam, a reservoir will be created. Although no cremation sites are known to exist in the proposed reservoir area, the presence of the reservoir would not prevent cremations or other cultural/religious uses from occurring. The presence of the reservoir, and the associated reduction in river currents, will make this area more attractive and safer for subsistence fishing, washing, and bathing, although public access will be prohibited to portions of the reservoir near the dam and headrace intake for safety and security reasons.

Flow in the diversion reach will be significantly reduced for most of the year, with only the proposed EFlow and tributary inflow contributing to flow in the river. There will still be sufficient flow in the river to conduct cremations and for other cultural/religious activities. There will be dewatered riverbed visible, but the flow will not cease. The reduced flow and the associated reduction in river currents and sediment will make this area safer for subsistence fishing, washing, and bathing for much of the year, except during the monsoon season. The Barun Mela occurs every January at the confluence of the Barun and Arun rivers. January is the peak of the dry season and Arun River flow will be at its lowest, but other than the visual impacts associated with a partially dewater riverbed, project operations would not interfere with the Mela. There are certain conditions, however, when flows could change rather quickly in the diversion reach, specifically when river flows are increasing and exceed the hydraulic capacity of the powerhouse, which will result in water spilling at the dam and flowing through the diversion reach, or when flows exceed 575 m^3/s and the Project begins to flush sediment in accordance with the Sediment Management Strategy (see Section 3.6.2, sub-section 2 – Sediment Management Strategy), which will dramatically increase flows in the diversion reach.

Flow downstream from the powerhouse will generally fluctuate daily from October to May when peaking operations will occur. Water levels and velocities will increase suddenly and quickly when peaking begins. This peaking operation should not prevent cremations, cultural/religious, subsistence fishing, or washing/bathing activities from occurring in the approximately 11 km reach between the UAHEP tailrace and the Arun-3 HEP reservoir backwater. The peaking operation has the potential, however, to create some safety hazards for people in or along the edge of the river when peaking begins. Peaking operations will occur on a regular schedule beginning around 6pm and continuing until about midnight, so downstream users will likely become accustomed to project operations.

Therefore, the Project's potential impact on downstream water users and uses during the operation phase is assessed to be direct, adverse, high in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The project will implement the following mitigation measures:

- Implement a Community Health and Safety Management Plan (see Appendix C, ESMP), including a community education and awareness program focusing on project operational safety risks, installing appropriate safety equipment, and providing alarms and signage to alert downstream water users of changing flow conditions (see Section 7.3.11 – Emergencies and Public Safety).

- Conduct periodic stakeholder engagement surveys and closely monitor grievances during the first two years of project operations to document any unanticipated project impacts on downstream water users and uses and implement an adaptive management program to mitigate these impacts if necessary.

These mitigation measures will reduce the magnitude of the impact to medium. Therefore, the Project's potential impacts on downstream water users and uses during the operation phase will be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

7.5.6 Transmission of Food and Water Borne Communicable Diseases

As explained in Section 7.3.3, the UAHEP will result in significant in-migration of at least workers and possibly others looking for direct and indirect employment opportunities. This brings with it a risk of introducing or increased the transmission of communicable diseases. In addition to typical communicable diseases such as TB and respiratory illnesses (see Social Baseline, Chapter 6.3), there is also the new risk of COVID-19 transmission into the DIA. Hydroelectric project also have the potential to contribute to the spread of vector-borne diseases through the creation of vector habitat during construction and potentially operation. In addition to standing water associated with hydroelectric dams, environmental modifications at construction sites (such as the tunnel adits, quarry sites and the new powerhouse) may create breeding grounds for vectors, such as mosquitos.

No cases of vector borne diseases were reported between 2016 and 2019 in Bhotkhola Rural Municipality (see Social Baseline, Section 6.3), and the risk that the Project will create vector habitat and lead to an upsurge in vector borne diseases is minor, as the UAHEP dam will not create standing water and there will be a fairly significant current running through it at all times. Therefore, the remainder of this section will focus primarily on communicable and non-communicable diseases (except the transmission of STDs/STIs, which is evaluated in Section 7.3.7).

Avoidance and Minimization Measures

The Project has adopted the following measures to avoid or reduce the dam safety risks, in accordance with the application of the mitigation hierarchy:

- Selected an alternative headworks location that is farther from local villages, especially Rukma.
- Adopted a PRoR operation mode with a relatively small reservoir storage volume, which reduces the risk of reservoir stratification and spread of mosquitos and other water-borne disease vectors.

Construction Phase

As explained in Section 7.3.3, the Project is expected to attract a significant number of migrant workers (approximately 4,500 at the peak of construction) to the DIA. The presence of an external workforce living in camps, where interaction with nearby communities is likely, could lead to the increased transmission of communicable diseases within these communities. This includes the potential for the workforce to introduce a new disease and/or a more virulent strain of an existing disease. In addition, although the Project anticipates being able to mitigate most population influx, the influx of opportunistic workers (those hoping to find employment on the Project or from related activities) migrating into the area could contribute to the introduction and transmission of communicable diseases. Finally, overcrowding or living in close quarters within workers' camps, poor hygiene and sanitation at workers' camps, and poor waste management could also facilitate the spread of communicable diseases. Some of these impacts would be short term and would only occur during the construction phase; however, the Project will also result in some permanent changes to the socioeconomic characteristics of the project impact area, thereby potentially having long term impacts on the health and wellbeing of the local community. The following discusses the various causes of disease transmission and their impacts:

- **Poor hygiene, sanitation, and waste management** associated with in-migration: These can all result in increased risk of transmission of water borne communicable diseases such as hepatitis A and E and typhoid, through increased risk of contamination of water and food with fecal matter. In addition, these factors could also result in increased number of pests, such as rats, which could be attracted to improperly stored food and waste and contribute to disease transmission. The additional migrant population will have a negative impact on natural resources and environmental sanitation, thus increasing the risk of transmission. An increase in the consumption of packaged foods and other supplies due to increased availability and decreased ability/willingness to pursue subsistence farming will likely increase the volume of non-organic waste. As there is no solid waste collection mechanism in the DIA, if not controlled, the litter could degrade the environment and contribute to the spread of diseases via the pathways discussed above.

- **Changes to dietary habits:** The increased likelihood of packaged food consumption mentioned above can also have adverse impacts on the health of the population as packaged food is often highly processed and likely to lead to dietary imbalances, as households opt for convenience and reliance on a smaller number of available packaged foods over a more holistic, farm-based diet.
- **Changes to water and air quality:** The Project's construction activities have the potential to impact on water and air quality (see Section 7.1.6 and 7.1.7). There is already a high prevalence of water/food and respiratory diseases in the DIA, as shown in the Social Baseline (Chapter 6.3). Increases in fugitive dust and other air pollutants and the degradation of water quality, especially as a result of poor waste treatment, could exacerbate these conditions.
- **Crowded living conditions:** At the workers' camps in particular, communicable diseases such as TB could spread quickly due to workers sharing accommodation. There is the potential for increased transmission between workers living and working in close quarters, and then onwards as a result of interaction with worker's families and local communities. Further, population influx of worker's families and others seeking employment and other opportunities to the project impact area could compound these risk.
- **Pressure on health infrastructure:** An increase in population as well as disease prevalence would put additional pressure on the existing health care system (see Section 7.3.8). Health care facilities are limited in the DIA. At present, most communities have health posts that are equipped to address only very basic health problems and may not have a resident doctor. While most workers' health issues will be dealt with by the Project's own medical facilities (see 7.3.13), local capacity (e.g., availability of diagnostic equipment and medicine) to respond to an increase in the transmission of communicable diseases outside of workers' camps is limited, thus, potentially exacerbating the effects of transmission on local communities.

Based on the analysis provided above, the Project's potential impact associated with transmission of communicable and vector borne diseases during the construction phase could be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Measures to prevent transmission:
  - Implement a Workers' Code of Conduct (see Appendix C, ESMP) that prohibits behaviors that could contribute to the spread of communicable diseases, such as defecating in open areas/bodies of water.
  - Provide accommodation to workers in accordance with international good practice on workers' accommodation, including those of ILO (specifically, Recommendation No.115), as well as IFC/EBRD standards to prevent transmission of diseases associated with poor living conditions.
  - Implement a Waste Management Plan (see Appendix C, ESMP) that lays out a solid waste management system for all workers' camps to ensure proper collection, segregation, and

disposal of solid waste, so that there is no contaminated surface runoff or public health issues associated with the waste.

- Implement an Occupational Health and Safety Plan (see Appendix C, ESMP) that mandates the Contractor to:
  - Provide education and training to the workers on disease prevention and mandates that each workers' camp be served by a health post to reduce the burden on the local health infrastructure and reduce the need for interactions between workers and the local community.
  - Establish requirements pertaining to water disposal and water use that will mitigate potential spread of communicable and vector borne diseases.
  - Train workers – as part of their induction and then regularly during construction "tail-gate" meetings – on the potentially high risk communicable and vector borne diseases, symptoms, preventative measures, and transmission routes, as well as treatment options. This will be particularly important for diseases with which non-local workers are unfamiliar and in case of any emerging disease outbreaks.
  - Establish pre-employment health screening protocols and follow-up medical check-ups as appropriate.
  - Monitor the emergence of major pandemics through WHO and other alerts and, in the event of a pandemic, review mobilization and demobilization of ex-patriate project personnel and/or implement appropriate control measures and an Emergency Preparedness and Response Plan (see Appendix C, ESMP).
  - Implement and monitor the following at workers' camps and other project facilities as appropriate, to minimize disease transmission:
    - Provide workers with appropriate sanitary facilities, which are appropriately designed to prevent contamination.
    - Develop a robust waste handling system to avoid the creation of new vector breeding grounds or attracting rodents to the area.
    - Implement measures to reduce the presence of standing water onsite through environmental controls and source reduction to avoid the creation of new breeding grounds.
    - Ensure the workers' camp is kept clean and free from any accumulation of waste, as well as supplied with clean potable water.
    - Ensure appropriate food preparation and monitoring measures are in place to avoid risk of food-borne disease.

- Implement a Community Health and Safety Plan that requires the Contractor to:
  - Conduct mandatory health check-ups for in-migrant workers to identify pre-existing contagious diseases before they come to the workers' camps.
  - Provide medical/health/first aid centers at each workers' camp to avoid placing any additional burden on local health posts (see Section 7.3.8). Only workers with emergency conditions that exceed the capability of the project medical facilities will use public facilities (i.e., hospitals in Khandbari and Kathmandu).
- Support local health capacity:
  - Implement the mitigation measures outlined in Section 7.3.8 to reduce burden on health infrastructure.

- Provide additional support to improve disease prevention, detection, and treatment capacity at the local level by doing the following:
  - Support NGOs to collaborate with the Department of Health Services (DoHS)/District Hospital to implement regular awareness campaigns (including nutritional awareness) and provide preventive health care services.
  - Provide technical and financial support to rural municipalities to prepare and implement a robust waste disposal plan and to carry out a public awareness campaign on proper disposal of waste.
  - Provide funding support to the DoHS to plan and implement a health surveillance program in the DIA, which will include the surveillance of all drinking water sources used by communities and workers for water borne diseases and the surveillance of vectors and other potential communicable disease transmission points.
  - In the event of a new disease, increased transmission or outbreak compared to the baseline, interact with local health care facilities and workers to ensure there is an appropriate response in place.

Based on the implementation of the proposed mitigation measures, the Project's potential impact on the transmission of communicable and vector borne diseases and community health will be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall residual significance of ***Moderate***.

Operation Phase

The operation phase of the Project will have fewer activities that have the potential to impact on community health. There will be only a small number of staff employed in the operation phase (approximately 130 employees, with about half not being local), and their interaction with local communities will be mitigated through the measures outlined in Section 7.3.3 (Project-induced In-migration and Population Influx). The conditions for food and water contamination contributing to communicable disease transmission will not be present.

Therefore, Project's potential impact on the transmission of food/water and vector borne diseases on community health during operations will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall significance of ***Low***. No additional mitigation measures are proposed.

7.5.7 Transmission of Sexually Transmitted Diseases/Sexually Transmitted Infections

The introduction of a large (mainly male) workforce has been shown in other large-scale infrastructure development project to increase the risk of transmission of STDs/STIs in surrounding communities. As shown in the project baseline (Chapter 6.3), a relatively low and stable level of STIs/STDs were reported within the DIA between 2016 and 2019. However, if appropriate precautions are not taken, the in-migration associated with the Project could increase the rates of STDs/STIs in the communities surrounding the Project. The following section addresses the impacts of a potential increase in STD/STI transmission in the DIA.

Avoidance and Minimization Measures

The Project has adopted the following measure to avoid or reduce the risks of STDs/STIs, in accordance with the application of the mitigation hierarchy:

- Proposed separate workers' camps, instead of workers living in local villages.

Construction Phase

The Project could result in increased transmission of STD/STI during construction due to:

- Presence of a large workforce including males with higher incomes engaging high risk sexual activities with commercial sex workers (CSWs), in particular near workers' camps
- Workers establishing casual relationships with women and girls in communities near the workers' camps, which may result in transactional sex or circumstances that the women and girls assume will result in a more committed and long-term relationship
- Increased numbers of CSWs, who may have higher infection rates of STDs/STIs, near workers' camps
- In-migration, resulting in the mixing of people with higher STD/STI prevalence rates than the host community, which may promote the transmission of the disease

CSWs may be better placed than other women to negotiate safe sex practices, such as the use of condoms, but may also be willing to waive their use for a fee. Due to vertical transmission pathways, an increase in the prevalence of STDs/STIs in the project-affected communities is a risk to the health of the community, including the men who engage in these activities, CSWs, the wives of married men, and children. Women and young girls in the area are particularly vulnerable to STDs/STIs due to their limited education, limited ability to negotiate safe sex practices for cultural and religious reasons, and the well-described higher risk that women have of contracting STDs/STIs through unprotected sexual intercourse (see Section 7.3.9 for further discussion of project impacts on women and Section 7.4 on Vulnerable People).

While there is access to treatment for STDs/STIs in the communities, it is limited in terms of quality. Further, there are significant taboos around STDs/STIs, which may influence people's willingness to access treatment. Any lack of access to treatment could affect the long-term health of those who contract STDs/STIs, including fertility, damage to internal organs, and long-term disability or even death.

The increase in risk of STDs/STIs will be long term, as it can take time for prevalence/incident rates to return to baseline levels. Further, those infected with some longer lasting STDs/STIs will have health effects that last beyond the duration of the construction activities. Although increased transmission of STDs/STIs is most likely to affect households in the project-affected communities – in particular those near workers' camps – impacts could spread regionally due to vehicle movements and the presence of CSWs in larger towns.

Based on the analysis provided above, the Project's potential impact associated with the transmission of sexually transmitted diseases during the construction phase could be direct, adverse, high in magnitude, local in extent, and medium term in duration (if one considers legacy of impact), with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Implement a Workers' Code of Conduct that prohibits consorting with prostitutes, fighting, intimidation, trafficking in persons, and sexual exploitation and abuse, with penalties including termination of employment.
- Implement the SEA/SH Prevention, Mitigation and Response Action Plan, which aims to create and maintain a safe working and living environment for all individuals in the community or those employed directly/indirectly at the project site, and to develop capacity for community engagement, and multi-sector collaboration in GBV response, including GBV mobile services. Establish a UAHEP Intergovernmental Coordination Committee as a forum to consult with local leaders to monitor and mitigate social vices such as prostitution towards minimizing them through punitive measures for offending project workers or rehabilitative measures for CSWs.

- Implement a Community Health and Safety Management Plan and a Workers' Code of Conduct (see Appendix C, ESMP) to reduce the interaction between migrant workers and local women by outlining rules for on-site behavior, entrance and exit policies, and prohibiting sex workers on site.
- Ensure women employees work with at least some other women at the work site, and are offered separate accommodation and toilet facilities, as well as flexible work shifts, to ensure their safety.
- Implement an Occupational Health and Safety Plan that requires the Contractor to:
  - Implement an awareness program (in partnership with NGOs) for workers and local communities for the prevention, detection, screening, and diagnosis of STDs/STIs. The program shall also include information on alcohol abuse, gender-based violence, sexual exploitation and abuse, and human trafficking, all of which can exacerbate the transmission of STDs/STIs.
  - Provide workers with information on STD/STI prevalence rates in Nepal, as well as the expectations of local communities if a woman falls pregnant by a worker (i.e., marriage, financial implications).
  - Require mandatory health check-ups for in-migrant workers to identify pre-existing contagious diseases (including STDs/STIs) before they come to the workers' camps and submit these documents to the DoHS for their review.
  - Encourage all employees to determine their STD/STI (especially HIV/AIDS) status periodically (and make it clear that their employment status will not be affected by this).
  - Ensure that workers have access to confidential health care for the treatment of STDs/STIs through medical facilities/health care at the contractor's camps.
  - Engage an STD/STI (including HIV/AIDS) service provider, who will be available on site to monitor and take appropriate preventive measures such as provision of condoms/femidoms.
- Promote the Project's existing GRM, through which local communities as well as the workers themselves (especially female workers) can raise issues and concerns associated with social vices, prostitution, and the behavior of workers.
- Set up an extended SEA/SH GRM at the project level, in parallel with the overall UAHEP GRM. Develop a specially constituted SEA/SH GRM Committee comprised of representatives of the client, consultants, and Contractor.

Based on the implementation of the proposed mitigation measures, the Project's potential impact associated with transmission of STDs/STIs will be direct, adverse, medium in magnitude (taking into account the project remoteness balanced with the large number of young male workers), local in extent, and short term in duration, with an overall residual significance of ***Moderate***. The Project should continue to promote sexual education and awareness training in the health clinics.

As with other impacts, this relies upon the capacity of both the Contractors and GoN to implement the proposed mitigation measures. This is particularly the case given the Nepali context in which these mitigation measures are proposed, in which gender norms and expectations may not be conducive to full and active respect of the rights of women and children. However, given the relative ease of implementing some of the mitigation measures (i.e., sharing of relevant information, distribution of condoms/femidoms), the nature of several of the mitigation measures, and the involvement of local NGOs/civil society in managing some of the impacts, the proposed rating remains ***Moderate***.

Operation Phase

Once operational, the risk of transmission of sexually transmitted diseases will be reduced as the large foreign workforce will leave. However, the prevalence rates may remain higher due to any increase in disease transmission during construction and changes in local sexual mores as a result of the presence of a large mostly male workforce for over seven years in the area. The impact associated with the transmission of STDs/STIs during the operation phase will be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall residual significance of ***Moderate***.

7.5.8 Health Infrastructure

The Project will increase the population in the DIA during construction, largely through introduction of a migrant workforce, but also to some extent through the influx of other people settling in the area with the intention of securing employment with the Project or seeking other economic opportunities (however, as noted, the Project anticipates being able to control most of this potential influx). This has the potential to increase the demand on services and existing infrastructure in the DIA. This section, therefore, focuses on the impacts of in-migration on health infrastructure.

Avoidance and Minimization Measures

There were no avoidance or minimization measures related to health infrastructure identified.

Construction Phase

The presence of a national and expatriate workforce is likely to lead to increased pressure on the existing health care facilities in the DIA and broader area. Despite the fact that the workers' camps will have their own medical facilities, an increase in demand will arise if there is increased transmission of diseases (see Section 7.3.6 and 7.3.7), increased accidents (including work-related fatalities, the risk of which increases with projects of this size) (see Section 7.3.11) and/or increased numbers of people accessing care for routine services. Considering the already limited health care capacity, this increase in demand may further limit access to facilities and result in longer waiting times or patients not attended to, worsening health outcomes and leading to the uncontained spread of diseases/infection. This is a particular risk in the case of incidents involving multiple casualties or patients from both the workforce and community where hospital level care is required, or in the case of a disease epidemic. Of particular concern is the strain on resources to deal with communicable diseases and STDs/STIs and acute respiratory diseases like TB. If access to public health services is restricted, the use of traditional medicine, frequently used in the DIA, may also increase. It will not be possible for existing infrastructure and services to accommodate the increased demand. The social, environmental and health risks that arise from a failure to adequately provide for the needs of a larger population will have consequences for the Project, the existing communities, as well as for the in-migrants and social and health service providers.

Based on the analysis above, the Project's potential impact on community health infrastructure during construction could be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.[110]

Proposed Mitigation and Residual Impact Significance

In addition to measures designed to reduce the demand for health care services by mitigating the transmission of communicable and non-communicable diseases, STDs/STIs, and traffic and other accidents (discussed elsewhere in this document), the Project will implement the following measures to mitigate impacts on health care infrastructure:

- Implement an Occupational Health and Safety Plan (see Appendix C, ESMP) that calls for the following measures:
  - Develop a COVID-19 strategy that includes pre-mobilization to site testing, periodic on-site monitoring, as well as procedures and facilities to quarantine/isolate workers who test positive.

[110] It should be noted that this rating fell only fractionally below the 'high' rating, according to the methodology presented in Chapter 5.

  - Ensure that each workers' camp is served by a health post, staffed by a senior nurse capable of treating all first aid cases and common illnesses (e.g., flu) to reduce the need to seek health care outside of the workers' camps.
  - Provide first aid stations with appropriate supplies at each of the primary work fronts (e.g., dam, headrace adit, powerhouse).
  - Ensure that at least one workers' camp contains a medical facility that will be designated for the treatment of more severe diseases and injuries, as well as medical emergencies, where patients can receive higher level care and/or be stabilized until they can be transported to district or provincial hospitals. This medical facility shall have at least one isolation room for infectious disease patients.
  - Only workers with emergency conditions that exceed the capability of the project medical facilities will use public facilities (i.e., hospitals in Khandbari and Kathmandu).
- Support improvements to existing health services to handle the increase in population numbers and changes to the existing health profile of the area, which may result from influx, in partnership with government authorities. This includes the following measures:
  - Establish an UAHEP Intergovernmental Coordination Committee to monitor and mitigate impacts on existing health services from the Project or from project-induced influx.
  - Provide funding support to the District Hospital in Khandbari to run additional health units in the DIA, such as expanding its capacity to handle trauma and emergency cases that cannot be dealt with by on-site medical facilities.
  - Support NGOs to collaborate with the DoHS/District Hospital and help them implement awareness campaigns and provide preventive and promotive health care services.
  - Provide financial support to the DoHS for planning and implementing a health surveillance program in DIA of the Project.

Taking into consideration these proposed mitigation measures, the Project's potential impact on community health infrastructure during construction will be direct, adverse, low in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Low***.

Operation Phase

The project will only employ about 130 workers during the operation phase, with about half of these workers likely drawn from the local area. There will be a health clinic at the project operations center. These workers will not place any significant demands on the local health care system. Therefore, the Project's potential impact on community health infrastructure during operation will be direct, adverse, low in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Low***. No additional mitigation is proposed.

7.5.9 Gender, Gender-Based Violence, and Trafficking in Persons

In Nepal, social, economic, and religious factors, combined with traditionally defined roles and responsibilities between Nepali men and women, have led to an institutional system that treats women inequitably (UNFPA 2008). Some of the issues faced by women in Nepal are child/early marriage, forced marriage, polygamy, payment of dowries, and *chhaupadi* (the requirement that women and girls stay out of the house during menstruation). FGDs and KIIs revealed that the traditional patriarchal system is very strong and domestic GBV is hampering the development and empowerment of women and girls. Although the rural municipality implements agriculture, health, education, and economic development programs (i.e., income generating activities) that focus on women, it does not have adequate financial support and staffing required for effective implementation. TIP – typically of women and girls – is also a major problem in Nepal. The trafficking cases registered with Nepal Police increased from 185 in 2014 to 305 in 2018 (National Human Rights Commission 2018).

The perceived power inequality between the locals and outsiders, with outsiders weighing more on the power scale owing to position, finance, knowledge, and information, can increase the risk of SEA/SH for women who are already in a vulnerable position. Moreover, the host community's societal power structures place men in a privileged position, and the adoption of similar practices by outsiders can perpetuate harmful gender norms and attitudes contributing to SEA/SH/SGBV. The presence of cultural and social norms upholding rigid and traditional gender roles and hierarchies can reinforce power imbalances, which are also valid for outsiders. This can influence outsiders to perpetuate existing norms that may condone violence as a means of maintaining control over women/girls and increasing the risk of SEA/SH/SGBV.[111.]

Large construction projects, primarily because they attract large numbers of young men to remote areas for extended periods of time, often result in increased GBV and trafficking in persons. However, the pre-existence of such issues in Nepal and cultural norms that contribute to their perpetuation (for example, by discouraging women from seeking help) demand close attention to the Project's impacts on matters relating to gender. The following sections address these potential impacts.

Avoidance and Minimization Measures

The Project has adopted the following measures to avoid or reduce the risk of GBV and TIP, in accordance with the application of the mitigation hierarchy:

- Proposed separate workers' camps, instead of workers living in local villages.
- Developed a Gender Action Plan (GAP) and SEA/SH Prevention, Mitigation and Response Action Plan, providing awareness raising, capacity building, a SEA/SH GRM, and a compliance monitoring mechanism.

Construction Phase

Impacts Associated with Physical Security

- **Gender-based violence, including sexual harassment, and sexual/child abuse/exploitation:** As the population of men increases disproportionately and more cash and material wealth emerges in the area from an increased presence of salaried workers, the likelihood of increased anti-social behaviors, such as prostitution and the consumption of drugs/alcohol, also increases. The consumption of alcohol by men often contributes to GBV, sexual assault, domestic violence, and child abuse and exploitation. While in some localities in Nepal there exists a Women and Children Development Unit (WCDU) that works to mobilize and empower women to combat gender-based violence, such a unit does not exist in Bhotkhola Rural Municipality, making women more vulnerable. These impacts may be exacerbated by a lack of police/security to protect women in the area and a general wariness among the community of police/security forces (thus, potentially deterring women from seeking help from them)[112] (see also Section 7.3.12).
- **Increased incidences of prostitution and casual sexual relations:** Increased disposable income could also lead to an increase in prostitution and casual sexual relations between workers and local women. These sexual relations could lead to an increased incidence of STDs/STIs (see Section 7.3.7). Women and young girls in the area are particularly vulnerable to STDs/STIs due to their limited education, limited ability to negotiate safe sex practices for cultural and religious reasons, and the higher risk that women have of contracting STDs/STIs through unprotected sexual intercourse, compared to men. This increased demand for prostitution in the DIA can contribute to increased risk of TIP for participation in the commercial sex trade, which disproportionately affects women and minors (particularly the poorest).
- **Forced marriage:** As per some normative social custom, if a man wants to marry a woman who does not agree to marry him, he may forcibly take her and hide for three days. After that they are

[111] Appendix H: Assessment of Protective Mechanisms and Safety of Women and Girls in Upper Arun Region.

[112] Appendix H: Assessment of Protective Mechanisms and Safety of Women and Girls in Upper Arun Region.

accepted as a couple by their families and society. Many of the ethnic groups present in the DIA such as Bhote, Tamang, Rai, Gurung, and Newar follow the same practice. The influx population (see Section 7.3.3) will be mostly young men; as such – and in combination with the increase in social vices described above – young women and girls in local villages may face unwanted sexual advances by men. The custom of forced marriage may legitimize such sexual advances and undermine the rights of those young women.

- **Early marriage**: Young girls may further be made vulnerable in the area due to the continued practice of early marriages due to poverty as well as culture and tradition related to the preservation of girls' sexual purity before marriage. Migrant workers may also father children with local women and girls while they are living in the DIA. Given the temporary nature of the work, it is possible that both these women and their children will be abandoned when the construction phase ends and the Contractors move on, leaving behind vulnerable single female-headed households.

Impacts Associated with Economic Marginalization and Hardship

- Fewer women may be able to access the employment opportunities created by the Project. This could create an imbalance in the financial contribution of women to their families. The reduction in their economic contribution could further reduce their household status. Increased opportunities for small businesses may benefit households in general (see Section 7.3.14); however, if the nature of these businesses is such that female children are expected to help their mothers in these additional activities, their education may be adversely affected.
- The impact of involuntary physical and/or economic displacement can disproportionately affect women, as their unique role in the household (i.e., being responsible for most household work, as well as agricultural work and the collection of fuelwood, fodder, and herbs) means they may have more difficulties coping with the familial disruption that resettlement can cause than do their male counterparts (see Section 0).
- Land acquisition for the Project, as well as opportunity to work as wage laborers in construction work, will take families away from agricultural practices. Women who used to have control over farm produce and food supply for the family will have to depend on men who would control cash (see also Section 0).
- Also, assets tend to be registered in men's names and, even in cases where they are registered in the woman's name, typically the male heads of households make the economic decisions for the family. As revealed in project FGDs and KIIs, women are more likely to opt for in-kind compensation (i.e., replacement land) than their male counterparts are, and worry that men will opt for cash compensation and then spend the money on things that do not benefit the household more broadly. To the extent that women would be responsible for making up the shortfall if men spend the compensation on frivolous things, women would, therefore, be disproportionately burdened by the payment of compensation for physical and/or economic displacement.

Based on the analysis above, the Project's potential impact on the risks to women during the construction phase could be direct, adverse, high in magnitude, local in extent, and medium term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

Mitigation of Impacts Associated with Physical Security

- Implement an Occupational Health and Safety Management Plan (see Appendix C, ESMP) that does the following:
  - Provides for separate public service (e.g., health clinics) for communities and workers to reduce the interaction between migrant workers with local women.

  - Implements a monitoring program for substance abuse (using breath analyzers and other methods) for strict enforcement of the prohibition on substance abuse, as such substances can lead to increases in GBV and the use of CSWs, not to mention threaten on-the-job safety.
  - Restricts workers to workers' camps during night-time hours unless working a night shift (there will be no worker access to villages during night-time hours).
- Implement a Community Health and Safety Plan and Sexual Exploitation and Abuse, and Sexual Harassment (SEA/SH) Prevention and Response Action Plan that mandates the Contractor to adopt a policy on gender-based violence, sexual exploitation and abuse, and trafficking in persons and collaborate with law enforcement agencies in the investigation of any violations of the law.
- Establish and enforce a Workers' Code of Conduct and induction training that includes legal provisions on GBV and its legal consequences for failure to comply with laws.
- Establish Women Awareness and Support Centers (WASC) at each workers' camps to:
  - Share project information including impacts, opportunities and benefits to the women visiting WASC.
  - Hold group meetings with women in villages as per the request of women from the village, including GBV meetings with *aama samuhas* (mothers' groups) and school girls to educate them on early marriage, forced marriage, GBV, and TIP, and how to recognize and prevent these things from happening. Conduct an awareness campaign in project-affected villages with adolescent girls and boys on these topics as well, to raise awareness.
  - Carry out an awareness campaign in both the local communities, as well as among workers, on how to prevent GBV and to provide counselling and support to victims.
- Encourage the hiring of a greater number of female police officers and staff to ensure the enforcement of laws on GBV and TIP (see Appendix C, ESMP, Security Personnel Management Plan).
- Provide funding to the District Administration to establish temporary police posts at locations where large workers' camps are located (Sibrun and Rukma) and deploy female police personnel to these posts. The police will consult with the UAHEP Intergovernmental Coordination Committee to monitor interactions between project workers and local residents, and specifically monitor for TIP, GBV, and sexual exploitation and abuse.
- Hire a qualified NGO to support GBV prevention and response programming in the area.

Mitigation of Impacts Associated with Social Exclusion/Marginalization

- Hold periodic women's group meetings in every village to discuss project impacts and benefits and approach concerned agencies to address them.
- Implement the provisions of the Gender Action Plan, including:
  - Provide education support for adolescent girls to reduce dropout rates, including merit scholarships for girls interested in higher secondary education (focus on those from vulnerable families).
  - Promote skill and vocation training for women to increase the capacity of women to take advantage of employment opportunities.
- Facilitate the economic empowerment of women by doing the following:
  - Strengthen existing women's savings and micro-credit groups and helping to create new groups.
  - Hold counselling camps for women through training institutes affiliated to the Council for Technical Education and Vocational Training (CTEVT) for helping women selecting appropriate skills training.

  - Provide livelihood training as per RAP.
  - Promote indigenous knowledge on craft and weaving and linking them to marketing channels.
  - Provide marketing support for women-led businesses.
- Implement the provisions of the Labor Management Procedures: Ensure that the Contractor accordingly prepares a Labor Management Plan that expressly prohibits child labor, forced labor, and discrimination against workers; commits the Contractor to the fair treatment of workers; and ensures equal opportunity for all, especially women.
- Ensure that mitigation of the impacts of physical and economic displacement is covered in the RAP/LRP.

Taking into consideration these proposed mitigation measures, the Project's differential impacts on gender will be direct, adverse, medium in magnitude, local in extent, medium term in duration, with an overall residual significance of ***Substantial***.

Operation Phase

Once the construction phase is complete, the construction workers will largely return back to their homes and temporary facilities created for construction will be dismantled and restored to their original use. Many of the adverse impacts linked to the construction phase will no longer be relevant. However, the Project will bring some lasting changes to the life of the community, in general, and women, in particular. Due to their inherent inequality in the society, women may not be able to take equal advantage of the Project's benefits during the operation phase, as employment positions will tend to require higher levels of skills/education.

For example, while education support programs and skills training programs will increase the number of educated women eligible for formal employment created by the Project and anti-discrimination practices may help to ensure women obtain some jobs during the construction phase, the employment opportunities during the operation phase of any hydroelectric project is limited. Men may be preferred for these positions and women may be marginalized. However, the livelihoods and skill training activities implemented during the construction phase may introduce a range of new skills and income generation activities for women. When the demand created by the Project during the construction phase ends, the women engaged in these activities may be able to take advantage of the improved vehicular access to the DIA and look for markets outside. Opportunities may exist in the tourism sector, however, as road conditions surrounding the DIA will have improved as a result of the Project and there will be better public transportation services available. Therefore, some of the infrastructure created to accommodate migration and population influx can be used for tourism purposes. Women often take an active role in running homestays and local shops. Hence, women may benefit from the increase in tourism (see also Section 7.3.14).

Based on the analysis above, the Project's potential impact on gender during the operation phase could be direct, adverse, medium in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Encourage women to showcase their traditional cultural talents for the tourists through the establishment of an ethnographic museum and cultural center created under the Cultural Heritage Management Plan.
- Train women to promote cultural tourism that involves local performing arts and local foods.
- Set up a women's cooperative to promote indigenous crafts.

- Encourage the selection of women for employment opportunities in the operation phase of the Project.

These measures will help women to obtain more equal access to project benefits in the operation phase.

These measures will also prevent some of the impacts and reduce the magnitude of those that remain. Therefore, the Project's differential impacts on gender will be direct, adverse, low in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Low***.

7.5.10 Nuisances

Project construction will result in various nuisance impacts on local communities, including increased noise, vibration, and fugitive dust. These impacts are described in Section 7.1 (Impacts on the Physical Environment), but are referenced here to provide a complete picture of the social impacts of the UAHEP.

Avoidance and Minimization Measures

The Project has adopted the following measure to avoid or reduce nuisance impacts on local villages, in accordance with the application of the mitigation hierarchy:

- Selected an alternative headworks location that is farther from local villages, especially Rukma.
- Sited or shifted the location of several project ancillary facilities (e.g., quarry, contractor's camps, crusher, spoil disposal areas) to maximize the buffer to local villages.

Pre-Construction Phase

During the pre-construction phase, several investigative studies were conducted. The most intrusive of these was some exploratory adits and geotechnical investigations to better understand the underlying geology. These investigations have generated several formal grievances relating to inappropriate spoil disposal, damage to crops that has not been compensated, downslope water quality concerns, tree clearance, and noise.

These grievances are being investigated by NEA through the GRM, but does highlight the need for the effective implementation of a robust ESMP.

Construction Phase

These nuisance impacts will be most significant in the villages of Sibrun, Hema, Namase, and Rukma, as project construction will occur through or in close proximity to these villages. Sibrun, Hema, and Namase are primarily affected by the project access road construction, while Rukma will be near both the access road and headworks construction. Limbutar will also be impacted, but this small cluster of houses will be physically resettled prior to construction beginning.

The nuisance risks during project construction could be direct, adverse, high in magnitude, local in extent, and short term in duration, resulting in an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Significance

Sections 7.1.7 (Air Quality), 7.1.9 (Noise), and 7.1.10 (Vibration) identify proposed mitigation measures to manage these issues, including the following key measures:

- Fugitive dust – minimize the area disturbed at any single moment of time and use water sprayers to control dust, especially during the dry season.
- Noise – prohibit above-ground night-time construction activities.
- Vibration – conduct a video-inspection of structures that could be affected by vibration, so as to provide documentation upon which to determine whether or not any damage claims are project-related.

- Communications – the Construction Contractor will implement an awareness program regarding project construction activities and provide prior notice to local residents of the timing of planned use of explosives and helicopters.
- General – the Project will have a community GRM in place to allow local residents to raise any complaints or offer suggestions to further minimize nuisance impacts.

These mitigation measures will reduce the magnitude of these impacts to low. Therefore, the nuisance risks during construction phase will be direct, adverse, medium in magnitude, site-specific in extent, and short term in duration, resulting in an overall residual significance of ***Moderate***.

Operation Phase

Project operation will present few nuisance impacts on local residents, as all disturbed areas will be stabilized and vegetated, thereby eliminating sources of fugitive dust; noise levels will be low as all noise generating equipment will be underground or located within a structure; and no activities will generate vibrations.

The nuisance risks during operation could be direct, adverse, low in magnitude, site-specific in extent, and long term in duration, resulting in an overall pre-mitigation significance of ***Low***.

Proposed Mitigation and Residual Significance

The project will have a community GRM in place to allow local residents to raise any complaints or offer suggestions to reduce any nuisance impacts.

As a result of the low levels of nuisance activities occurring during project operations and the availability of the community GRM, the nuisance risks during operation phase will be direct, adverse, low in magnitude, site-specific in extent, and short term in duration, resulting in an overall residual significance of ***Low***.

7.5.11 Emergencies and Public Safety

During project construction and operation, a variety of emergencies may occur involving natural disasters and accidents, which could affect community safety. Natural disasters include floods, GLOFs, earthquakes, fire, and landslides. Project-related accidents may include construction accidents, tunnel collapse, explosions, drownings, traffic accidents, dam failure, and project-induced landslides. Several of these accident scenarios have the realistic potential to only impact project workers (e.g., construction accidents, tunnel collapse, explosions) and are discussed under Section 7.3.13 (Labor and Working Conditions). The project-related accidents with the potential to impact the public (e.g., traffic accidents, landslides, drowning, dam failure) are discussed below.

Avoidance and Minimization Efforts

The Project will adopt the following measures to avoid or reduce the dam safety risks, in accordance with the application of the mitigation hierarchy:

Site dam in area with low downstream population within flood zone.

- Adopt a PRoR operation mode with a relatively small reservoir storage volume, which reduces the risks associated with a dam break (e.g., gross reservoir storage only represents approximately 11 minutes of flow under the design GLOF of 7,576 m^3/s).
- Design dam with appropriate factors of safety relative to seismic hazard design to minimize dam stability risks.
- Design dam to manage both probable maximum flood and a GLOF.
- Optimize dam height to reduce slope stability.
- Avoid disturbance of landslide prone areas.

Construction and Operation Phases

Several of the natural disaster and accident risk scenarios could occur during construction and operation phases, so are discussed in an integrated manner below.

Natural Disasters

Although disasters like floods, GLOFs, earthquakes, landslides, and fires occur naturally, the Project has the potential to increase the frequency of occurrence of some of these events (e.g., the risk of landslides could increase because of construction activities or reservoir water level fluctuations; there could also be an increased risk of fires from project workers discarding cigarettes) and the magnitude of their impacts (e.g., increase the volume of water or debris associated with flood events). These natural disasters, potentially worsened by project construction or operation, pose risks to community life and property.

Therefore, the risks during the construction and operation phases could be direct, adverse, high in magnitude, local in extent, and long term in duration, resulting in an overall pre-mitigation significance of ***High***.

Proposed Mitigation, Enhancement, and Residual Significance

The Project will adopt an Emergency Preparedness and Response Plan, which will include the following measures to mitigate the potential safety risks associated with natural disasters:

- Establish an UAHEP Intergovernmental Coordination Committee to promote coordination and communication between the Project and all levels of government regarding emergency response to natural disasters and emergencies.
- Carefully monitor geotechnical conditions and stabilize steep slopes that must be disturbed.
- Implement a peaking operation rule that limits the rise and fall of water levels within the project reservoir to no more than 2.5 m/hr to maintain slope stability and reduce risk of landslides.
- Prohibit workers from smoking outside of designated areas within the workers' camps.
- The Project will provide the following protections to local residents, including:
- Enhanced protection from flooding and GLOFs, as a result of the additional storage volume in the reservoir.
- Enhanced warning of flooding and GLOFs to local residents, as a result of project monitoring of upstream flow conditions.

Implementation of these measures will reduce the magnitude of the impact to low. Therefore, the potential risk from natural disasters during construction and operation phases will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Substantial***.

Traffic Accidents

The Project will require the transportation of equipment, supplies and labor to the project site from as far away as India and Kathmandu. The increase in traffic on main highways due to the Project should be minimal until Khandbari, after which all project traffic, which is estimated to be an average of 23 trucks and 5 buses per day each way (total of 56 one-way trips per day), will be concentrated on the Koshi Highway to the project site.

The project access road, branching off from Koshi Highway north of Gola, will increase/introduce vehicular traffic in an area where there were previously no roads. Traffic will include large trucks delivering equipment and supplies to the construction sites and buses shuttling workers from workers' camps to construction sites. Project-related traffic volume along the project access road is estimated to be 102 vehicles per day (72 trucks and 30 buses; see Section 3.5.5 – Construction Traffic) each way, for a total of 204 vehicular trips/day. Traffic along the Koshi Highway from Khandbari to the project site will vary significantly on a daily, seasonal, and annual basis. Most of the traffic would be expected just prior to the initiation of construction activities, as equipment, supplies, and workers will all need to be transported to the project site. After this initial flush of traffic, vehicles from Khandbari will be reduced and will primarily be support services, including the transport of food and materials (e.g., cement, diesel fuel) to the site, transport of waste back from the site, and the transport of workers back and forth as project workforce requirements change by season, construction stage, or for worker's leave.

This vehicular traffic increases the potential for road accidents between project vehicles and other vehicles, pedestrians, livestock, and wildlife (wildlife impacts are described in Section 7.2). The risk of traffic accidents is high because of poor road conditions between Khandbari and the project site, the lack of safety signage and control measures (e.g., guardrails, lighting), the poor condition of many vehicles, driver behavior, and the fact that many local residents are relatively unfamiliar with the safety risks posed by vehicles. This is particularly true from Num to the project site and along the proposed access road, where the presence of a road and vehicles is a recent development. These risks to local residents are compounded by the fact that the roads will likely become the preferred pedestrian route because of gentler slopes and, at least initially, the better condition of the roads relative to trails. At a minimum, during project construction, children will have to cross or go around construction areas/project roads to reach schools and return home, and all residents will need to cross construction areas/project roads to access various community facilities (e.g., health posts), non-timber forest products, livestock grazing areas, and even to visit friends and relatives. Further, because most of the vehicular traffic will be large vehicles (i.e., trucks and buses), any accidents involving pedestrians or livestock will likely involve serious injuries or fatalities.

Therefore, the risks of traffic accidents during the construction and operation phases would be direct, adverse, high in magnitude, local in extent, and long term in duration, resulting in an overall pre-mitigation significance of ***High***.

Proposed Mitigation Measures and Residual Significance

The project Contractor and operator will develop and implement a Traffic Management Plan (see Appendix C, ESMP). This plan will include, at a minimum, the following key mitigation measures (see Appendix C for a complete list of minimum requirements for the Traffic Management Plan):

- Ensure all project-related vehicles comply with designated speed limits:
  - Vehicles travelling within the construction site shall be limited to 20 km/hr.
  - Vehicles travelling along the Koshi Highway shall travel at the posted speed limit, unless road conditions, vehicle loads, or visibility dictate a lower speed.
  - Monitor vehicles speeds using GPS trackers with governors.
  - Establish penalties for Construction Contractor drivers exceeding established speed limits and incorporate penalties in transport subcontracts for non-compliance with vehicle speed limits.
- Provide appropriate signage and safety measures:
  - Provide speed bumps and caution signage at each entrance to a village along the project access road (i.e., Sibrun, Hema, Namase, and Rukma) to alert drivers that they are entering a residential area and near identified wildlife crossings.
  - Provide directional signage around the construction areas to facilitate traffic movement.
- Establish driver candidate minimum employment requirements, including:
  - A valid license to drive the type/class of vehicle required
  - An accident-free driving record
  - Pass an eye chart exam

- Provide driver-safety training:
- – Ensure that all drivers of project vehicles, as well as suppliers and their delivery drivers, receive driver safety training, including defensive driving instructions, and are clearly informed of the safety risks in the project impact area and the importance of safe driving.
- – Ensure that all project drivers are aware of specific project procedures and restrictions (e.g., respect speed limits, prohibit use of mobile phones while driving, prohibit the use of alcohol or drugs, limits on night-time driving, limits on hours of driving, accident/incident reporting requirements, disciplinary actions).
- Ensure project vehicles are safe to operate:
- – Provide regular maintenance for all vehicles, including inspection of tires, breaks, lights, and warning signals.
- – Ensure that all vehicles are equipped with seat belts, first aid kits, and communication devices (e.g., phone, radio), so that any accidents can be reported immediately. Drivers will be responsible for ensuring that their passengers wear seat belt.
- – Conduct random vehicle safety inspections.
- Provide community vehicular traffic safety education and awareness training for all residents in the project impact area and in all local schools at the initiation of project access road construction, and again at six month intervals throughout project construction.
- Prepare a Pedestrian Plan for the project impact area to enable residents to walk between villages and for students to have safe access to schools, including:
- – Provide continuous safe access to the pedestrian bridge across the Arun River near Chongrak.
- – Construct a new pedestrian bridge downstream from the existing Rukma-Chepuwa pedestrian bridge across the Arun River to allow safe uninterrupted pedestrian movement.
- – Designate and construct, as needed, a continuous and safe walking path from the Chongrak pedestrian bridge to the Rukma-Chepuwa pedestrian bridge and on to the village of Chepuwa. Where portions of the existing path system are impacted by project activities, construct an alternative path in consultation with the local village.
- – Provide alternative safe student access to the Sibrun and Namase Basic Schools separate from the project access road.
- – Provide a pedestrian crossing with appropriate signage where residents will need to cross the project access road to access community facilities.
- – Provide alternative safe student access from Rukma to the secondary school in Lingam.
- – Manage pedestrian access to the road tunnel.
- – Develop and install signage to maintain pedestrian safety during construction and operation (e.g., pedestrian crosswalks, village entrance signage, school crossing signs).
- Traffic safety procedures:
- – Use signs and flag-people for traffic control as needed.
- – Plan entry/exit routes and transportation timings for heavy transport vehicles to minimize disturbance to the surrounding locality.
- – Provide a wheel wash system and make sure the construction vehicles, and especially their tires, are properly cleaned, free of dirt, mud and other debris at each point of exit onto roads that pass through villages.
- – Material shall be appropriately secured in the vehicles to ensure safe passage between destinations during transportation.

- Trucks/dumpers loads shall be covered (e.g., tarpaulin sheets) during offsite transportation.
- The Contractor shall be responsible for any clean-up resulting from the failure by its personnel or suppliers to properly secure transported materials.
- The Contractor is responsible for the costs associated with repairing any damage caused to local roads and bridges due to the transportation of excessive loads.
- Conduct random alcohol and drug testing of drivers.
- Limit night-time vehicle traffic between the powerhouse and headworks areas.

Implementation of these measures will reduce the magnitude of the impact to medium. Therefore, the potential risk from vehicular traffic will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Substantial***.

Landslides

The project impact area is naturally susceptible to landslides because of its underlying geology, very steep slopes, and monsoon climate. Project construction will involve the disturbance of steep slopes and the extensive use of explosives for tunnel construction, both of which could induce landslides as a result of direct disturbance or through vibrations. The project design has taken landslide risk into consideration and avoided areas especially prone to landslides to the extent possible. Nevertheless, the potential for naturally caused and project-induced landslides remain.

Therefore, the Project's landslide risks during the construction and operation phases could be direct, adverse, high in magnitude, local in extent, and, although the duration of a landslide would be short, the impacts would take a long time to recover from, resulting in an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Significance

The Project Contractor and operator will develop and implement an Emergency Preparedness and Response Plan, which will include measures specifically for landslides. This plan will include at a minimum the following key mitigation measure (see Appendix C, ESMP for a complete list of minimum requirements):

- Closely monitor slope stability, especially those slopes most susceptible to landslides and where construction and/or tunnelling activity is occurring directly above a village (e.g., Rukma, Namase, Hema, Sibrun). The Construction Contractor will include a slope stability monitoring strategy as part of the Response Plan to detect movement of overburden material, which could serve as an early warning of a potential landslide.

Taking into consideration this mitigation measure, as well as the others identified in Section 7.1.1 (Geology and Topography), the Project's landslide risks during the construction and operation phases could be direct, adverse, medium in magnitude, local in extent, and, although the duration of a landslide would be short, the impacts would take a long time to recover from, resulting in an overall pre-mitigation significance of ***Substantial***.

Dam Failure

The UAHEP involves construction of a large dam (i.e., defined as having a height over 15 m and impounding more than 3 million m^3 of water), as it is designed to have a total height of 91 m and store 5.07 million m^3 of water. A dam of this size poses risks to downstream communities in the event of dam failure, which could include loss of life.

The design engineer will prepare a dam break analysis as part of the upcoming Detailed Design Phase of the engineering contract to evaluate the potential consequences of a dam failure. The effects of a dam failure during construction or operations would be expected to extend downstream to at least the Arun-3 HEP dam and impact villages and structures located near the Arun River.

Therefore, the Project's dam safety risks during the construction and operation phases could be direct, adverse, high in magnitude, local in extent, and, although the duration of a dam break incident would be short, the impacts would take a long time to restore and recover from, resulting in an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Significance

Given that it is a large dam, the WB Environmental and Social Framework and the World Commission on Dams (2000) establish special requirements for dam safety (ESS 4, Annex 1: Safety of Dams), which include the following:

- Review of the dam investigation, design, construction, and start of operations by an independent panel of experts.
- Prepare and implement detailed plans for construction supervision and quality assurance, instrumentation, operation and maintenance, and emergency preparedness.
- Prequalify bidders during procurement and bid tendering for dam.
- Conduct periodic safety inspections of the dam after completion, and implement measures required to address any safety deficiencies identified.

UAHEL has established a Dam Safety Panel of Experts, who have already reviewed the investigation studies and design of the dam. As a condition of the World Bank's project funding, this panel will continue in its review capacity through construction and the start of operations. The Bank will also include as conditions of funding that the detailed plans referenced above are prepared and implemented, bidders for construction are prequalified, and dam safety inspections conducted. Implementation of these measures will reduce the magnitude of the impact to low. Therefore, the potential risk of dam failure will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Moderate***.

Operation Phase

The one impact that is specific to the operation phase is related to changes in river flow, as a result of project operations. This impact is evaluated below.

Changes in Flow

Operation of the UAHEP will create some acutely unsafe areas and conditions that could pose drowning risks to the public where flow levels may change quickly and dramatically:

- Area immediately upstream from the dam – poses risks for people to be pulled into the headrace tunnel or impinged against the headrace intake trash racks or impacted by the opening of the dam gates or use of the spillway.
- Area at the toe of the dam – poses risks for people in terms of hydraulic conditions and the risk of water spillage resulting in sudden and large changes in flow.
- Area immediately below the tailrace tunnel – poses risks for people as a result of sudden changes in flow from project operation, especially during times when the Project begins to peak.

There are also three other areas that do not present the same acute risks, but still represent potential safety risks for people not aware of the potential for changes in water levels, including:

- Project reservoir – although the area immediately above the dam presents acute risks, the remainder of the reservoir also poses risks for water users, especially boaters or swimmers, to float with the current into the acute risk area by the dam.
- Diversion reach (toe of dam to tailrace) – the 16.5-km-long diversion reach will incur a significant reduction in flow for much of the year where only the proposed EFlow release from the dam and tributary inflow would contribute water. There is the potential for water to be spilled at the dam

because of a powerhouse upset or during the monsoon season when flows exceed the hydraulic capacity of the turbines or the Project conducts sediment flushing. In these cases, flow could unexpectedly begin to increase relatively rapidly and any people in or along the river (e.g., fishermen, bathers, cremations, washing clothes, recreation users) could be swept away with the increased flow and currents.

- Downstream from the tailrace – project peaking operations will result in rather rapid increases in water levels downstream from the tailrace of about 1.5 m. This impact would continue downstream to the Arun-3 HEP reservoir.

Each of these areas and scenarios pose risks of drowning.

Therefore, the Project's operational risks during the operation phase could be direct, adverse, high in magnitude, local in extent, and, long term in duration with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Significance

The Project will adopt the following measures to mitigate the potential safety risks associated with project operations:

- Conduct public education and awareness meetings in local communities and local schools prior to project commissioning to make all local residents aware of the effects of project operations on flow, and the risks to be aware of, especially in areas open to the public, such as along the diversion reach and downstream from the tailrace. These meetings will help residents understand the Project's operating schedule and the safety precautions and warning signals that will be implemented, as described below. Annual refresher meetings shall also be conducted over the life of the Project.
- Delineate exclusion zones above and below the dam and tailrace outlet using floating booms and prohibit public access to these areas for safety reasons.
- Install signage along the reservoir shoreline upstream from the dam, along the diversion reach, and downstream from the tailrace to the upper end of the Arun-3 HEP reservoir warning river users of the potential for sudden and significant changes in river flow in these areas. Warning signage (in Nepali and with graphics) will be placed at locations commonly used for cremations, other ritual areas, and fishing areas.
- Provide warning sirens near the dam and tailrace to alert river uses that rapid changes in flow will occur in 15 minutes and that they should move out of the river to higher ground.
- Provide appropriate life-saving equipment at appropriate locations upstream and downstream from the dam and the tailrace outlet.
- Notify communities at least one day in advance when sediment flushing will occur, as this will result in the most significant and dangerous change in flow.
- Establish an early warning system for GLOFs or flooding via water level monitoring for the Project's benefit and to notify local residents. This system should also include measures for early detection of any dam safety risks and evacuation training.

Implementation of these measures will reduce the magnitude of the impact to medium. Therefore, the potential risk of drowning from project operations will be direct, adverse, medium in magnitude, local in extent, long term in duration, with an overall residual significance of ***Moderate***.

7.5.12 Use of Security Personnel

As with any infrastructure project, the UAHEP is faced with both internal and external security risks, such as a Maoist separatist movement, which is active in the project impact area. Internal security risks relate to risks arising out of the working environment of the Project, including non-compliance with the Code of Conduct, and relate to risks to personnel and material. The level of internal risk is determined by the value of the material, risk to workers, as well as perception of local community about their safety and security. External risks include the threats arising to the Project due to its geographical presence in the given area and include the region/overall country context, such as conflict, criminality, vandalism, and armed protests due to socioeconomic conditions. External risks can also arise from lack of a positive relationship with communities that directly influence company operations and the unjust treatment of fence-line communities, particularly of women, by the security personnel, which can have a negative impact on the Project. To mitigate these risks, the Project will implement a number of security measures, including the use of security personnel. The impacts associated with the use of security personnel are discussed in the following sections.

Avoidance and Minimization Efforts

There were no avoidance or minimization measures identified related to the use of security personnel.

Construction Phase

The security personnel will be employed at the project sites to help reduce the aforementioned internal and external risks. This will consist of private and possibly public (Nepal Police and Nepal Army) security agencies.

The security personnel will be deployed as follows:

- Unarmed private security personnel to watch over the site boundary and control access to the site to prevent trespassing, vandalism, and petty theft
- Armed private security personnel at all sites where construction materials and machines are stored or being used
- Public security forces, either Nepal Army or Nepal Police Force, to secure high risk sites with explosives and fuel storage areas
- Nepal Police Force will establish check posts and patrol teams for general vigil over law and order situations

The potential impacts associated with the use of security personnel are as follows:

- **Excessive force:** Security personnel will be employed at project sites to protect assets and prevent community members from entering restricted areas. In the event of protests, trespassing, or other actions by community members or other stakeholders, there is the potential for unlawful or abusive interaction between security guards and community members, especially if site security are not adequately trained. This use excessive force has been seen in other development projects.
- **Community disquiet:** The number of public security personnel (Nepal Army, Nepal Police Force, and MBNP Forest Rangers) deployed in Bhotkhola Rural Municipality is typically relatively low. Project construction will set additional security personnel camps and deploy private security guards at multiple locations. Many of these sites will require round the clock protection; hence, a large number of private security forces will be deployed. Although local people are familiar with the movement of security personnel and interact with them in the course of their business, the increased number may cause a sense of insecurity and uneasiness. This sense of insecurity and uneasiness will be more for local communities that interact with armed security personnel. The deployment of armed security personnel is envisaged at explosive and fuel storage sites. The explosive storage site will be at the side of the proposed road at Limbutar Camp. The fuel storage site will also be located abutting the Koshi highway, along with the maintenance shop. The local community and workers are likely to cross these locations.
- **Restrictions on community movement:** The private security personnel will secure the project sites and exercise their authority to control any unauthorized entry or activity within these boundaries. Hence, private security personnel will mostly interact with project workers. However, project construction and other barriers (e.g., fences) may restrict the movement of local people, requiring them to take detours. Private security personnel will also enforce temporary entry

restrictions to construction sites, due to safety and security reasons. The enforcement of such restrictions may intimidate, inconvenience or anger local people.

- **Opposition to project:** The presence of private and public security personnel may dissuade local people from expressing their dissatisfaction and concerns with the Project openly. If such dissatisfaction remains suppressed, it will give rise to latent frustration with the Project. Such frustration can come out during community protests, causing disorder and even violence. Such protests could cause destruction of project assets and create distrust, as well as cause delays in project execution. In such tense situations, establishing peace and restoring normalcy is a difficult task.

There will likely be multiple sources of security personnel, including the Nepal Army and Nepal Police Force, as well as private security personnel. UAHEL will have limited control over the army and police. Based on the analysis above, the Project's potential risks from security personnel during construction could be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

Mitigation of Impacts Associated with the use of Security Personnel

There are a number of actions the Project can take to reduce security risks to the Project (and the local communities), thereby reducing the need for security personnel intervention. These include:

- Implement a Security Personnel Management Plan containing measures to:

– Establish security checkpoints at each Arun River road or pedestrian bridge crossing to confirm the identity and purpose of each individual seeking to enter the construction area.

– Obtain written permission for visitors and relatives of the camp residents to enter the camp. This permit shall be approved by the construction camp manager.

– Develop and implement a sign-in procedure for permitted visitors involving identify verification and an OHS briefing for all visitors, and ensure that, while on the site, they are escorted at all times (note: regular visitors such as NEA staff and site monitors will undergo a more in-depth OHS training and certification and would not require an escort).

– Arrange guided tours whenever required to inform people about the Project's construction activities to avoid local people from gathering and crowding near construction sites.

- Implement a Community Health and Safety Plan that mandates the Contractor to:

– Sensitize local community members prior to the commencement of the construction phase so that they are aware of the presence and role of security guards, the risk of site trespass and how to interact with the Project in the event of any concerns or issues. This should be undertaken as part of ongoing stakeholder engagement and can include community education and awareness training/seminars on project related safety risks.

– Install safety fencing and warning signs to control public access to high risk areas, including tunnel and cavern portals, the quarry, power plants, the headworks site, crusher and batching plants, and spoil disposal areas.

– Provide adequate night-time lighting around the Contractor workers' camps.

– Restrict workers to the workers' camps at night, unless they are working a night shift.

– Install a perimeter security fence around the Contractor workers' camps with guards to restrict access by the public and to ensure that workers remain in the camp at night.

- Collaborate with local leaders, such as ward chairs, to find ways of ensuring that site trespass and theft are minimized, either through punitive or rehabilitative measures.
- Establish a community watch group to help patrol key areas within the DIA, thereby reducing the presence of police/security forces.

Mitigation of the Impacts Associated with the Use of Private Security Personnel

- Implement a Security Personnel Management Plan containing the following measures:
  - Avoid the use of force by direct or contracted workers in providing security, except in self-defense, in proportion to the nature and extent of the threat.
  - Ensure that the Project is compliant with the World Bank ESS 4, UN Voluntary Principles on Security and Human Rights, and World Bank's Good Practice Note for Borrowers on Assessing and Managing the Risks and Impacts of the Use of Security Personnel (World Bank 2018a).
  - Conduct reasonable inquiries/background checks to verify that any security personnel to be hired for the Project are not implicated in any past wrong doings, such as allegations of past abuses, inappropriate use of force, or criminal activities.
  - Give preference in hiring to local candidates with required qualifications and maintain diversity in hiring by including women.
  - Develop standard operating procedures for security guards and conduct training as per the International Code of Conduct for private security providers.
  - Train security personnel in the appropriate conduct toward workers and affected communities.
  - Prohibit use of force by private security personnel.
- Develop and implement a grievance mechanism to address any security related grievances. During the pre-construction/planning stage, the Project shall decide whether the security personnel will be engaged as direct staff or through a third-party security provider.

Mitigation of the Impacts Associated with the Use of Public Security Personnel

The primary task of public security forces (Nepal Police Force in general and Nepal Army for use of explosives) will be to maintain overall law and order in and around the project site location, and for investigation into criminal activities. Public security forces also will control any potential community unrest, armed protest, or civil disorder caused by or influencing the Project. The control over public security forces will be limited, as the Project does not control the decision making or behavior of those forces (e.g., Nepal Army, Nepal Police Force, and Armed Police Force). Therefore, to mitigate the impacts of the use of public security forces, the Project will:

- Enter into a memorandum of understanding (MoU) with any public security forces requiring them to follow the Project's Policy on Security, commit to the proportional use of force, and comply with other requirements including disciplinary measures, training, and incident follow-up.
- Avoid the use of force by public security personnel, if private security can intervene and respond to the matter in a peaceful manner.
- Request public security personnel only when there is an urgent need at a specific location, and then clearly define their mandate, as well as the time limit for their expected withdrawal.
- Coordinate with the Nepal Police Force and Nepal Army to provide training in GBV and community safety.
- Report incidents of physical force used by public security to the appropriate authorities. After the use of force on civilians during any threat or risk situation, medical aid should be provided to injured persons, including to those who took part in such protests or civil unrests.

Summary

Based on the implementation of the proposed mitigation measures, the significance of the risk associated with using security personnel on community health and safety will be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Moderate***.

Operation Phase

During the operation phase, a reduced number of security personnel will remain. The Arun River checkpoints established during the construction phase will be removed, and all facilities that are no longer required for operation (i.e., the explosives magazine) will be decommissioned and their security forces disbanded. However, security will remain at the dam and powerhouse, and provide monitoring at the Owner's Camp and water treatment plants. The mitigation measures applied during the construction phase will remain in place during the operation phase. As no new impacts are anticipated, the use of security personnel during the operation phase is not considered further in this assessment.

The risk associated with the use of security personnel on community health and safety will be direct, adverse, low in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Low***. No additional mitigation measures are proposed.

7.5.13 Labor and Working Conditions

Workers' rights, including occupational health and safety, need to be considered to avoid accidents and injuries, loss of man-hours, and labor abuses, and to ensure fair treatment, remuneration, and working and living conditions. These issues should be considered not only for those who are directly employed by the Project, but also their subcontractors and those within the supply chain. This section discusses these potential construction phase impacts.

Avoidance and Minimization Measures

There were no avoidance or minimization measures identified related to impacts on labor and working conditions.

Construction Phase

- **Worker health and safety**: Given the nature of the activities being undertaken during construction, worker health and safety is a key risk area with the potential for accidents that may result in injuries and potentially fatalities, as well as lost man-hours. Poor working conditions and occupational health and safety issues relate to doing hazardous work, such as working at heights or in confined spaces, use of heavy machinery, or use of hazardous materials. Employees working informally and those with limited experience or without awareness of their rights (e.g., migrant workers, or those newly entering the labor market) are most at risk. This is particularly critical given that an occupational health and safety culture is not prevalent in Nepal. Therefore, the onus will be on the Project to ensure that workers are advised of their rights, and to actively promote and protect those rights on behalf of the workers.
- **Workers' rights**: Although Nepal has signed several major international labor laws and conventions,[113] the implementation of workers' rights may not be fully aligned with these instruments. There is, therefore, a risk that some of the Project's subcontractors/suppliers may not be fully compliant with Nepal's legal requirements related to labor conditions. This can result in unfair terms and conditions of employment, unfair treatment, discriminatory hiring practices and treatment of employees, the violation of recognized labor rights including freedom of association

[113] Some relevant examples include: Forced Labor Convention, 1930; Minimum Age Convention, 1973; Equal Remuneration Convention, 1951; Discrimination (Employment and Occupation) Convention, 1958.

and collective bargaining by project workers, and inadequate/unsanitary living conditions in the workers' accommodation provided by Contractors.

- **Forced labor:** The large demand for labor means that the Project could contribute to the risk of forced employment, if appropriate employment practices are not put in place. Forced labor can result from a range of employment practices, such as not paying workers fairly and in a timely manner, withholding (without access) passports or other identification, and using recruitment agencies that charge high fees. The migration of illiterate and poor families as construction workers is quite prevalent in the South-Asia region. This carries an inherent risk of unfair labor recruitment process and the use of trafficked persons and forced labor practices. The foreign workers, therefore, would be in a more vulnerable position than local or community workers (see Section 7.4 on Effects on Vulnerable People).
- **Child labor:** In the context of Nepal, child labor is a risk in subcontractor organizations, as well as in the supply chain. Approximately one fifth (19%) of households in the DIA are below the poverty line defined by the GoN (see Section 6.3 – Social Baseline). The DIA does not have secondary schools and the dropout rate for adolescents is high (see Section 6.3). In such a situation, adolescents are more likely to join – whether voluntarily or at the behest of their family members – the project workforce if strict regulations are not in place. Even with regulations preventing children from being directly employed by the Project, the relative poverty in an areas can mean that children – particularly female children – may be expected to work in supporting/indirect employment opportunities associated with providing for the needs of an increased population in the area (see Section 7.3.3). The social baseline (Section 6.3) shows that several households reported that their children were formally engaged in labor (the type of labor was not specified, but is presumed to be agricultural labor); therefore, the precedent for child labor in ancillary industries exists in the DIA.
- **Discrimination against women:** During FGDs and KIIs, women indicated that they are often not offered the same opportunities in paid employment or are limited to taking on certain roles, which are traditionally associated with women, such as cooking food or providing laundry services at the camps. Therefore, women are at risk of being discriminated against in terms of paid employment with the Project (see Section 7.3.9).

Based on the analysis provided above, the Project's impact on labor and working conditions during the construction phase could be direct, adverse, high in magnitude, local in extent, medium term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Implement an Occupational Health and Safety Plan that provides for the following:
  - Identify an acceptable set of international good practice standards that the Occupational Health and Safety Plan will follow (e.g., United States, Australia, New Zealand, United Kingdom), to be approved by UAHEL.
  - Design and implement appropriate health and safety training and emergency procedures.
  - Provide and enforce the use of proper PPE, such as safety boots, safety glasses, helmets, hearing protection, gloves, dust masks, and respirators.
  - Provide adequate worker accommodation and living conditions that meet at least the minimum requirements identified in the IFC/EBRD's *Workers' Accommodation: Processes and Standards* (IFC and EBRD 2009) and ILO (specifically Recommendation No.115).
  - Provide separate facilities for women and men working at the site. Ensure safe and easily accessible facilities like toilets and childcare for women and install 24-hour proper lighting across all campsites and project sites, as per Nepal's Labor Act and the World Bank's Labor Good Practice Note.

  - Provide adequate medical facilities, supplies, and staffing at each workers' camp to ensure that workers' needs are cared for, to reduce the risk of disease transmission among workers and with local communities (see Section 7.3.6 and Section 7.3.7) and to reduce the burden on local health infrastructure (see Section 7.3.8).

- The Contractor will conduct risk assessments in line with good international industry practice to ensure worker safety. All workers (direct employees, subcontractors, and suppliers where relevant) should receive an induction and continuous training regarding this system.
- Implement a worker induction training that provides appropriate health and safety, and environmental and cultural sensitivity training to workers. In addition, implement a Workers' Code of Conduct aligned with the World Bank's Request for Bids (Section IV), which requires the Contractor to retain documentation demonstrating that all project employees, including subcontractor personnel, have received the required health and safety, and environmental and cultural sensitivity training, as well as training on the Code of Conduct including orientation and training on GBV/SEA/SH. Develop Labor Management Procedures to protect project workers' rights and to ensure that the Project complies with the requirements of the World Bank's Environmental and Social Framework (ESS 2 – Labor and Working Conditions). The Labor Management Procedures provide the guidelines for the Contractor's Labor Management Plan and include, among other things, the following requirements:
  - Expressly prohibit child labor, forced labor, and discrimination against workers, and commits the Contractor to the fair treatment of workers, equal opportunity, especially for women and people with disabilities, and recognition of labor rights, including freedom of association and collective bargaining.
  - Ensure that the Contractor, including any subcontractors, does not employ or engage a child under the age of 14 and does not allow workers below the age of 18 to undertake any work that is hazardous. The Contractor should undertake surveillance and assurance that no children or forced labor are employed directly or, to the extent possible, by third parties related to the Project and primary suppliers when such risk may exist.
  - Recognize and respect workers organizations, as per the law, or any alternative collective labor forums constituted by workers to protect their labor rights.
  - Establish a GRM to allow employees to raise workplace concerns, which does not impede access to other judicial or administrative remedies that might be available, or substitute for grievance mechanisms provided through collective agreements.
- Ensure that all workers (including those of subcontractors and suppliers) have contracts, which clearly state the terms and conditions of their employment and their legal rights. These contracts will be aligned with Nepali labor laws and the requirements of ESS 2. Contracts will be verbally explained to all workers, where necessary, to ensure that workers understand their rights. Contracts will be in place prior to workers leaving their home location if applicable. These contracts should specifically state that project workers shall receive timely payment for their labor.
- The Contractor will develop a fair and transparent Employment and Procurement Policy and related processes to avoid any potential for nepotism or favoritism. The policy should be shared with local community members and leadership.
- The Contractor will provide employment to women who have acquired new skills (refer to GAP, Section 5.1.4 on the economic empowerment of women) such as machine operators so that women get a fair share in the employment opportunities in construction works.[114]

[114] More generally, the Project will endeavour to hire women as part of the Project implementation team (i.e., at the PIC/ administrative level).

- The Contractor will develop a Human Resources Policy and Plan to ensure that workers have access to clear and understandable information regarding their rights, as they pertain to labor and working conditions.
- UAHEL will conduct periodic health and safety audits to confirm the Construction Contractor and subcontractors are strictly implementing and enforcing the Occupational Health and Safety Plan. The Construction Contractor bid documents should include penalties for non-compliance.

Based on implementation of the proposed mitigation measures, the significance of the Project's impacts on labor and working conditions will be direct, adverse, medium in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Moderate***.

However, given the size of the labor force and nature of the work involved, the lack of health and safety culture within Nepal, and poor track record of OHS performance, as well as workers' low level of awareness of their rights, the implementation of these mitigation measures will require significant commitment and capacity on the behalf of the responsible parties (in this case, both the Project and its contracted organizations). This is particularly so because several of the measures proposed to mitigate the effect of this particular impact rely heavily on the capacity of the Project to remain rigorous and consistent in its application of the proposed mitigation measures. If the Project does not have – or develop – the capacity to implement the mitigation measures outlined above, then the residual risk would be ***Substantial***.

Operation Phase

The Project will employ approximately 130 workers during the operation phase. As discussed above, in the absence of specific policies and standards, workers would be potentially subjected to unsafe working conditions, labor abuses, unfair remuneration, and inappropriate working and living conditions.

Based on these risks, while acknowledging a much smaller operational workforce, the Project's impact on labor and working conditions during the construction phase could be direct, adverse, medium in magnitude, local in extent, short term in duration, with an overall pre-mitigation significance of ***Moderate***.

Proposed Mitigation and Residual Impact Significance

The Project Operator will prepare and implement the following operations phase management plans:

- Worker Induction Training and Code of Conduct – to provide appropriate health and safety, and environmental and cultural sensitivity training to its workers
- Worker's accommodation – Ensure that worker's accommodation complies with the requirements of IFC/EBRD Workers' Accommodation: Processes and Standards (IFC and EBRD 2009) and ILO (specifically Recommendation No.115). If relevant, provide separate facilities for women and men working at the site. Ensure safe and easily accessible facilities like toilets and childcare for women and install 24-hour proper lighting across all campsites and project sites, as per Nepal's Labor Act and the World Bank's Labor Good Practice Note.
- Occupational Health and Safety Plan – to identify key risks (e.g., electrocution), required PPE, and good safety practices
- Labor Management Plan–- to protect project workers' rights and to ensure that the Project complies with the requirements of the World Bank's Environmental and Social Framework (ESS 2 – Labor and Working Conditions)
- Human Resources Policy and Plan – to ensure that workers have access to clear and understandable information regarding their rights, as they pertain to labor and working conditions

Based on the implementation of the proposed mitigation measures, the significance of the Project's impacts on labor and working conditions during the operation phase will be direct, adverse, low in magnitude, local in extent, and short term in duration, with an overall residual significance of ***Low***.

7.5.14 Employment Creation, Skills Enhancement and Local Business Opportunities

The Project is expected to generate positive impacts on the local economy and livelihoods in terms of 1) employment and skills enhancement; and 2) local business opportunities through the procurement of goods and services. The following sections address these opportunities and their impact on the Project.

Construction Phase

Most of the direct economic and employment impacts from the Project will occur during the construction phase. It is during this period that the Project will need to hire the most workers and purchase goods and services. The workforce can be divided into two segments: 1) people directly employed by Contractors and sub-contractors needed to build the Project, and 2) people indirectly supplying goods and services needed to support the construction process, including food and transport services and support staff at workers' camps. In FGDs and KIIs, local stakeholders expressed that, as recipients of most of the impacts of the Project, they expect employment opportunities, as well as for goods, services, and supplies to be locally procured.

- **Impact on local businesses**: While the Project anticipated being able to control most of the population influx, there will nevertheless be an increase in population in the area. This increase could provide opportunities for some local shops and businesses to increase their income. Some of them could have opportunity to build houses to meet the demand for rental accommodation resulting from in-migration to the DIA; however, given the limited amount of land and extra space in existing houses, this could lead to unsanitary and overcrowded conditions in the DIA if not well-managed. Moreover, extant levels of poverty in the DIA[115] could act as a constraint on the ability of the local population to mobilize additional capital required to establish petty business to serve the increased demand by the Project. Hence, some local people may not be able to compete with traders arriving from outside the project impact area and may ultimately end up disadvantaged as a result. This is particularly the case for non-aadibasi/janajati households in the DIA, which are socioeconomically disadvantaged (see Section 7.4 on Vulnerable People). Finally, households that own land along the Koshi Highway corridor may benefit from opportunities to lease/sell their land to in-migrants looking to take advantage of the direct and indirect employment opportunities associated with the Project. However, if not well-managed, this may result in landlessness among vulnerable populations who sell their land to cover immediate expenses, with no alternative source of sustainable income.
- **Direct employment during constructio**n: The construction workforce will reach approximately 4,500 workers at peak levels, and will consist of skilled, semi-skilled, and unskilled personnel. Employment levels of local Nepali's will vary across the skill levels, but, overall, are expected to be approximately 30% of the project workforce (see Chapter 3, Project Description). However, it is expected that skilled work may include a higher percentage of non-Nepali staff where specific skill sets are required. The duration of employment for the construction workforce will vary, depending on the project component and the ability of workers to work on subsequent components. It is important to note that expectations for employment for the duration of the construction phase and perceptions of preference being given to workers from different areas of Nepal, or even other countries, are two sources of conflict that may arise from the employment generation.
- **Indirect employment during construction:** Local employment will be generated as in-migration and the presence of workers will increase the demand for various goods and services. This will provide income indirectly, to people supplying goods and services needed to support the construction process, including food and transport services and support staff at workers' camps.

[115] As demonstrated in the Social Baseline (Section 6.3), 19% of PAHs are below Nepal's poverty line (0.5 USD/day/person) and 60% are below the internationally defined poverty line (1.9 USD/day/person).

- **Local procurement:** The percentage of supplies that will be procured within the project-affected wards is unknown, but will likely be low and focused on the provision of food for workers' camps. However, it is not uncommon for such goods to be procured from national companies. The total amount of job creation associated with national level procurement is expected to be moderate.
- **Skills upgrade during construction:** During construction, sub-contractors and workers will have the opportunity to receive on-the-job training and enhance their construction skills, which should assist individuals and organizations to find work on other construction projects in Nepal.[116] Those who have worked on the Project will, therefore, have an advantage when seeking alternative jobs on similar projects due to the experience and any training received through this Project. However, opportunities for women to take advantage of economic opportunities will require specific support (see Section 7.3.9). Physically and/or economically displaced households will also be eligible for participation in a range of livelihoods training programs, the benefits of which will go beyond the end of the construction phase (see Section 7.3.2 and the RAP).
- **Taxes and royalties during construction:** The Project will be required to pay several permitting fees and taxes during the construction phase. Most of the benefits from taxes and fees are expected to accrue at the national level. The impacts of royalties, taxes and profit sharing are by definition a positive impact on net economic contribution; however, these revenues are paid nationally and, therefore, the way that the money is allocated to areas that are directly impacted is outside of the control of the Project.

Demobilization of Workforce Following End of Construction

Towards the end of the construction phase, there will be a downscaling of the workforce and labor contracts will come to an end. The migrant workforce will leave the area in search of new opportunities (and also as a requirement following the end of their work contract). For locals employed by the Project, there will be a sudden reduction in wage labor, meaning that individuals and households in the project DIA that have relied on wages from the Project will lose this source of income. A limited number of individuals may be able to secure employment during the operation phase, but for the majority, this will not be the case and there will be a need for employees to find alternative livelihoods in the area or move to a different area in search of economic opportunities. However, those that have worked on the Project will have a significant advantage when securing other jobs on similar projects due to the experience and training received. The reduced number of community members earning a wage will result in reduced expenditure within the DIA. This will have negative implications for small businesses which have been established in the area to service the workforce (as described above).

Positive impacts will be primarily associated with the construction phase and, therefore, temporary in nature. While demobilization of the workforce will most likely take place over the course of six months, the impacts of the out-migration of the construction workforce and loss of income are likely to be felt over a more extended period. However, there will be residual benefits arising from a more highly-trained workforce and better road connectivity, as well as other development and education impacts provided for through the various development plans such as the Indigenous Peoples Plan and the Gender Action Plan.[117] Therefore, the impact significance during the construction phase would be largely positive.

Enhancement/Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

Enhancement Measures for Employment Creation, Skills Enhancement, and Local Business Opportunities

- The objective of enhancement is to optimize opportunities for the employment of local people, wherever possible, or alternatively that Nepali citizens are prioritized for employment over

[116] It is important to note that a formal Nepal-based apprenticeship program is not accessible to local workers.

[117] As mentioned above, a formal Nepal-based apprenticeship program is not accessible to local workers.

foreigners. In order to enhance this positive impact, the following measures are recommended (many of these are covered in the Influx Management Plan):

- Indicate in the Construction Contractor bid documents that local hiring (i.e., Sankhuwasabha District and especially Bhotkhola and Makalu rural municipalities), and the hiring of women and other marginalized/traditionally excluded groups, is strongly encouraged and request bidders to submit a hiring plan indicating how they will meet these hiring objectives.
- Notify identified representatives (i.e., ward chairs) of the specific jobs and skills required for the Project, prior to the commencement of construction phase. This should give the local population time to prepare and apply for available job opportunities in time. This is mainly applicable to unskilled and semi-skilled workers who will be locally sourced.
- Provide training for local residents to help qualify them for employment by the Project and/or procurement opportunities for providing services, materials, or supplies. This will include business training, financial training, training on specific skills and labor requirements.
- Include requirements for the recruitment of women and other vulnerable groups (see discussion in Section 7.4) to ensure equal opportunities. Recruitment for women in particular should be for a wide range of job types, including machine operators and Project staff.
- Limit local hiring at Gola recruitment center to only local residents (e.g., Bhotkhola and Makalu Rural Municipalities) who can prove their local residency, to discourage the influx of job-seekers.

- Provide training and incentives to encourage the participation of local companies and individuals in bidding to provide services and materials.
- Coordinate with the UAHEP Intergovernmental Coordination Committee to find ways to ensure that all affected villages receive equal access to opportunities in terms of local recruitment, training, small business development, procurement, and community outreach programs.
- Develop and implement a program of up-skilling, training, and development for workers to assist them in accessing opportunities associated with the Project and in finding work following completion of their contracts.

Mitigation Measures for Demobilization of Workforce

- Develop and implement a program of on-the-job training and development for workers, which will help them in finding work following completion of their contracts.
- Encourage and invest in alternative livelihoods development (in collaboration with relevant partners) to reduce the reliance of the local population on employment and economic opportunities linked to the Project. This will include LRP provided to the Project's physically and/or economically displaced population (see RAP), as well as investment in the area through the Indigenous Peoples Plan and the Gender Action Plan.
- Develop a retrenchment process for implementation related to completion of the construction phase. This will include substantial timely stakeholder engagement efforts to discuss the process with local workers prior to construction demobilization.

Based on the analysis provided above, the Project's impacts on employment, procurement, and the economy during the construction phase will be direct and ***Positive***. The magnitude of this positive impact will vary depending on the level of employment and procurement that can be achieved. However, the Project remains cognizant that following the end of the construction phase demobilization of workers will have a depressing effect on this positive impact for some stakeholders.

Operation Phase

Like in the construction phase, local workers are expected to be qualified to fill unskilled and semi-skilled positions at first, while a limited number of people may be sufficiently qualified for skilled positions. Workers for semi-skilled and skilled positions will initially be recruited from elsewhere in the region and throughout Nepal, as necessary. Over time, however, local workers will be able to fill more of the semi-skilled and skilled positions, as on-the-job training will be provided by the Project to the local workforce, which will improve skills levels relevant to the Project.[118] Women's access to these opportunities may, however, be limited without intervention (see Section 7.3.9).

During the operation phase, the contracts that were in place during the construction phase will be terminated and procurement opportunities will be centered around maintenance activities and providing goods and services to the Project. For those companies that meet eligibility criteria, become approved suppliers, and enter the supply chain, there may be long-lasting and sustained benefits to businesses and their employees through increased experience, capacity, and training. As such, during the operation phase there will be opportunity for local business growth and development. Further, it is anticipated that the Project itself will bring about economic benefits associated with increased connectivity between project-affected villages and other population centers, such as Khandbari and Biratnagar.

Opportunities may exist in the tourism sector, as road conditions surrounding the DIA will have improved as a result of the Project and there would be better public transportation services available. Therefore, some of the infrastructure created to accommodate influx and migrant populations can be used for tourism purposes. Women often take an active role in running homestays and local shops. Hence, women will benefit from the increase in tourism (see Section 7.4 on Vulnerable People).

Based on the analysis provided above, the Project's impacts on employment, procurement and the economy during the operation phase could be direct and ***Positive***.

Enhancement/Proposed Mitigation and Residual Impact Significance

The mitigation/enhancement measures provided for the construction phase will also apply to the operation phase. However, during the operation phase specifically, the Project will support the following additional activities to enhance beneficial impacts on cultural heritage through a Local Tourism Promotion Plan (LTPP) (see also Section 7.3.15 below). UAHEL will hire a qualified consultant to prepare the LTPP concurrent with the initiation of access road construction. The LTPP will include the following:

- Identify natural and cultural sites that can be restored/enhanced for tourism purposes. The restoration of dilapidated cultural sites would involve an experienced cultural heritage conservation agency. The conservation agency will train local masons and artisans/craftsmen in conservation techniques to transfer the know-how.
- Improve the connectivity and infrastructure for devotees at existing sacred places, such as Jalpa Devi Temple in Tungkhalin and other devithans in Namase/Hema and Hatiya, by UAHEL providing financial assistance and construction materials to committees taking care of these cultural sites.
- Promote cultural tourism in coordination with the Ethnographic Museum and Culture Centre by holding cultural performances. The center will provide opportunities for experiential activities for tourists, like traditional food making and cultural performances. It will also provide documentation and support for the prevention of intangible cultural heritage practices, including those related to ecosystem services (see Sections 7.3.4 and 7.3.15).

Prepare and implement a plan to conserve and enhance the cultural heritage of the Barun Bazar.

Based on the analysis provided above, the Project's impacts on employment, procurement and the economy during the operation phase will be direct and ***Positive***.

7.5.15 Cultural Heritage

This section presents the Project's potential impacts on cultural heritage. Cultural heritage and archaeological resources include all tangible heritage as listed in Nepal's Ancient Monument Preservation Act, 2013 (1956 AD) and as defined under WB ESS 8. These include:

[118] As mentioned above, a formal Nepal-based apprenticeship program is not accessible to local workers.

- Monuments
- Structures having archaeological, paleontological, historical, architectural, or religious significance
- Works of art
- Natural sites or natural features (including trees and plants) with cultural value
- Graves and burial grounds
- Archaeological and paleontological finds (scattered or in their original context)

Accordingly, cultural heritage includes shrines, stupas, temples, other places of worship, *chautaris* (rest area/community meet spot), as well as trees, stones, waterfalls, and other natural features associated with indigenous community spiritual beliefs, and intangible cultural heritage, which includes traditional practices, representations, expressions, knowledge, and skills that are recognized locally as part their cultural heritage. The Project will not impact on any UNESCO World Heritage Sites.

Avoidance and Minimization Measures

The Project has adopted the following measure to avoid or reduce impacts on cultural heritage, in accordance with the application of the mitigation hierarchy:

The location of several project ancillary facilities (e.g., quarry, contractor's camps, crusher, spoil disposal areas) has been sited or shifted to avoid or reduce impacts on tangible cultural heritage sites.

Construction Phase

The cultural heritage baseline study did not identify any protected monument or archaeological site within the project footprint area. The absence of any protected archaeological sites or historical monument was also confirmed during consultation with Department of Archaeology in Kathmandu. However, the Project will have impacts on tangible (including natural heritage sites) and intangible cultural heritage resources of importance to multiple local indigenous peoples groups, and in the case of the Barun Dovan, to a much wider group of various faith communities.

The assessment of project impacts on cultural heritage is discussed below in terms of tangible cultural heritage and intangible cultural heritage, which also includes natural heritage sites.

Impact on Tangible Cultural Heritage Sites and their Users

Project construction will result in the following impacts on tangible cultural heritage sites:

- Displacement of privately-owned cultural sites – private land on which seven cultural sites are located will be acquired by the Project (see RAP and Chapter 6.3, Social Baseline for details):
  - Two stupas/gumba located in Sibrun
  - One devithan located in Namase
  - Two chautari, one located in Hema and one in Sibrun
  - Two manes, one located in Hema and one in Rukma
- Access to burial sites – Each ethnic group in the villages within the DIA of the Project has burial sites (graveyards), mostly at mountain peaks or cremation grounds (locally referred as *Chihan Danda*), which are located along riverbanks. Most of these sites are away from the construction area. However, access to some sites is likely to be impacted due to construction activities.

The construction work will include ground clearance and earth moving/excavation work at several locations. There is a chance of finding currently unknown materials with cultural heritage significance, including grave sites, skeletal remains, archaeological artefacts, and paleontological finds.

The Project's impacts on tangible cultural heritage during the construction phase could be direct, adverse, high in magnitude, local in extent, and short term in duration, with an overall pre-mitigation significance of ***Substantial***.

Impacts on Intangible Cultural Heritage and its Users

While the Project anticipates being able to control much of the population influx that typically accompanies large infrastructure projects, the in-migration of workers and changes in socioeconomic and consumption patterns in the DIA will nevertheless have implications for cultural heritage. The impacts of the Project on different facets of the intangible culture include the following:

- The in-migrant population will be from different parts of Nepal as well as from other countries. The local community shops, hotels, and homestays will interact with this in-migrant population, who will speak different languages. The community workers will also work alongside the in-migrant workforce and will need to communicate in a language other than their own language. These exposures will impact on their native language skills.
- The Bhote have *Phalo* and Rais have oral traditions called *Mindums*, which are transmitted from one generation to another. The transmission of these rich source of knowledge on customary practices, mythologies, and worldviews require a culture that values oral traditions. As aadibasi/janajati communities come under the influence of external cultures, the cultural significance of these rituals may dwindle. As new generations show little interest in such ritual performances, these oral traditions may remain restricted to elderly practitioners and ultimately could be lost. There are only a few elderly practitioners who possess this information and rapid socio-cultural changes introduced by the Project may expedite the extinction of these oral traditions.
- The project impact area is multi-ethnic and they celebrate a range of local festivals. Some of these festivals are linked to religious beliefs and others are linked to the seasonal cycles of their occupation. For example, Ubhauli and Udhauli celebrations and rituals are linked to the harvest of crops and the seasonal migration of Bhote. As the local community may accept un-skilled wage work for several years, the subsistence farming and migration cycles will be disturbed. The significance of the associated rituals is expected to lose relevance and their cultural significance will be lost.
- The aadibasi/janajati communities will be exposed to an in-migrant population, who will have different dietary habits. Food items from other regions, which were previously not available locally, could become available in local markets. Processed and packaged foods may become preferred by young people and the frequency of cooking of traditional recipes could decrease. As the knowledge of using local edible foods and cooking recipes recedes in cultural memory, there is the risk that they will be forgotten and lost.[119]
- The knowledge of weaving, basket making, and manufacturing household articles from local raw materials, which is currently a common skill in the project area, may be lost by the new generation, as they accept more formal employment with the Project and have less leisure time available for traditional crafts. Local handicraft items may lose the patronage of the local people, as they aspire to adopt modern articles, which may be available at a lesser price. The Kami/Bishowkarma households provide important support to farmers by preparing and repairing their farm equipment. The potential availability of farm equipment at a cheaper price in local markets may impact the on continuation of their traditional craftsmanship.
- Certain traditional songs and dances are performed on occasions and are linked to the traditional lifestyle. Due to change in lifestyle, as well as exposure to popular art forms through electronic media, these traditional performances may face strong competition.

[119] As noted in Section 7.3.6.2, there are also health implications to the introduction and wide-spread adoption of packaged foods within communities.

- Traditional know-how on the identification, collection and use of herbs and forest resources is handed down from one generation to another through practice. As the new generation receives a modern education and parents have less time to continue these activities, as they become occupied with new income opportunities provided by the Project, there is the potential threat of disruption in transmission of this customary know-how.
- The subsistence life-style involves close communal relationships, which are based on reciprocity. As part of the cultural obligation, members exchange of labor, equipment, and products. They help each other in difficult times. With the increased availability of cash, this socioeconomic interdependence may be reduced, thereby decreasing community cohesion.
- People's loss of land and disruption of their agricultural activities, even when compensated, could result in a significant shift away from known activities and alter their sense of identity (see Section 7.3.2 on Land Acquisition). Further, although the Project will be able to control population influx through measures described in Section 7.3.3, there will still be a significant increase in the number of people living in the Direct and Indirect Impact Areas. The elderly people in the area are likely to view the changes in a negative light (changing "the way things used to be") compared to the youth and middle-aged, who are likely to focus on the employment and other opportunities that the Project will bring.

The aadibasi/janajati in the DIA attach cultural significance to various natural features, including rivers, springs, and mountains, in general, but there are a few specific sites that have cultural significance to local people, as cultural rites are performed at these sites and there is strong cultural attachment. Some of these sites are in close proximity to the construction sites. These sites include the following:

- Arun River: This has cultural and spiritual importance to several ethnic groups. The Bhote people practice a Khola Puja (worship of the river) ritual along the Arun River with the objective of achieving *sharp bahani* (washing away curses, misfortune, and inauspicious elements of life). The Bhote also practice the ritual of Panchabali, which involves the sacrifice of live animals along the banks of the Arun River, as an offering to the gods.
- Arun-Barun Dovan (confluence): This site is located at the confluence of Arun and Barun River (see Chapter 6.3, Social Baseline, for additional details) and hosts religious rites and an annual fair. There are two religious sites, one Buddhist Gumba and one Hindu Shiv temple close to the confluence of these two rivers. The natural landscape around the confluence, along with these cultural sites, forms a cultural complex. Fugitive dust, noise and visual impacts from construction activities, especially for Spoil Disposal Area #4, will impact on the psychological and spiritual experiences of its users. Population influx will also likely encroach on the traditional use of this cultural space.
- Chepuwa and Bhembhema waterfalls: These waterfalls are located near the project dam site on streams joining Arun River. The construction activities will change the landscape and visual setting of these sites and may temporarily limit access for its users.

Based on the analysis provided above, the Project's impacts on intangible cultural heritage during the construction phase could be direct, adverse, high in magnitude, local in extent, and long term in duration, with an overall pre-mitigation significance of ***High***.

Proposed Mitigation and Residual Impact Significance

The Project will implement the following mitigation measures:

- Implement a Cultural Heritage Management Plan that ensures that the Contractor:
  - Relocates affected cultural heritage sites only after the local community or their custodians are consulted, an acceptable alternative location is agreed upon, a forgiveness ritual is performed, and the site is physically moved in a culturally acceptable and agreed upon manner.

- Engage a suitable organization with experience in heritage conservation to carry out following heritage conservation activities, which will be identified in consultation with the Ministry of Cultural, Tourism, and Civil Aviation:
  - Proactively protect and conserve cultural heritage structures in the vicinity of construction sites from the impact of vibration and dust.
  - Ensure that the movable cultural artefacts inside these cultural heritage sites are removed to a safer location (Ethnographic Museum and Culture Centre).
- Build alternative access to natural heritage sites during the construction phase.
- Avoid the disruption of festivals, community rituals, and gatherings, in consultation with communities, including the temporarily halting the disposal of spoil in the Spoil Disposal Areas #2, #3 and #4 across the river from Barun Bazar during the Barun Mela.
- Prepare and implement a plan to conserve and enhance the cultural heritage of Barun Bazar, as part of the Local Tourism Promotion Plan;
- Conduct regular consultations with the local communities to notify them of construction work.
- Maintain an updated central list of tangible cultural heritage sites and artefacts around the project impact area for the avoidance of heavy transport (to mitigate potential vibration damage).
- Ensure that access to cultural sites by their users is not restricted during construction activity.
- Formulate a '**Chance Finds Procedure**' as part of the ESMP, taking into consideration applicable Nepali legislation and good international industry practices, based on the World Bank's ESF (ESS-8); the 1972 UNESCO Convention on the Protection of World Cultural and Natural Heritage to which Nepal is a signatory; and the International Council on Monuments and Sites' (ICOMOS') Guideline on Heritage Impact Assessment. Ensure all relevant workers are trained in this procedure.
- Establish an effective GRM to ensure that any concerns regarding impacts on cultural heritage resources are addressed to immediately.

■ Protect intangible cultural heritage from the risk of "cultural fading" due to exposure to other cultures introduced by the Project by doing the following:

- Establish an Ethnographic Museum and Culture Centre (EMCC) at a location in consultation with local communities and undertaking other activities outlined in the Local Tourism Promotion Plan described in Section 7.3.14.
- Establish a Handicraft and Local Produce Market (HLPM) to foster the continuation of practices such as basket weaving and customary know-how such as the use of herbs and NTFP.
- Provide financial support for the publication of books in local/aadibasi/janajati languages maintain traditional languages and oral tradition.
- Support the setting up a community radio center to maintain traditional songs and dances.
- Promote a Lama Education System, including shamanistic/faith healing traditions, by providing assistance to Lamas and other traditional practitioners to record those ritual practices and obtain intellectual property rights where appropriate.
- Organize training and awareness programs for Contractors and their employees on local cultural sensitivities and ensuring implementation of the Workers' Code of Conduct.

■ Implement a Blasting and Explosives Management Plan (see Appendix C, ESMP) that requires Contractors to take necessary precautions to prevent damage to special features in the surroundings (e.g., ecological, historical, or culturally important areas) and the general environment.

- Implement mitigation measures outlined in Section 7.1.12 (Landscape Values and Visual Amenity) and also:
  - Pursue a proactive Stakeholder Engagement Program that is built on transparency, mutual trust and inclusiveness in terms of its construction and community-based development initiatives. This involvement will empower communities to identify and address issues of concern to them and will facilitate solutions to some of the manageable changes resulting from the Project.
  - Where significant changes to wellbeing are identified (particularly among the most vulnerable groups), explore partnerships with local health services to attempt to address such changes (e.g., by support additional social welfare/social worker positions in the area to assist people struggling with the transition).

These measures will reduce the risk of impacts on known tangible cultural heritage resources to a medium magnitude. Therefore, the Project's impacts on tangible cultural heritage during the construction phase will be direct, adverse, medium in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Moderate***. The Project's impacts on intangible cultural heritage during construction will be direct, adverse, high in magnitude, site specific in extent, long term in duration, with an overall residual significance of ***Substantial***.

Operation Phase

During the operation phase, no new construction will occur and, therefore, no new impacts on cultural heritage are anticipated. While some of the in-migrant population will remain (see Section 7.3.3), the majority will leave in search of new economic opportunities, therefore, there will also be little new population-related impacts on cultural heritage. While there will be some ongoing impacts in terms of the proximity of some project structures to cultural heritage sites (specifically the dam will be a modern structure that will be a permanent addition to the local landscape), other project components such as the spoil dump sites and camp locations – in addition to improved road access – can provide infrastructure to foster the growth of a new tourism industry (see Section 7.3.14).

Therefore, the Project's impacts on tangible cultural heritage during the operation phase will be direct, adverse, low in magnitude, site specific in extent, long term in duration, with an overall pre-mitigation significance of ***Low***. No specific mitigation measures have been identified, so the residual significance remains ***Low.***

The Project's impacts on intangible cultural heritage during the operation phase will be direct, adverse, high in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Substantial***.

The Project will implement the following mitigation measures during operations:

- Ensure that Spoil Disposal Areas #2, 3, and 4 are restored and the vegetation maintained to minimize visual impacts on Barun Bazar.
- Although unlikely because the Barun Mela occurs in January during the dry season, take special precautions with project operations and ensure that visitors to the Mela are informed about potential changes in flow below the dam and below the powerhouse.

With these mitigation measures, the Project's impacts on intangible cultural heritage during the operation phase will remain direct, adverse, high in magnitude, site-specific in extent, long term in duration, with an overall residual significance of ***Substantial***.

7.5.16 Summary of Social Impacts

Table 7.42 provides a summary of the pre-mitigation and post-mitigation (residual) impact significance for both construction and operation phases as described above.

Table 7.42: Summary of Project Construction and Operation Phase Impact Significance (Social Environment)

Impact	Pre-mitigation Significance	Post-mitigation/Residual Significance
Construction Phase		
Land acquisition and physical/economic displacement	High	Substantial
Project-induced in-migration and population influx	High	Moderate
Effects on ecosystem services	Substantial	Moderate
Impacts on downstream water users and uses	Low	Low
Transmission of food/water borne diseases	Substantial	Moderate
Transmission of sexually transmitted diseases	Substantial	Moderate
Impacts on health infrastructure	Substantial	Low
SEA/SH, gender-based violence, and TIP	High	Substantial
Nuisance impacts (e.g., noise, dust, vibration)	Substantial	Moderate
Natural disasters	High	Substantial
Traffic accidents	High	Substantial
Landslides	High	Substantial
Dam failure	High	Moderate
Use of security personnel	Substantial	Moderate
Labor and working conditions	High	Substantial
Employment creation, skills enhancement, and local business opportunities	Positive	Positive
Tangible cultural heritage	Substantial	Moderate
Intangible cultural heritage	High	Substantial
Operation Phase		
Physical and economic displacement	Moderate	Moderate
Project-induced in-migration and population influx	Moderate	Moderate
Effects on ecosystem provisioning services	Moderate	Moderate
Impacts on downstream water users and uses	High	Moderate
Transmission of food/water borne diseases	Low	Low
Transmission of sexually transmitted diseases	Moderate	Moderate
Impacts on health infrastructure	Low	Low
SEA/SH, gender-based violence, and TIP	Substantial	Low
Nuisance impacts (e.g., noise, dust, vibration)	Low	Low
Natural disasters	High	Substantial
Traffic accidents	High	Substantial

Impact	Pre-mitigation Significance	Post-mitigation/Residual Significance
Landslides	High	Substantial
Dam failure	High	Moderate
Emergencies and public safety	High	Moderate
Use of security personnel	Low	Low
Labor and working conditions	Moderate	Low
Employment creation, skills enhancement, and local business opportunities	Positive	Positive
Tangible cultural heritage	Low	Low
Intangible cultural heritage	Substantial	Substantial

7.6 Effects on Vulnerable People

Section 7.3 presented this ESIA's assessment of pre-mitigation and residual impact significance for all social risks associated with the Project, in accordance with the impact significance methodology outlined in Chapter 5. However, as outlined at the outset of that discussion, the evaluative matrix employed in this document is based on the *overall effect* of particular impacts on the communities in the project DIA. Thus, in instances where there is a small sub-group of the population for whom a given project risk is particularly high, it is possible that the impact significance on that specific sub-group does not align with (and is not accurately represented by) that of the *overall* population.

Recognizing that the impacts described in this chapter will affect different segments of the population differently, with some segments being more vulnerable than others to particular impacts, the following discussion addresses some of the ways in which vulnerable people can be differentially impacted. This discussion should be considered alongside information presented in the RAP pertaining to vulnerability among PAHs that are subject to physical and economic displacement, as well as the Social Baseline (Chapter 6.3), which collectively offer details pertaining to the nature and extent of vulnerability in the DIA.

7.6.1 Land and Ecosystem Services

One of the most important forms of vulnerability in the DIA relates to land and landlessness. Permanent displacement can result in landlessness, loss of income and livelihoods, reduced food and fodder security, poor health and increased morbidity, reduced social and economic resilience of households (to withstand shocks like natural and other adverse events), and increased marginalization. For both physical and economic displacement, the more vulnerable groups and households may be more significantly impacted by economic displacement, given their already reduced ability to withstand shocks like the loss of land and assets, or loss of access to land and community resources, upon which they are wholly dependent. The most vulnerable in this regard are female-headed households, those renting land, the elderly, and those without land rights and/or who only own small parcels (such as Dalits and other non-aadibasi/janajati households – see Chapter 6.3, Social Baseline). With population influx comes increased pressure on lands and, again, here it is poor and indebted households that will be lured to sell their land to outsiders, and such alienation of land to outsiders will have a long-term impact on the communities, as well as the newly-landless households. Moreover, those who rely on ecosystem services for their livelihood will be most vulnerable to impacts on these services. This includes, but is not limited to, women, who are often in charge of collecting NTFPs, fodder, and firewood for the household, and who will be disproportionately disadvantaged by the destruction of or restricted access to the ecosystems that provide such services.

7.6.2 Disease Transmission

The population in general is vulnerable to increased risk of transmission of communicable and vector borne diseases. In the case of outbreaks or increased transmission, access to health care facilities and treatment is limited. Particularly vulnerable groups, who are especially at risk of diarrheal diseases, include children, due to their poorer hygiene and sanitation practices, and the elderly, who are more at risk due to their age. In addition, local workers have the highest risk of being exposed to communicable diseases associated with the presence of the non-local workforce. For sexually transmitted diseases, particularly vulnerable groups include younger women, who are greatest risk of engaging in commercial or transactional sex.

7.6.3 Personal Security Risks

Communities in the DIA are considered to have a moderate level of vulnerability to potential negative interactions with security personnel or injuries as a result of site trespass. Youth (particularly young men) are most vulnerable to such negative interactions, as evidence suggests they are most likely to protest or trespass onto construction sites. This is because youth often feel underrepresented in leadership structures and have the highest expectations of employment and project benefits.

7.6.4 Labor Conditions and Work Opportunities

In general, people are considered to have a medium level of vulnerability to poor labor and working conditions, and in relation to access to work opportunities, as they may not understand their labor rights under the law or may be willing to waive these rights to earn cash income. In addition, unskilled and semi-skilled workers are less likely to be familiar with international best practice around occupational health and safety (OHS) standards, or understand the importance of such standards, putting them at greater risk of being involved in accidents or being injured in accidents. Women are particularly vulnerable, as they are more likely to be discriminated against during recruitment and, once recruited, may not be provided with the same working conditions as men. Migrant workers are also at increased risk of poor labor and working conditions, particularly in relation to accommodation, rest periods, and payment terms.

Communities have a high level of vulnerability, as many people in the communities in the DIA lack the qualifications, skills, and formal work experience to benefit from employment opportunities associated with the Project. This limits people in terms of their ability to take on even unskilled work depending on recruitment criteria (language, years of experience and ability to provide references). Further, formal contracts that require workers to show up to work daily may impact on workers abilities to continue with their subsistence livelihood activities or place additional pressure on other household members (most often women and female children) to do this work.

Those who will be least able to take advantage of employment opportunities include the elderly and physically disabled, who may be less able to carry out construction tasks (or tasks that support construction activities), and women (including those in female-headed households), for whom it may not be culturally acceptable or feasible (given the requirements to attend to primary care duties) to pursue formal employment or who may stay at home to continue subsistence livelihoods, as culturally it is the role of men to earn cash income. Groups in the area with lower incomes and higher rates of landlessness, such as non-aadibasi/janajati groups (see Chapter 6.3, Social Baseline) are even more disadvantaged in terms of their ability to compete with local businesses and in-migrants seeking to offer support services to the project workforce. They will also be less able to compete with increased prices for land, rent, and local goods and services, as a result of project-induced in-migration (see Section 7.3.3).

7.6.5 Reduced Community Cohesion

Certain groups are more likely to rely on support from their community to maintain their livelihood and any quality of life. These include:

- Dalit families
- Single person households composed of widowed or elderly women
- People with disabilities or incapacitating chronic diseases
- Single mothers/female-headed households, who are burdened by domestic workloads
- Women in general, as they typically have little or no education

As such, any activities that disrupt social cohesion or cause conflict may disproportionally affect these groups, as it may result in a reduction in or loss of support. Elderly people in the area are likely to view changes in culture and consumption habits in a negative light.

7.6.6 Emergencies

Project-related emergencies could result in damage or loss of homes and other assets, and injuries or fatalities. Vulnerable people have fewer resources and savings available to them to help them manage through an emergency, or until relief can be provided. They also have less capacity to respond to a serious injury or the death of a family member.

7.6.7 GBV, TIP, and Forced Labor

The poorest segments of the population – particularly women – are most at-risk of impacts relating to TIP, as population influx can drive TIP, while economic desperation and perceived lack of economic alternatives for women and girls means that they are more like to be victims.

Women and young girls in the area are particularly vulnerable to STDs/STIs due to their limited education, limited ability to negotiate safe sex practices for cultural and religious reasons, and the higher risk that women have of contracting STDs/STIs through unprotected sexual intercourse compared to men. The increased demand for prostitution in the DIA can contribute to increased risk of TIP for participation in the commercial sex trade, which disproportionately affects women and minors. Women can also be victims of forced marriage or sexual assault, the risk of which increases with a large population of mostly male workers in-migrating to the area. Young girls in the area are further vulnerable due to the continued practice of early marriages due to poverty as well as culture and tradition related to the preservation of girls' sexual purity before marriage.

The migration of illiterate and poor families as construction workers is quite prevalent in the South-Asia region. This carries an inherent risk of unfair labor recruitment processes and the use of trafficked persons and forced labor practices. Foreign workers are, therefore, in more vulnerable position than local or community workers, as it relates to the risk of forced labor.

7.6.8 Cultural Heritage

The elderly people in the area are likely to view changes to culture and customary habits brought by the Project in a negative light (changing "the way things used to be"), compared to the youth and middle-aged, who are likely to focus on the employment and other opportunities that the Project will bring.

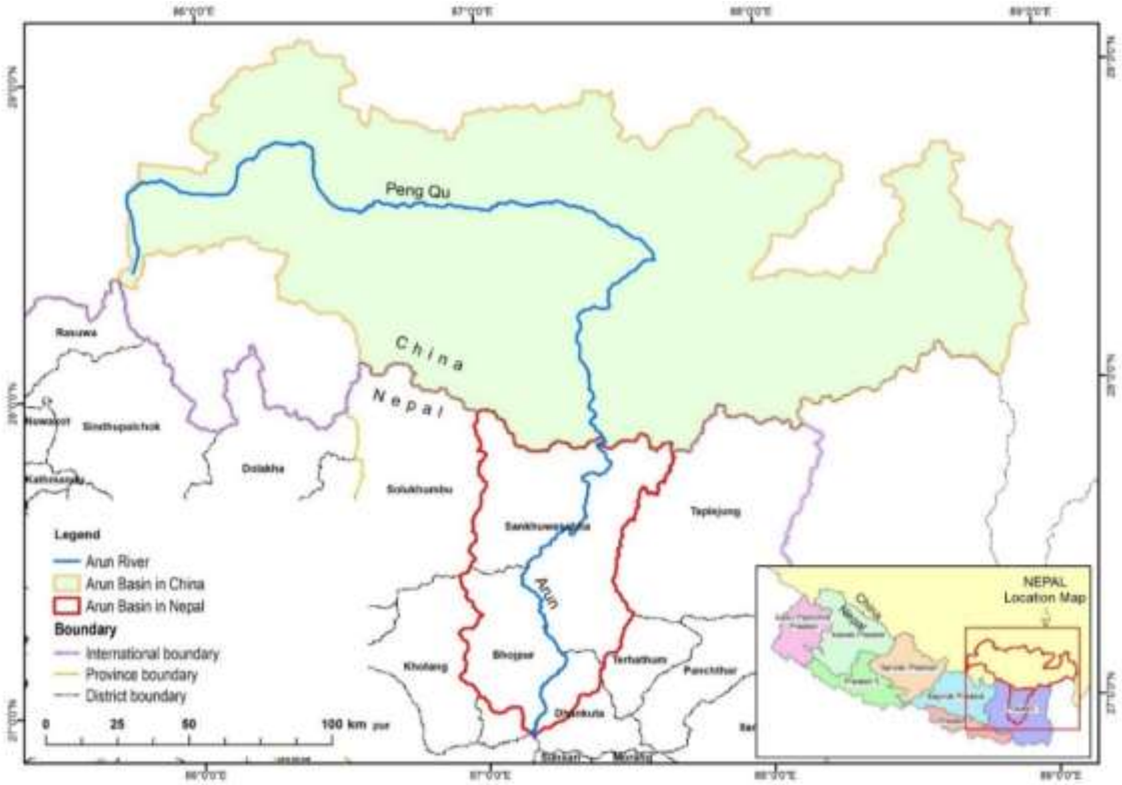
7.7 Cumulative Impact Summary

As indicated in Chapter 1, the Arun River has long been recognized as having significant hydropower potential. A Cumulative Impact Assessment (Appendix E) has been prepared for the UAHEP, which takes into consideration the entire Arun River Basin (30,041 km^2), of which 83% is located in China (***Figure 7.23***). Presently, there are five major hydropower projects in various stages of planning and development along the main stem of the Arun River (***Table 7.43*** and ***Figure 7.24***), plus another one downstream on the Sapta Koshi River, which would form an impoundment that would inundate the lower portion of the Arun River. In total, there are 37 hydropower projects proposed within the Arun River Basin in Nepal (none have been identified in the Chinese portion of the basin). Of these, there are 9 operating HEPs, 22 are under construction (i.e., obtained a construction license), 12 have applied for a construction license, and 17 have obtained a survey license, all of which total approximately 4,763 megawatt (MW). These hydropower projects also involve access roads and transmission lines. Other planned activities include road improvements, especially the Koshi Highway, which is currently under construction from Num to the Chinese border. Finally, the scope of the CIA also takes into consideration other risks such as climate change and natural disasters (e.g., GLOFs, earthquakes).

Table 7.43: Proposed Hydropower Projects Along the Arun River

Hydropower Project	Proposed Capacity	Proposed Operations	Current Status
Kimathanka	450 MW	PRoR	Survey license
Upper Arun	1040 MW	PRoR	Survey license
Arun-4	473 MW	RoR	Survey license
Arun-3	900 MW	PRoR	Under construction
Lower Arun	470 MW	PRoR	Survey license

Figure 7.23: CIA Spatial Boundary – Arun River Basin

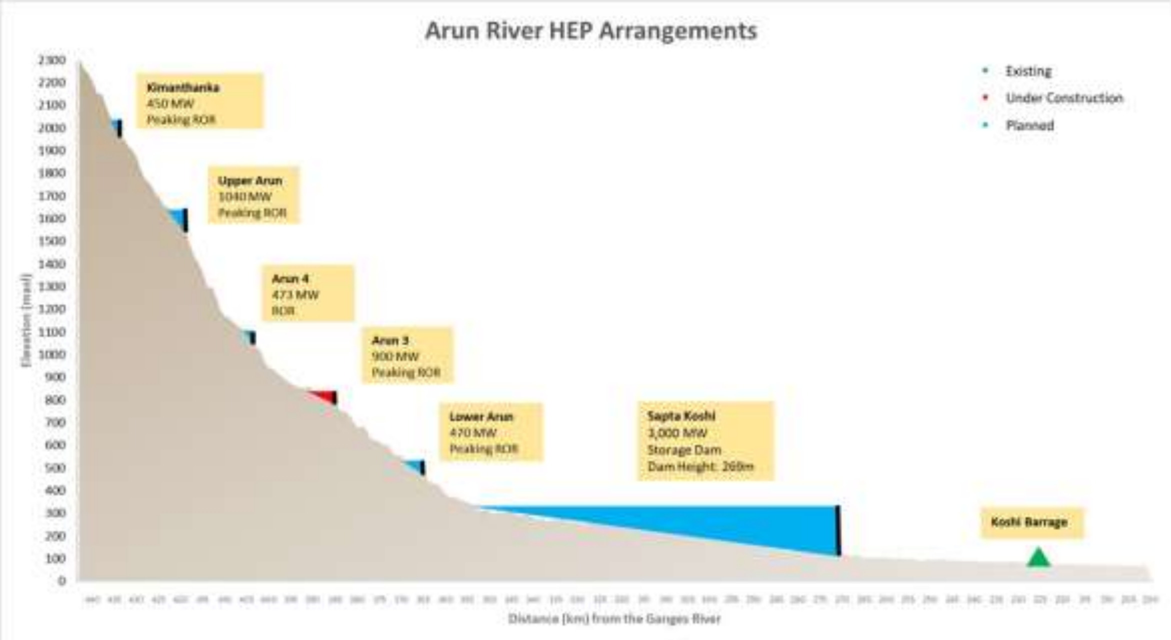


Consultations were held with key stakeholders (e.g., local residents, local representatives, ministry officials) to identify the key valued environmental, social, and ecosystem components (VECs) within the river basin. These VECs were then screened to identify those with the potential to be cumulatively affected by multiple proposed activities within the basin. Based on this analysis, the following VECs were selected:

- Natural forest integrity
- Makalu Barun National Park (MBNP)
- Water resources
- Fish and aquatic habitat
- River based livelihoods
- Settlement patterns
- Social cohesion
- CIA mitigation measures for which UAHEL will seek support from the Government of Nepal include:
- Coordinate proposed linear facilities (e.g., transmission lines, access roads) to minimize impacts on forest and agricultural land covers and the MBNP.
- Provide fish passage for golden mahseer at the Lower Arun HEP, as there is documented important spawning habitat upstream from this dam.
- Maintain naturally reproducing populations of all native fish species in each segment of the Arun River between the main stem hydropower projects. This will require an adequate EFlow in the dewatered sections and protecting key clear, water-water tributaries, which are used by some fish species for spawning, as well as adequate ramping up and down rates to allow juvenile fish to reach a safe location.

- Provide livelihood restoration for residents whose livelihoods are adversely affected by conversion of the Arun River into a series of reservoirs, diversion reaches, and modified flow reaches.
- Develop a strategic plan and provide funding to help local indigenous people (especially upstream from Num) to retain their social identity, cohesion, and heritage in response to both significant improvements in access to this area and labor influx.

Figure 7.24: Upper Arun and Koshi HEP Arrangements



7.8 Estimated Budget

The ESMP budget considers the following items:

- General mitigation measures including ES staffing, capacity building, stakeholder engagement and the GRM;
- Physical mitigation measures;
- Biological mitigation measures, including the budget for BMP implementation, and
- Social risk mitigation measures and benefits sharing, including the budget for health and safety aspects.

Detailed budget table will be agreed upon with stakeholders and presented in this document by project appraisal.

8. CONCLUSION

UAHEL is proposing to construct the UAHEP, which will include an 1,040 MW (installed capacity) hydroelectric project, a 21.6-km-long access road, and a 5.8-km-long transmission line connecting to the NEA-proposed Hitar (Arun Hub) substation. The World Bank, EIB, and possibly other lenders are considering providing financing for the construction of this Project, which in turn requires the Project to conform with the World Bank's Environmental and Social Standards and Environmental Health and Safety Guidelines, and the EIB's hydropower guidelines, requirements, and recommendations. This ESIA has been prepared to document the project's conformance with these standards and requirements.

This chapter summarizes the Project's benefits and impacts, sets out the basis for selecting the project design and consistency with applicable WB EHS Guidelines, and provides an assessment of the balancing of project benefits and impacts.

8.1 Project Benefits

The UAHEP will provide 4,549.57 GWh of clean, renewable energy to meet electricity demands in Nepal and will provide, in particular, 833.9 GWh of critically needed dry season peak hour energy, which is possible because of the Arun River's naturally high dry season flow and the Project's proposed PRoR mode of operation.

During construction, the Project will employ up to a peak of 4,500 workers over a 7-year construction period. It is estimated that Nepali workers could fill about 40% of these construction jobs. The Project will also create 130 permanent jobs during the operations phase. It is anticipated that initially 75% of the workers could be from Nepal, with this percentage increasing over time as Nepali staff gain more operational experience and can assume more responsibility. The hiring of qualified women and other marginalized/traditionally excluded groups will be encouraged. The Project will also need to purchase a wide variety of construction materials (e.g., aggregate, cement, rebar) and will require a wide range of support services (e.g., food, cleaning, vehicle rental), which will create opportunities for local businesses.

The Project will provide construction and other skills training to help local residents to take advantage of employment opportunities and provide small business support to help local businesses secure service and supply contracts.

UAHEL is also working toward achieving consent from local indigenous people for the Project through a FPIC process, which will result in the identification of other project benefit sharing actions.

8.2 Project Impacts

UAHEL has applied the concept of the mitigation hierarchy by first avoiding impacts to the extent possible, minimizing impacts where avoidance is not possible, and mitigating any remaining impacts, so all residual impacts have been reduced to the extent possible. This has involved an extensive evaluation of project alternatives and close coordination with the project engineer.

The Project has spent over two years optimizing the project design based on detailed environmental and social baseline studies and consultations with government officials, conservation organizations, civil society groups, and affected communities. This has resulted in minimization of the extent of physical displacement and the amount of forest clearing.

Tables 8.1 and ***8.2*** present each of the Project's impacts and predict the pre-mitigation and post-mitigation (residual) significance (see Chapter 7) of these impacts for the Project's construction and operation phases, respectively.

Table 8.1: Summary of Project Construction Phase Impacts and Residual Significance

Impact	Pre-mitigation Significance	Post-mitigation/ Residual Significance
Physical Impacts		
Project road construction slope failure	High	Substantial
Spoil disposal areas slope failure	High	Substantial
Transmission line slope failure	Low	Low
Natural hazards	Substantial	Moderate
Erosion and sedimentation	High	Moderate
Soil compaction and damage	Moderate	Low
Effects on Arun River flow	Low	Low
Effects of tunnelling on local springs	Substantial	Moderate
Effects of water demands	Moderate	Low
Sediment transport and deposition	Low	Low
Stormwater runoff	Substantial	Moderate
Wastewater disposal and discharge	High	Substantial
Improper solid waste disposal	High	High
Hazardous materials/waste management	Substantial	Low
Emissions from large diesel power plants	Substantial	Moderate
Emissions from aggregate crushing plant	Moderate	Low
Emissions from concrete batching plants	Substantial	Moderate
Emissions from road and non-road diesel engine	Moderate	Low
Emissions from small diesel generators	Low	Low
Fugitive dust emissions	Substantial	Moderate
Greenhouse gas emissions	Low	Low
Project transportation corridor traffic noise	Moderate	Low
Project access road construction noise	Substantial	Substantial
Hydropower facility construction noise	High	Substantial
Transmission line construction noise	Low	Low
Noise from explosives	Substantial	Moderate
Noise from helicopters	Moderate	Low
Vibration	Substantial	Moderate
Landscape values	Substantial	Substantial
Biological Impacts		
Effects on legally protected areas (MBNP)	High	Positive
Effects on internationally recognized areas of high biodiversity value	Moderate	Positive
Loss of terrestrial habitat	Substantial	Positive
Effects on critical habitat-qualifying species	High	Positive

Impact	Pre-mitigation Significance	Post-mitigation/ Residual Significance
Disturbance and/or displacement of terrestrial fauna	Substantial	Moderate
Terrestrial barriers, fragmentation and edge effects	Substantial	Moderate
Degradation of terrestrial habitat	Moderate	Low
Wildlife mortality events	High	Low
Loss and conversion of aquatic habitat in the headworks area	Moderate	Moderate
Degradation of aquatic habitat in the diversion reach	Low	Low
Degradation of aquatic habitat downstream of the powerhouse	Low	Low
Degradation of aquatic habitat in small streams	Substantial	Low
Effects on fish movement and migration	High	Substantial
Effects on ecosystem supporting services	Moderate	Low
Social Impacts		
Land acquisition and physical/economic displacement	High	Substantial
Project-induced in-migration and population influx	High	Moderate
Effects on ecosystem provisioning services	Substantial	Moderate
Impacts on downstream water users and uses	Low	Low
Transmission of food/water borne diseases	Substantial	Moderate
Transmission of sexually transmitted diseases	Substantial	Moderate
Impacts on health infrastructure	Substantial	Low
SEA/SH, gender-based violence, and trafficking in persons (TIP)	High	Substantial
Nuisance impacts (e.g., noise, dust, vibration)	Substantial	Moderate
Natural disasters	High	Substantial
Traffic accidents	High	Substantial
Landslides	High	Substantial
Dam failure	High	Moderate
Security personnel	Substantial	Moderate
Labor and working conditions	High	Substantial
Employment creation, skills enhancement, and local business opportunities	Positive	Positive
Tangible cultural heritage	Substantial	Moderate
Intangible cultural heritage	High	Substantial

Table 8.2: Summary of Project Operational Phase Impacts and Significance

Impact	Pre-mitigation Significance	Post-mitigation/ Residual Significance
Physical Environment Impacts		
Project roads slope failure	Substantial	Moderate
Project transmission tower slope failure	Moderate	Low
Reservoir slope failure	Moderate	Low
Spoil disposal area slope failure	High	Substantial
Natural hazards	Substantial	Moderate
Erosion and sedimentation	Moderate	Low
Effects on Arun River flow	High	Substantial
Effects of tunnelling on local springs	High	Moderate
Effects of water demands	Low	Low
Sediment deposition in the reservoir	High	Moderate
Sediment transport/deposition downstream of dam	High	Moderate
Stormwater runoff	High	Low
Wastewater disposal and discharge	Moderate	Low
Impact on the reservoir water quality	Low	Low
Impact on water quality in the diversion reach	Low	Low
Impact on downstream of the powerhouse water quality	Low	Low
Impact from hazardous materials	Moderate	Low
Project air emissions	Low	Low
Greenhouse gas emissions	Low	Low
Project noise emissions	Low	Low
Project vibration	Low	Low
Landscape values	High	Substantial
Biological Environment Impacts		
Effects on legally protected areas (MBNP)	High	Positive
Effects on internationally recognized areas of high biodiversity value	Moderate	Positive
Loss of terrestrial habitat	Substantial	Positive
Effects on critical habitat-qualifying species	High	Positive
Disturbance and/or displacement of terrestrial fauna	Moderate	Low
Terrestrial barriers, fragmentation and edge effects	Substantial	Moderate
Degradation of terrestrial habitat	Moderate	Low
Wildlife mortality events	Substantial	Low
Loss and conversion of aquatic habitat at headworks	Moderate	Moderate
Degradation of aquatic habitat in the diversion reach	High	Substantial
Degradation of aquatic habitat downstream of powerhouse	High	Substantial

Impact	Pre-mitigation Significance	Post-mitigation/ Residual Significance
Degradation of aquatic habitat in small streams	Low	Low
Effects on fish movement and migration	High	Substantial
Effects from fish impingement and entrainment	High	Low
Risk of gas bubble disease	Low	Low
Effects on ecosystem supporting services	Moderate	Low
Social Environment Impacts		
Land acquisition and physical/economic displacement	Moderate	Moderate
Project-induced in-migration and population influx	Moderate	Moderate
Effects on ecosystem provisioning services	Moderate	Moderate
Impacts on downstream water users and uses	High	Moderate
Transmission of food/water borne diseases	Low	Low
Transmission of sexually transmitted diseases	Moderate	Moderate
Impacts on health infrastructure	Low	Low
SEA/SH, gender-based violence, and trafficking in persons (TIP)	Substantial	Low
Nuisance impacts (e.g., noise, dust, vibration)	Low	Low
Natural disasters	High	Substantial
Traffic accidents	High	Substantial
Landslides	High	Substantial
Dam failure	High	Moderate
Emergencies and public safety	High	Moderate
Use of security personnel	Low	Low
Labor and working conditions	Moderate	Low
Employment creation, skills enhancement, and local business opportunities	Positive	Positive
Tangible cultural heritage	Low	Low
Intangible cultural heritage	Substantial	Substantial

As ***Tables 8.1*** and ***8.2*** indicate, despite these efforts to avoid, minimize, and mitigate project effects, some unavoidable environmental and social impacts remain, which are summarized below:

- Erosion and sedimentation – Given the unavoidable disturbance of steep slopes, and considering the seasonal monsoon rains, the avoidance of erosion and sedimentation impacts is impossible, but these impacts will be minimized through the implementation of a detailed Soil Erosion and Sediment Control Plan (see Appendix C, ESMP).
- Solid waste – The Project will generate large quantities of solid waste from its 4,500 person workforce. There is no suitable land for a solid waste landfill near the Project site, so the Khandbari municipal landfill will be accessed, or an alternative site, and the landfill needs to be upgraded to meet WB standards.
- Fugitive dust – Given the relatively large area of required disturbance and the long dry season in the project impact area, generation of fugitive dust is unavoidable. Even with implementation of

mitigation measures (stabilization and/or spraying of disturbed areas – see Air Quality Management Plan in Appendix C, ESMP), residual impacts during the dry season will likely remain.

- Impacts on legally protected areas and internationally recognized areas of high biodiversity value – The Project will permanently impact approximately 35.55 ha of land within the Makalu Barun National Park Buffer Zone and Important Bird Area, and result in a permanent reduction in flow in the diversion reach (except during sediment flushing events) along 16.45 km of the park's eastern boundary. The Project will not directly impact on any land within the MBNP Core Area. There remain other risks associated with the in-migration of workers and influx of others, which will put additional pressure on the park (both Core Area and Buffer Zone) and could result in an increase in illegal clearing, poaching, and collection of plants and animals.
- Impacts on terrestrial natural habitat – The Project will disturb 94.58 ha of natural habitat, including the clearing of approximately 175.1 ha of forest. The Project will also result in indirect impacts associated with worker in-migration and influx, including the potential for poaching, plant and animal collection, habitat disturbance, road kills, and the overall degradation of habitat values because of the presence of a large workforce over a 7-year period. UAHEL intends to achieve no net loss of natural habitat by re-planting cleared trees on a 1:25 basis (i.e., plant 25 saplings for each tree cleared in the MBNP Buffer Zone and 10 saplings planted for each tree cut in the Community and Government forests), in accordance with the Nepal Forest Guidelines and providing offsets (see Appendix C, ESMP, Annex C3, Biodiversity Management Plan).
- Impacts on aquatic natural habitat – The Project will result in the loss of aquatic habitat because of dam construction (1.0 ha), the conversion of riverine to lacustrine habitat (5.2 ha), and potential degradation of aquatic habitat (20.8 ha in the diversion reach and approximately 40 ha downstream from the powerhouse subject to fluctuating water levels due to seasonal peaking operation). There is the potential that the reduced flow in the diversion reach could enhance aquatic habitat and maintain the relatively low fish populations currently found in this river segment. Through the application of a ramping up and down of no more than 1 cm/minute water increase and decrease during the peaking operation juvenile and adult common snow trout can maintain a viable population in this segment of the river.
- Impacts on critical habitat – Critical habitat is present within the Project area for the Himalayan black bear, Himalayan red panda, clouded leopard, and the spotted linsang. The Project could result in direct and indirect impacts on these species, primarily through vehicle strikes and loss of habitat (primarily for the Himalayan black bear), as well as poaching. The MBNP Core Area is also identified as critical habitat. A Biodiversity Offset Strategy has been developed to achieve a net gain in biodiversity values for these four mammal species (see Appendix C, ESMP, Annex C3, Biodiversity Management Plan).
- Barrier to fish movement and migration – The project dam will prevent fish from moving or migrating upstream, but the Project is located near the upper limit for migratory fish and the fish that are present are low in abundance and do not need to migrate past the dam to complete their life cycles, as long as other suitable spawning habitat is preserved downstream from the dam. The preservation of spawning habitat in Ikhuwa Khola and Leksuwa Khola, the only major streams suitable for common snow trout spawning between Arun-3 HEP and UAHEP dams, is critical to achieving a sustainable, naturally reproducing fish population in this river segment. The Government of Nepal should take action to protect these streams from hydropower development.
- Changes in river flow – The Project will significantly reduce flow in the 16.5 km long diversion reach and cause fluctuations in flow downstream from the powerhouse as a result of the Project's peaking operations. To maintain the ecological integrity of the aquatic habitat within the diversion reach, the Project will maintain a permanent EFlow of a minimum of 5.41 m3/s, which will be topped up by the flows from the tributaries in this section of the river, and will monitor aquatic habitat downstream to make sure that peaking operations and the adopted ramping up and down rate of no more than 1 cm/minute do not result in the stranding of fish; and, if stranding is observed, then adaptive

management measures, such catch and release or a hatchery for common snow trout, local river training by gabions to provide fish swimming lanes and create pools, will be implemented (see Appendix C, ESMP, Annex C3, Biodiversity Management Plan).

- In order to achieve no net loss in the common snow trout population and to achieve the no more than 1 cm/minute increase and decrease in depth during the peaking operations the following ramping time schedule has to be adhered to (see ***Table 8.3***).

Table 8.3: Ramping Schedule

Parameter	Recommendation	Rationale
Base EFlow in dewatered reach (Jan)	> 5.41 m^3/s	Minimum swimming depth for the largest fish at all sections. Needs to be increased gradually up to monsoon.
Ramping up 1st stage (when reservoir full)	> 30 min > 30–45 min > 30 min	Human safety Adult fish entrainment in main stream Entrainment of macroinvertebrates
Ramping up 2nd stage (full demand)	> 15 min > 15–30 min	Human safety Adult fish entrainment in main stream
Ramping down (midnight)	> 40 min 155 to 60 Followed by > 45 min–60 to 0 m^3/s	Fish stranding is the limiting factor (depth and wetted perimeter)

- Fish impingement and entrainment – Fish upstream of the dam have the potential for impingement against the Project's track racks and entrainment through the Project's turbines, both of which will likely result in a high percentage of mortality. Fish abundance upstream from the dam is relatively low and the fish present do not need to migrate downstream to complete their life cycle. Screens will be provided to prevent at least larger fish from being entrained (Appendix C, ESMP, Annex C3, Biodiversity Management Plan).
- Land acquisition – The Project will need to permanently acquire approximately 196.9 ha of land, place permanent land use restrictions on 25.5 ha of land within the transmission line RoW, and require temporary access to and disturbance of 76.9 ha of land for construction access and grading. These impacts will be mitigated through the implementation of the Resettlement Action Plan.
- Physical and economic displacement – The Project will require the physical resettlement of 22 households and the economic displacement of an additional 335 households. These impacts will be mitigated through the Resettlement Action Plan and the Livelihood Restoration Plan.
- Loss of high value land – The Project will impact on approximately 78.2 ha of agricultural land, especially land used for growing cardamom. The Project will mitigate these impacts via the provisions of the Livelihood Restoration Plan.
- Loss of ecosystem services – The Project will impact on approximately 36.0 ha of community forest. Although community forests provide a variety of ecosystem services to local residents, the Project will only impact about 1.4% of the total land within the affected community forests. MCA-Nepal will mitigate these impacts through entitlements included in the Resettlement Action Plan and provide livelihood support for vulnerable households.
- Community health and safety – The Project will bring up to 4,500 construction workers, most of whom will be male and foreign, to a remote and rural area for several years. There is a high potential for conflicts between construction workers and the local community, which could result in gender-based violence, trafficking in persons, community health issues (e.g., introduction or spread of

communicable and sexually transmitted diseases), and conflicts with project security personnel, among other things. The Project will implement and enforce a robust set of management plans to mitigate these potential impacts, including the adoption of a Workers' Code of Conduct, Influx Management Plan, Occupational Health and Safety Plan, Security Personnel Management Plan, and a Community Health and Safety Plan (see Appendix C).

- Occupational health and safety – The Project will be constructed in a remote area with very steep topography that is susceptible to a variety of natural hazards (e.g., landslides). Experience with OHS good international industry practice is limited in Nepal. These two factors combine to pose a significant OHS risk, which will require robust implementation by the Construction Contractors and oversight by UAHEL.
- Impacts from natural disasters and accidents – The Project could increase the frequency and/or magnitude of natural disasters, increase the risk of traffic accidents, especially in the project impact area where people are unaccustomed to vehicular traffic, and create the potential for dam failure. The Project will develop and implement an Emergency Preparedness and Response Plan and a Traffic Management Plan to manage these risks (see Appendix C). The Project has established a Dam Safety Panel of Experts to review dam investigation, design, construction, and start of operations.
- Impacts on cultural heritage – The Project will displace three locally important tangible cultural heritage sites and impact the landscape setting of three natural heritage sites with religious/spiritual value. The in-migration of largely foreign workers and the potential of influx of others seeking employment or offering services could undermine the traditional customs, practices, and beliefs. The Project will mitigate these impacts through implementation of a Cultural Heritage Management Plan and other measures to protect intangible cultural heritage such as establishing an Ethnographic Museum and Cultural Centre and a Handicraft and Local Produce Market (see Appendix C), but there will likely remain un-mitigatable impacts on intangible cultural heritage.
- Impacts on vulnerable people – Nearly all of the project-affected people can be considered vulnerable because of their age, gender, health, caste, land ownership, and/or economic situation. Nearly all of the project-affected people are indigenous people, and may, therefore, be differentially affected by the project impacts listed above. The RAP and Livelihood Restoration Plan provide special provisions for vulnerable, marginalized, or otherwise disadvantaged project-affected people.
- Cumulative impacts – The project, in combination with other under construction (i.e., Koshi Highway and Arun-3 HEP) and planned (e.g., Kimathanka HEP, Arun-4 HEP, Lower Arun HEP, Sapta Koshi HEP) projects, has the potential to result in significant cumulative impacts on several important VECs, including natural forest, MBNP, fish and aquatic habitat, river-based livelihoods, settlement patterns, and local community social cohesion.

As indicated above, some of these unavoidable impacts can be mitigated, but require effective implementation and monitoring oversight of the management plans. Significant residual impacts on legally protected areas (i.e., MBNP), natural habitat, and critical habitat will remain, which will require the implementation of biodiversity offsets to compensate for these impacts. The Project needs to demonstrate conformance with the WB's no net loss and net gain requirements, which required additional studies which have been carried out: the Aquatic Biodiversity Survey carried out by Hydrolab in 2022 (Hydrolab 2022) and the high resolution EFlow Report by Artelia and Hydrolab in 2024 (Artelia and Hydrolab 2024). These studies have been presented as free standing reports. See also Appendix

C, ESMP. There will be fundamental changes to social cohesion and cultural heritage as a result of the Project and other cumulative impacts.

8.3 Design Measures

The World Bank Group has established EHS Guidelines for various measures including environmental, occupational health and safety, and community health and safety. The project design has taken these guidelines into consideration. The applicability of the EHS Guidelines is identified in ***Table 8.4***.

Table 8.4: Applicability of WBG EHS Guidelines (World Bank 2007)

EHS Guideline	Applicability	Comments
Environmental Guidelines		
Air emissions	Yes	Project emissions to comply with WB EHS standards and meet WHO Ambient Air Quality Guidelines (Table 1.1.1) – see Air Quality Management Plan (Appendix C)
Energy conservation	Yes	Guidelines applicable to temporary worker housing and permanent owner camps
Wastewater quality	Yes	Project wastewater treatment plants will meet Indicative Values for Treated Sanitary Sewage Discharges (Table 1.3.1) – see Water Quality Management Plan (Appendix C)
Water conservation	Yes	Guidelines applicable only to temporary worker housing and permanent owner camps
Hazardous materials management	Yes	WB EHS requirements reflected in Hazardous Materials Management Plan (Appendix C)
Waste management	Yes	WB EHS requirements referenced in Waste Management Plan (Appendix C)
Noise	Yes	Project will comply with WB EHS Noise Level Guidelines (Table 1.7.1) – see Noise Management Plan
Contaminated land	Possibly	No contaminated land identified in DIA, but there is the potential that the Project could result in accidental spills or releases that could contaminate land.
Occupational Health and Safety Guidelines		
General facility design/operation	Yes	To be addressed in project final engineering design
Communication and training	Yes	WB EHS requirements referenced in Occupational Health and Safety Plan (Appendix C)
Physical hazards	Yes	WB EHS requirements referenced in Occupational Health and Safety Plan (Appendix C)
Chemical hazards	Yes	WB EHS requirements referenced in Occupational Health and Safety Plan (Appendix C)
Biological hazards	Yes	Only applicable to limited amount of medical waste – see Occupational Health and Safety Plan (Appendix C)
Radiological hazards	No	No radiological hazards anticipated
Personal protection equipment	Yes	WB EHS requirements referenced in Occupational Health and Safety Plan (Appendix C)
Special hazard environments	Yes	Special hazard environments specifically identified in the Occupational Health and Safety Plan (Appendix C)
Monitoring	Yes	Contractor, Project Engineer, and UAHEL all have responsibility for OHS monitoring
Community Health and Safety Guidelines		
Water quality and availability	Yes	WB EHS requirements referenced in the Water Quality and Spring Management Plans (Appendix C)

EHS Guideline	Applicability	Comments
Structural safety of project Infrastructure	Yes	To be addressed in project final engineering design
Life and fire safety	Yes	To be addressed in project final engineering design
Traffic safety	Yes	WB EHS requirements referenced in the Traffic Management Plan (Appendix C)
Transport of hazardous materials	Yes	WB EHS requirements referenced in the Hazardous Materials Management Plan (Appendix C)
Disease prevention	Yes	WB EHS requirements referenced in the Community Health and Safety Management Plan (Appendix C)
Emergency preparedness and response	Yes	WB EHS requirements referenced in the Emergency Preparedness and Response Plan (Appendix C)
Construction Guidelines		
Environment	Yes	See Environmental Guidelines above.
Occupational health and safety	Yes	See Occupational Health and Safety Guidelines above.
Community health and safety	Yes	See Community Health and Safety Guidelines above.

8.4 Balancing Project Benefits and Impacts

The overall conclusion of this ESIA is that the Project offers substantial benefits to the government, economy, and people of Nepal, while at the same time presenting several significant risks and potential impacts.

This ESIA identifies key mitigation and management measures needed to address the Project's potential adverse impacts (see ***Tables 8.1 and 8.2***). Despite these measures, there will remain significant residual impacts. In terms of physical resources, the Project is susceptible to slope failures and natural hazards (e.g., landslides), and wastewater treatment/disposal, solid waste management/disposal, sediment and erosion control, fugitive dust, noise, and vibration all pose significant risks to the Project and local residents. From a biodiversity perspective, the Project will require offsets to meet WB ESF ESS 6 requirements for legally protected areas (i.e., MBNP), critical habitat, and natural habitat. There will also be fundamental changes to social cohesion and cultural heritage as a result of these currently isolated villages being exposed to a large foreign workforce for approximately 7 years, associated influx, and improved access.

The effective implementation of the proposed mitigation measures and offsets will be critical to deliver a successful project. To ensure the effective implementation of these measures and achieve successful environmental, social, health and safety performance during project construction and operation, UAHEL will adopt an Environmental and Social Management System, include environmental and social performance requirements in all construction contracts, require the Construction Contractor to develop and implement a detailed Construction Environmental and Social Management Plan, conduct a robust environmental and social monitoring program, implement a biodiversity offset program, and otherwise comply with the requirements of the Environmental and Social Commitments Plan. UAHEL will require capacity building to manage these project expectations. An Institutional Capacity Assessment and Strengthening Plan is included as Annex C4 of Appendix C, ESMP. These measures will help to ensure that all required mitigation measures and other conditions of ESIA approval are fully implemented and that actual project impacts are consistent with those predicted in this ESIA.

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APPENDICES

APPENDIX A ESIA ERM CONTRIBUTORS

APPENDIX B CABINET DECISION

APPENDIX C ENVIRONNMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN

APPENDIX D ALTERNATIVE MEMOS

APPENDIX E CUMULATIVE IMPACT ASSESSMENT

APPENDIX F BASELINE DATA

APPENDIX G PUBLIC HEARING

APPENDIX H ASSESSMENT OF PROTECTIVE MECHANISMS AND SAFTEY TO WOMEN AND GIRLS IN UPPER ARUN REGION

Appendices available on request.