



नेपाल सरकार

वन तथा वातावरण मन्त्रालय

गण्डकी प्रदेश स्थित गोरखा जिल्लाको धार्चे गाउँपालिका वडा नं १ र ३ चुमनुव्री गाउँपालिका वडा नं. ३ मा निर्माणका लागि प्रस्तावित बुढी गण्डकी जलविद्युत् आयोजना (३४१ मेगावाट) को वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनमा राय सुझावको लागि आव्हान गरिएको सार्वजनिक सूचना

प्रथम पटक प्रकाशित मिति २०८०/०८/०७

श्री टाइम्स इनर्जी प्राइभेट लिमिटेड, बानेश्वर, काठमाडौं प्रस्तावक रहेको गण्डकी प्रदेश स्थित गोरखा जिल्लाको धार्चे गाउँपालिका गाउँपालिका वडा नं १ र ३ चुमनुव्री गाउँपालिका वडा नं. ३ मा निर्माणका लागि प्रस्तावित बुढी गण्डकी जलविद्युत् आयोजना (३४१ मेगावाट) को वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन प्रस्तावकले तयार गरी यस मन्त्रालयमा पेश हुन आएको छ ।

प्रस्तावित बुढी गण्डकी जलविद्युत् आयोजना पीकिंग रन अफ रिभर (PROR) प्रकारको आयोजना हो । यो आयोजना गण्डकी प्रदेशको गोर्खा जिल्लाको धार्चे- १, ३ र चुमनुव्री ३ गाउँपालिकाहरूमा अवस्थित छ। प्राप्त प्रतिवेदन अनुसार यस आयोजनाको बाधस्थल र जलाशय चुमनुव्री गाउँपालिकामा पर्दछ, जुन मनास्लु संरक्षण क्षेत्रको दक्षिणी सुरुवाती भागमा पर्दछ । आयोजनाको बाकी सबै संरचनाहरू मनास्लु संरक्षण क्षेत्रको बाहिर पर्दछन् । यस आयोजनाको कुल क्षमता ३४१ मेगावाट हो र यसले १८३७.१६ गिगावाट प्रति घण्टाको दरले उर्जा उत्पादन गर्नेछ । यस आयोजनाको डिजाइन डिस्चार्ज १००.२७ घन मि. प्रति सेकेन्ड रहेको छ र यसको जलाधारको क्षेत्रफल ३६२८ वर्ग कि.मी. रहेको छ। खोलाको जमिन सतहबाट ३६ मि. अग्लो रहने Concrete Gravity with Spillway बाँधको Crest Level बुढीगण्डकी नदीमा समुद्री सतहबाट १३२५ मि. उचाईमा रहने छ । बाँधको कारणले करिब १.५ कि. मि. लामो जलाशय बन्नेछ । बाँधले पानीको सतहलाई करिब १३२५ मि को उच्चतम नियमित तह (Highest Regulated Water Level, HRWL) सम्म ल्याउदा करिब १९ हेक्टरको जलाशय बन्नेछ, जसमा करिब ३.२५ Million घन मि. पानीको भण्डारण हुनेछ । नदीको दायीं किनारामा ६ वटा इन्टेकहरू बनाउन प्रस्ताव गरिएको छ । ५.८ कि मि लम्बाईको Headrace Tunnel मार्फत भूमिगत सर्ज साफ्ट (Surge Shaft) सम्म पानी पठाइने छ । ११०.५ मि. लम्बाई १६.५ मि. चौडाई र ३७ मिटर उचाई भएको भूमिगत विद्युत गृहमा ६ वटा ५७ मे. वा. क्षमताको Vertical Axis Pelton Turbine हरूमा पानी खसाली सो Turbine संग जोडिएको ६ वटा ६६ २४५ एम. भि. ए. को श्री Phase Synchronous जेनेरेटर मार्फत ३४१ मेगावाट विद्युत उत्पादन गरिनेछ । Turbine को Axis Level समुद्री सतहबाट ९२७ मि. उचाईमा हुनेछ । विद्युत उत्पादनपछि १५० मि. लम्बाई भएको Tailrace Tunnel बाट पानीलाइ पुन बुढीगण्डकी नदिमा पठाइनेछ ।

प्रस्तावित आयोजनाका मुख्य संरचनाहरूमा बाँध, स्पिलवे, इन्टेक, हेडरेस टनेल, सर्ज साफ्ट, पेनस्टक पाइप, विद्युतगृह, टेलरेस पर्ने प्रतिवेदनमा उल्लेख गरिएको छ । वातावरण संरक्षण नियमावली, २०७७ को नियम ९ को उपनियम (६) बमोजिम यस प्रतिवेदनमा राय सुझाव दिनका लागि सर्वसाधारणले प्रतिवेदन पढ्न वा उतार गरी लैजान पाउने व्यवस्था रहेकोले श्री विद्युत विकास विभाग प्रस्तावक रहेको बुढी गण्डकी जलविद्युत् आयोजना (३४१ मेगावाट) निर्माण गर्ने प्रस्तावको वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदन देहाय बमोजिमका स्थानहरूमा सार्वजनिक गरिएको र वन तथा वातावरण मन्त्रालयको Web Site: www.mofe.gov.np मा समेत सार्वजनिक गरिएको छ । प्रतिवेदनमा उपयुक्त राय सुझाव प्राप्त भएमा यस मन्त्रालयले उक्त प्रस्ताव कार्यान्वयनका लागि स्वीकृती दिने क्रममा त्यस्ता राय सुझावहरूलाई समेत ध्यानमा राखिनेछ। उक्त प्रतिवेदन सम्बन्धमा सर्वसाधारण व्यक्ति वा संस्थाको कुनै राय सुझाव भए यो सूचना प्रथम पटक प्रकाशन भएको मितिले सात (७) दिन भित्र आफ्नो राय सुझाव निम्न ठेगानामा पठाई दिनु हुन यसै सूचनाद्वारा आव्हान गरिन्छ ।

प्रतिवेदन हेर्न वा उतार गर्न सकिने स्थानहरू:-

श्री वन अनुसन्धान तथा प्रशिक्षण केन्द्रको पुस्तकालय, बबरमहल, काठमाण्डौ ।

श्री त्रिभुवन विश्वविद्यालयको केन्द्रीय पुस्तकालय, किर्तिपुर काठमाण्डौ

श्री नेपाल राष्ट्रिय पुस्तकालय हरिहर भवन काठमाण्डौ ।

श्री ऊर्जा जलश्रोत तथा सिंचाइ मन्त्रालयको सिंहदरवार, काठमाण्डौ ।

श्री जिल्ला समन्वय समितिको कार्यालय, गोरखा ।

श्री डिभिजन वन कार्यालय, गोरखा ।

श्री मनास्लु संरक्षण क्षेत्र, गोरखा ।

श्री धार्चे गाउँपालिकाको कार्यालय, गोरखा ।

श्री चुमनुव्री गाउँपालिकाको कार्यालय, गोरखा ।

राय सुझाव पठाउने ठेगाना

वन तथा वातावरण मन्त्रालय,

वातावरण प्रभाव मूल्याङ्कन शाखा

सिंहदरवार, काठमाण्डौ ।

फोन नं. ०१-४२११५६७, ४२११६३८

फ्याक्स नं. ०१-४२११८६८

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF
BUDHI GANDAKI HYDROELECTRIC PROJECT
(BGHEP 341 MW)**

Gorkha District, Gandaki Province, Nepal



Submitted to:

Government of Nepal

Submitted to

Ministry of Forest and Environment (MoFE)

Singha Durbar, Kathmandu, Nepal

Through

Ministry of Energy, Water Resources and Irrigation (MoEWRI)

Singha Durbar, Kathmandu, Nepal

And

Department of Electricity Development (DoED)

Sanogaucharan, Kathmandu, Nepal

Submitted by

Total Management Services (TMS)

Hattisar, Kathmandu, Nepal

Phone: +977-1-4439182, 4425745

September, 2023

EXECUTIVE SUMMARY

INTRODUCTION

The Department of Electricity Development (DoED) awarded a survey license to Times Energy Pvt Ltd to conduct the Feasibility and EIA study of Budhi Gandaki Hydroelectric Project with an installed capacity of 341 MW. Given the capacity of the BGHEP, and in compliance with the Environment Protection Rule (2020).

Project Description

The proposed BGHEP is a peaking run-off-the-river (PROR) type of project. The BGHEP is located in Dharche and Chum Nubri Rural Municipalities of Gorkha District in Gandaki Province. Geographically, the license area of the project lies between longitudes 84°55'15" E to 84°52'40" E and latitudes 28°17'00" N to 28°22'00" N. The headwork's of the project lies near the lower end boundary of the Manaslu Conservation Area, whereas all other major structures lie outside the Conservation Area.

Main Project Features

The installed capacity of the proposed BGHEP is 341 MW, and will generate a total of 1904.7 GWh.

The design discharge of the proposed plant is 100.27 m³/s. From the point of the proposed dam, its catchment area is about 3075 km².

A concrete gravity dam with a spillway of 54 m length at crest, 36 m high from the riverbed, has been proposed in the river near the Salleri Village of Chum Numbri Rural Municipality. The dam is expected to raise the water level up to 33 m above the river bed.

A head pond is expected to extend about 2 km upstream of the dam. At the Highest Regulated Water Level (HRWL) of 1325 *masl*, the surface area of the head pond will be about 190,000 m², and the live storage volume between HRWL and LRWL is about 1.76 million m³.

The intake is proposed on the right river bank of the river with six inlet openings (4 m wide × 6 m high).

A headrace tunnel (HRT) of length 6,654 m is proposed as the major water conveyance conduit. The modified horse shoe shaped tunnel will be of 6.5 m in diameter. The headrace tunnel will start from the Jagat village and end at Bhinchet Village.

An underground surge shaft has a 22 m diameter. The surge shaft will be located at the North-Eastern edge of the Uiya village and south to the Bhinchet village.

The power house site will be located underground within the steep walled rock mass about 1 km upstream of Tatopani village on the right hill side of the Budhi Gandaki River. The generation cavern of the powerhouse complex contains major mechanical and electrical equipment for power generation such as turbine, generator, control valves, governor and hoisting equipment. The generation cavern is connected by the main accesses tunnel. The size of the cavern will be 110.5 m in length and 16.5 m wide. 6 Pelton turbines, each with the capacity of 60.43 MW are proposed to be installed in the power house at the elevation of 927 *masl*.

The tailrace tunnel outlet is located about 100m upstream of the existing suspended bridge at Tatopani village. The flow discharged from the six draft tubes will be connected by first 100 m long and 3.2 m inverted D shaped tailrace tunnels to the main tailrace tunnels of about 670 m long 6.2 m diameter inverted D shaped tunnel. The river tail water level is proposed to be at the elevation of 918.86 *masl*.

Methods

The EIA study has utilized secondary sources as well as conducted field studies to yield primary data. Extensive literature review, study of maps and photographic images, and national and district level statistics were done. Primary sources of information included administering questionnaires and checklists for interviews, focus group discussion and field observations and surveys. Public consultations and disclosure on project details, built upon the scoping study were carried out through the EIA period. The public hearing was held on the 29th of February, 2020.

Project Area

The ‘project area’ refers to the river valley of the Budhi Gandaki River and its tributaries with the adjoining farmland, forest and settlement areas where the project impacts are both ‘direct’ and ‘indirect’. These impacts would also include;

the primary project sites and related facilities that the proponent (including its contractors) develops or controls;
areas potentially impacted from the further planned development of the project;

areas potentially affected by impacts from unplanned but predictable developments caused by the project.

other associated facilities that are not funded as part of the project (funding may be provided separately by the proponent or a third party including the government),

Chum Numbri Municipality –3, Dharche – 1 and Dharche - 3 are considered as the project influenced area as mentioned by the survey license issued by DoED of GON to the BGHEP, hereafter referred as the project area. The project area has been further classified into two areas; the ‘Direct Impact Area’ and the ‘Indirect Impact Area’.

Direct impact area refers to a direct alteration in the existing environmental condition as a consequence of project activity. The natural resources, community infrastructures, facilities and services including land and asset of locals might be lost as a result of project construction and implementation. Some of the important direct impact areas are:

forests, cultivated land, roads in the intake area, which might be inundated by the water storage, or construction of intake structures,

project structures such as power house, adit sites, permanent project camps, temporary campsites, quarry and spoil disposal sites, access road, rig areas *etc.* require acquisition of land both permanently and temporarily, clearance of vegetation, *etc.*

‘Low Flow Area’, the stretch of the Budhi Gandaki River between the dam site and the tailrace outlet is also the direct impact area.

Indirect impact area: are the area affected indirectly by the project activities. People in the indirect impact area may partially lose their land or dependable natural resources such as forests and grazing lands or partially or fully deprived of community infrastructure and facilities, built-in structures, religious or cultural sites, market centers *etc.* Habitat fragmentation in such areas may result and influence wildlife mobility and limit food resources.

Project Affected Families are the families in the direct or indirect impact areas whose land, properties or livelihoods may be affected due to construction or operation of project components are considered as ‘Project Affected Families’. In addition to the generic PAF category, the entitlement matrix presented in the RRP classifies the affected families under different classes depending on the degree of affect. One of these categories is represented by the **Severely Project Affected Families (SPAF)**, which include families who are physically displaced from their residences or commercial establishments and those who are severely affected through loss of agricultural land as defined in the “Entitlement Matrix”.

Total Land Requirement

Total land required for the project components is 56.22 hector out of which 49.62 hector is permanently required while 6.6 hector is temporarily required. The total government land is 49.65 hector is required in which total 13.61 hector out of which 12.01 hector is permanently required while 1.68 hector of Manaslu Conservation area is temporarily required. Similarly, National Forest land of 35.96 hector out of which 31.04 hector is permanently required while 4.92 hector is temporarily required. A total of 6.57 hectares of private land is permanently required for this project.

Land Types	Permanent Land (ha)	Temporary Land (ha)	Total (ha)
Forest (Ministry of Forests and Environment)	31.04	4.92	35.96
Manaslu Conservation Area	12.01	1.68	13.69
Private Land	6.57	0	6.57
	49.62	6.6	56.22

ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION MEASURES

Physical Environment

Physiography, Topography and Land use

The project municipalities are distributed in High Mountain (53%), and Middle Mountain (47%). The higher parts of the municipality are glaciated, and significant post glacial down cutting could be observed. The river valley of the Budhi Gandaki River can be characterized by steep slopes ranging from 30⁰ to 75⁰. The lower reaches of the municipalities' experiences intense monsoonal rain, which results in landslides depositing loose colluvial and alluvial materials. The land use pattern of these municipalities indicates low human activities and harsh climatic conditions as most of the areas are covered by snow. The forested area is the second largest land use category of the municipality which is followed by cultivated land.

The project will require land on permanent as well as temporary basis. Temporary facilities like quarry site, borrowing pit, spoiling disposal sites, coffer dam will change the land use during the construction phase, which will be restored after project completion. However, permanent land use change is expected in permanent structures like reservoir area, dam, project camps, access road *etc.* About 4.86ha of cultivated land is expected to be acquired temporarily. Majority of the permanent project structures are underground, thus, the permanent land use change is expected to be small. From among the remaining project structures, about 26.78% *i.e.* 11.85ha will be occupied by sand/gravel and boulders, 22.32% *i.e.* 9.87ha area by shrubland and grassland and about 19.66% *i.e.* 8.70 ha by forest.

The permanent and temporary sites have to be acquired by the project in coordination with the government bodies and local communities. The acquisition and rehabilitation approaches have been discussed in the social component of this study with adequate compensation. However, the land temporarily used for contractor and labor camps, crushing/batching plants, workshops, stores, construction yard and scrap yard will have to be rehabilitated. The top soil from these areas have to be carefully removed and stored prior to the construction activities, which shall be used to cover to rehabilitate the sites. Furthermore, in order to ensure vegetative coverage of the sites, the compensatory plantation proposed in the biological component of this study, will be carried in these sites.

Geology and slope stability

The project area is located within ortho-and para-gneiss of the Greater Himalaya. It is also located about 1-2 km North of the Main Central Thrust (MCT) system, which represents one of the ductile deformation features in the Himalayan region. The river is a carved steep walled gorge and narrow V-shaped valley across the Greater

Himalayan crystalline rocks to the south of Manaslu peak (8125 masl). The project is laid out on the right bank of the river, which is mostly steep rock slope.

No existing landslides were recorded in this part of the river valley, though; the left bank has number of landslides. However, heavy rainfall and earthquake result in shallow slides of the colluvium masses that are deposited on the slopes, which can be further accelerated by the project activities like tunneling and blasting. One of the concerned areas of landslide is the reservoir area. The site of Salleri settlement is the colluvial deposit of an old landslide. The interaction of reservoir water fluctuation can destabilize the slope resulting to its wasting.

Comprehensive mitigation measures are necessary to address this issue, which are;

- The slopes using toe embankments and/or toe buttressing and/or slope angle reduction, drainage galleries/tunnels and/or sub horizontal drains to lower groundwater level, removal of potential slides either by excavation or by triggering them under controlled conditions (e.g. during reservoir filling), and erosion protection measures in the water fluctuation zone (rip rap) and upslope (drainage trenches and vegetation planting).
- Besides protection of the slope in Salleri, relocation of the houses is being considered to minimize the risk to inhabitant. The relocation plan is presented in the social component. Before the detail design, it is recommended to execute further investigations especially in the most vulnerable areas identified in the geology report, in order to obtain a much clearer picture of geotechnical parameters, groundwater level(s) movement patterns and slip/sliding surfaces of the identified slides.

Climate

The project municipality is distributed over larger elevation range which also controls the climatic diversity, from subtropical to alpine region. Seasonal variation is strongly influenced by the monsoon rain, which deposit 80% of the annual rain. Rainfall is one of the factors contributing to the instability of the slopes. It is necessary to make adequate consideration of rainfall pattern and intensity to keep the project and its surrounding safe.

GLOF

ICIMOD had been identified as "**gabud_gl_0009**", locally known as "**Birendra Tal**" in the catchment area of the Budhi Gandaki River, which was categorized as a potentially critical lake. However, in the recent "Inventory of Glacial Lake (2018)", ICIMOD has removed it from the potentially dangerous glacial lake, thus, no GLOF is expected.

Hydrology and Environmental Flow

The hydrological study of the Budhi Gandaki has revealed that the river discharge reaches 377 m³/sec at the peak of monsoon season (August) and goes down to 22.5 m³/sec in the driest month (*i.e.* February). The dam will divert most of the discharge to the powerhouse, significantly reducing the discharge of Budhi Gandaki between the dam and the tailrace. The project is obliged to maintain environmental flow in this stretch of the river. No cultivation or irrigation was recorded in this stretch, thus, 2.3 m³/sec discharges will be maintained during the driest period. During the monsoon period (June – Sept), the discharge will range between 92 m³/sec and 277 m³/sec.

Noise, Sound and Water Quality

The on-going road construction is the primary source of noise in the project area. However, the vehicular movement is expected to start in near future, which will increase the noise level. The water quality assessment carried out in the river water has shown lower physical and chemical contamination level, though, total suspended solid content is higher. The biological contaminations were observed in the stations near settlement of Jagat and Yaruphant, due to human waste release to the river. The air quality is still pristine in the project area. The road construction is still at the stage of alignment opening and the drilling and blasting have not had caused significant raise in air pollution level. However, the operation of road is expected to raise the pollution level.

Biological Environment

Plant Species diversity

The project area is found relatively rich in floristic diversity. Due to rocky environmental setting there is much habitat differentiation. The species recorded around the project construction and its ancillary facility sites were Salla (*Pinus roxburghii*), Tooni (*Toonaciliata*), Kafal (*Myrica esculenta*), Khanayo (*Ficus scunia*), Bakaino (*Melia azadiractah*), Khirro (*Sapium insigne*), Bains (*Salix sp.*), Uttis (*Alnus nepalensis*), Mayal (*Pyrus pashia*), Jamun (*Syzygium cumini*), Saandan (*Desmodium oojainensis*), Chilaune (*Schimawallichii*), Daar (*Boehmeria rugulosa*), Gunelo (*Callicarpa borea*), Chiuri (*Diploknemabutyracea*), Malato (*Macaranga pustulata*), Hade Bayar (*Zizyphus incurva*), Lodo (*Ehretia sp.*), Gayo (*Bridelia retusa*), Chuletro (*Brassia sishainla*), Tejpaat (*Cinnamomum tamala*), Ankhitare (*Trichilia connaroides*), Ban Kangiyo (*Wendlandia coriacea*), Siris (*Albizziachinensis*), Ankol (*Alangium sp.*), Mauwa (*Englehardtiaspicata*), Phaledo (*Erythrina stricta*), Amala (*Phyllanthus emblica*), etc.

Common shrubs and herbs recorded are Chutro (*Berberis asiatica*), Bhaki Amilo (*Rhus javanica*), Bilaune (*Maesachisia*), Fakata (*Maesamacrophylla*), Jangali Gulab (*Rosa sp.*), Dhursul (*Colebrokia oppositifolia*), Gueli (*Elaeagnus sp.*), Sisnu (*Urtica dioica*), Bhalayo (*Rhus wallichii*), Allo (*Girardinia diversifolia*), Dhayero (*Woodfordia fruticosa*), Aiselu (*Rubus ellipticus*), Khareto (*Phyllanthus parviflora*), Rato Chulsi/Seto Chulsi (*Osbekianepalensis*), Titepati (*Artemisia sp.*), Gaanja (*Cannabis sativa*), Pashanbhed (*Berginia ciliate*), Nihuro (*Dryopteris cochleata*), Pankha Phool (*Hedychium sp.*), Amriso (*Thysanolaena maxima*), Dhaturu (*Datura suaveolens*), KumKum (*Didymocarpus sp.*), Doobo (*Cynodon dactylon*), Chari Amilo (*Oxalis corniculata*), Unyu (*Pteris sp.*), Sarpako Makai (*Ariasaema sp.*), Kurilo (*Asparagus racemosus*), etc. All together 86 plant species have been recorded and among them several species bear ethno botanical and medicinal value. Two species of orchids were also found in the project area, which fall under CITES appendix II, which needs to be regulated or controlled for trade.

Forest Management system

The forest in the project impact area is managed by the local community users' groups. Within the Manaslu Conservation Area (MCA), particularly in the headwork's area, the forests are managed by the Manaslu Conservation Area Forest Management Committee. In Chum Nubri Rural Municipality, Sirdibas -1 Kamaladanda CFUG is managing the forest area. In reduced water zone and the power house area, Sallaghari CFUG and Dobhan CFUG (within Kerauja Rural Municipality 7,8,9), Bengrang Saatkanya CF (within Uiya Rural Municipality 1,2,3), manage the forests. Likewise Gungdang CFUG manages forest (within Darche Rural Municipality 5).

Agro-diversity of the area

Among the agricultural production, upland rice (ghaiya), makai (maize), kodo, barley (jau), buckwheat (fapar), etc. are grown. Almost all spices and vegetables such as ginger, garlic, onion, chilly, potato, cabbage, bottle-gourd, cucumber, tomato, pumpkin, etc. are grown. Among the fruits, lemon, orange, peach, plum, guava, banana, pear, etc. are also cultivated. And among the fodder plants *Khanayo*, *Nibharo*, *Chyuri* are more common.

During the construction period, the project is expected to have the following impacts:

- For the establishment of project structure and facilities, 49.65 ha of forest land (forest and shrubland/grassland together/ water bodies/ manaslu conservation area) will be cleared. About 1636 numbers of trees (tree and pole size) together will be felled from the forest and shrubland. The forest land will be cleared from national forest, community forest and community managed conservation area forest.
- Due to the change in land use system from forest to man-made environment, there is likely to have a considerable change in forest dynamics and reduction in ecosystem services than to have a single forest block.
- The project impact area consists of numerous forest products including medicinal and aromatic plants, NTFPs having economic values such as fiber bearing plants, religious plants, ornamental plants, etc. Loss of such valuable plants deprives the local community from the traditional use since long time.

- The project area consists of numerous plant species of indigenous origin which carry biodiversity value for maintaining the ecosystem functions. The loss of these plants might affect reproductive cycle resulting in poor functioning of the ecosystem.
- Project construction sites, especially the quarry site, access road, camp site, and its vicinity become more fragile due to construction activity. Reservoir area and the surroundings of power house, are partly fragile and landslide prone localities and the inundation activity adversely affects the habitat of the floral and faunal species including rare, endangered, vulnerable and protected plants. Only two species of orchids have been recorded under CITES II in the project influence area.
- A large numbers of work forces might put pressure on forest for firewood. Furthermore, timber might also be needed for the construction of temporary huts and shade houses. Such requirements may also be applicable to local residents who live in the vicinity of project sites. These activities lead to the degradation of the forest.
- The project activity might result in loss of agro-diversity and agricultural products that include varieties cereals, pulses, vegetables, fruit trees, fodder plants and other plant species cultivated under agro-farming practices. Furthermore, due to increasing development activities there might be diminishing trend of cultivation of traditionally grown and resistant varieties. Thus social paradigm can be shifted to grow new and improved varieties which adversely impacts upon the availability of traditionally conserved genetic resource.
- Cases of forest fire either deliberately or accidentally affects the large area and much critical to wild-life species inhabited there including the migratory ones. It is also introduced for capturing wild animals and makes the forest area fertile allowing new grasses to regenerate for feeding cattle. In the project scenario, there are some chances of the occurrence of forest fire within the project site due to deliberate attempts or ignorance of construction workers.
- The project construction site, especially the headwork's and the inundation area, falls in the fringe of the MCA and hence moderate impact is envisaged in the construction phase.

During the operation period, the project is expected to have the following impacts;

- During the operation phase also the project area, especially the sites of immediate vicinity of the project construction, will be impacted due to easy access than before that may attract the remaining project staff and local inhabitants for the unauthorized collection of timber, firewood and wildlife species.
- The project area comprises of rare, endangered, vulnerable and protected species of flora; especially the epiphytic or ground orchids which are regulated under trade category. Due to easy access there is an increased opportunity for their collection and utilization through illegal means.

Mitigation during the Construction and Operation Phase

Construction Phase

- The impacts due to the loss of vegetated area will have to be mitigated through compensatory plantation and conservation practices of the remaining forest areas. A total of 275 trees are expected to be felled for construction of the project structures, of which 44 trees are in the Manaslu Conservation Area, and 231 are outside of the conservation area. Therefore, the total number of saplings required for the compensatory plantation is 3410, out of which 1100 saplings will be planted inside the MCA, and rest 2310 will be planted outside of the MCA. Moreover, the cost required for felling, stockpiling and transportation of the felled trees will be also provided to the related institution and stakeholder. Appropriate areas will be selected in coordination with DFO (Division Forest Office) and executives of (CFUG) Community Forestry Users Group under Manaslu Conservation Area Management System and for the conservation of planted species through fencing, regular water treatment, caring and watching. Appropriate areas will be selected in coordination with DFO (Division Forest Office) and executives of (CFUG) Community Forestry Users Group under Manaslu Conservation Area Management System and for the conservation of planted species through fencing, regular water treatment, caring and watching.
- As the project construction sites are found rich in terms of medicinal and other non-timber forest products, site clearance will sweep away these valuable plant species. The management group will be allowed to collect these products before implementation of the project. But for the plants within the vicinity, general

instruction and awareness programs will be conducted to construction forces which will enrich the knowledge status of labor forces. But who are prompted for illegal benefit will be penalized according to the code of conduct approved from the project implementation authority.

- The labors will be instructed to walk and carry their duties with due care and not to damage the plant species. They will also be taught about the value of biodiversity and the role of these species for maintaining the environmental balance through awareness program. However, as complete safeguard of these species from such type of construction work is unavoidable, nearby unproductive and degraded lands will be re-vegetated and emergence of plant species will be secured.
- Due to adverse physiographical settings, the project construction site does not harbor tree species of protection category. However, for climbers and herbs of such category transplantation program has been recommended. These include some orchids under trade regulation purpose which will be translocated in suitable habitat conditions in nearby areas for their survival and multiplication in nature as a part of ex-situ conservation.
- Lasting actions through mitigation will be achieved only after forestry plantation and application of conservation programs and proper environmental protection measures. However, everyday control for the forest resource, from being harvested by the work forces that are prompted by easy access, will be achieved by applying strict regulations and awareness programs to the targeted groups up to the dismissal of job.
- Alternate source of energy such as kerosene will be supplied to the workforce and labors. Dead logs and branches only will be allowed to take from the forest areas in case of inadequacy of the alternate sources. Awareness program will be conducted to the working staff and labors about the importance of forest environment and healthy ecosystem that will help to a great extent to control the unwanted use of firewood and timber.
- Local residents will be encouraged to grow traditionally cultivated agricultural crops as far as practicable. DADO (District Agriculture Development Office) will also be consulted for providing seeds and necessary technical support.
- Considerable area around the project site, especially at the surroundings of power house and partly at the reservoir area, is having forest vegetation which is more susceptible to forest fire and difficult to control. Numbers of wild animals and birds have been observed during the field study. Awareness programs will be conducted not only to the construction forces but also to the local residents about its serious consequences and unpredictable losses. Division forest office (DFO) will also be consulted with to be prepared to control such hazards.

Operation Phase

- The project area, especially the sites of immediate vicinity of project implementation, will be adequately afforested and the impact upon the forest will be minimized to a great extent. This ensures suitable habitat formation for the wildlife species of the area. However, for the protection of illegal timber and firewood collection, hunting and poaching strong vigilance mechanism will be developed along with awareness program about the value of forest and wildlife species.
- During operation phase afforested tree species, especially to those ones under protection category, will be nurtured with priority for five years and handed over to the forest officials.

Primary data on terrestrial animals were collected from direct observation/indirect evidences along the walking trails of project area. Secondary data were collected through consultations and from secondary literatures. Field guide books containing photographs of wild animals were shown during consultation with the local residents. Baseline survey recorded a total of 99 species of terrestrial wild animals from the project and its peripheral areas which includes 16 species of mammalian fauna, 71 species of avifauna and 12 species of herpetofauna. Based on the baseline survey, the area is not a natural or critical habitat and it does not provide the migratory route for terrestrial wildlife species. Out of 99 species of terrestrial wild animals; 17 species are listed on CITES Appendixes and 7 on IUCN red-data list as threatened species and 1 namely Assam Macaque (*Macaca assamensis*) was listed under 'Protected species' under NPWC act was recorded.

The baseline status of fish fauna was unraveled from four sampling stations selected along the Budhi Gandaki River. These stations were located at the upstream of dam, downstream of dam, upstream of powerhouse and

the downstream of powerhouse. Cast net was used for sampling fishes and the fishes caught by local fishermen were also observed. Consultations were conducted with local fishermen. Field guide books containing photographs of fishes were shown during consultation.

Jagat Khola and Yaru Khola are the perennial streams present at dewater-zone of Budhi Gandaki River. At Yaruphant steep river gradient (called Yaru Chhanga) exists within the Budhi Gandaki River. It might act as natural barrier for the migration of fishes. During the survey period, road was under construction. Hence the aquatic habitat was highly disturbed during the survey period.

In the baseline survey, three fish species were recorded (including reported species) within the impact area of Budhi Gandaki River which includes *Schizothorax richardsonii*, *Schizothoraichthys progastus* and *Pseudecheneis sulcata*. *Schizothorax richardsonii* and *Pseudecheneis sulcata* have been reported from all the sampling stations and *Schizothoraichthys progastus* from below powerhouse area only. *Schizothorax richardsonii* was found as a dominant species in the project area.

Two fish species namely *Schizothoraichthys progastus* and *Schizothorax richardsonii* of medium distance migratory nature were recorded. *Pseudecheneis sulcata* is a resident (R) species. Out of 3 recorded species, *Schizothorax richardsonii* is a Vulnerable (VU) species observed during the survey.

Impact Mitigation of Terrestrial Ecological Resources during the construction and operation phase

- Vegetation will be cleared for the installation of project structures. Loss of vegetation will decrease the habitat. As a result, wild animals may be forced to live nearby in the forested area. Some wild animals which are forced to leave the nearby forested area due to loss and degradation of habitat will return after habitat rehabilitation. In order to mitigate the impact, habitat will be rehabilitated to wild state after construction through compensatory plantation program. The construction activities generate noise, vibration, light which will frighten or disturb movement of wild animals or degrade their natural habitats. Wild animals which are sensitive to such changes will move to a safer habitat or adopt in the disturbed environment. In order to mitigate the impact, construction activities and light will be limited or restricted at night. Pressure horn will be restricted and speed limits will be enforced to the project vehicles. Blasting will also be restricted at night. Wastewater will be treated and solid waste will be properly managed.
- Construction of road provides easy access for construction workers, staff and local residents. This might increase the instance of hunting and poaching of wild animals and may lead to decrease in the population of wild animals with special food and medicinal value such as Malayan Porcupine, Barking Deer, Common Goral, and Kalij etc. In order to mitigate the impact, regulations for project staff and contractors to avoid illegal hunting and poaching will be incorporated in contract documents. Wildlife awareness program will be launched to the local people, project staff and contractors as well.
- The operation of hydropower plant and associated activities will generate noise and light that can influence nocturnal species. Inadequate management and disposal of solid waste from the camping locations can cause a negative impact to the flora and fauna. To mitigate the impact lights during the project construction and operation period will be directed towards the project facilities and not towards the natural habitats. Speed limits of vehicles will be enforced in ecologically sensitive areas and pressure horns will be restricted. Wastewater will be treated and solid waste will be properly managed.

Impact Mitigation of Aquatic Ecological Resources during the construction and operation phases

- During dam construction, the river will be diverted through a tunnel which is likely to affect the migration of blunt nosed snow trout. Moreover, construction workforce may practice fishing in the river diversion. To mitigate the impact of diversion, gentle slope and minimum depth of about 40 cm of river diversion will be maintained. Adequate knowledge will be provided to the workers on fishing regulations. Construction of the dam & road, quarrying, river diversion and other works near the riverbank and loss of riparian vegetation during construction may cause soil erosion and silt deposition into the river. Silts may block gills causing fish mortality or degrade the spawning ground. Similarly, liquid run off from the construction sites, hazardous substances and wastewater from the camps may be deposited in the river affecting the aquatic life. Riparian habitat will be restored by immediate re-vegetation with fast growing, flower and fruit bearing

native vegetation to the extent possible. Solid waste will be disposed at designated sites and the wastewater will be treated.

- Increased erosion due to the peak operations and seasonal drawdown will increase sediment in the river affecting its aquatic life. To mitigate this issue, stabilization of bank will be carried out with diligent construction practice. Riparian vegetation will be planted with local species along the bank of the river which will stabilize the river bank. Construction of dam will create a reservoir at Budhi Gandaki River upstream of the dam. A deeper reservoir is characterized by different zones which affects the species living there. Enhanced protection of the riverine ecosystem upstream of reservoir will be carried out that will mitigate the impact to riverine species such as blunt-nosed snow trout.
- To maintain the spawning ground of aquatic animals and their population, a minimum environmental flow will be maintained throughout the year. Upstream and downstream migration for *Schizothorax richardsonii* will be carried out through fish trapping and hauling activities. A fish hatchery will be established for *Schizothorax richardsonii*. Fish fingerlings developed from the fish hatchery will be released upstream and downstream of the dam and powerhouse area. Fish moving downstream may be drawn into the power plant intake flow and may die in the turbine. A physical mesh with a trash rack will be provided to prevent fish entrainment and impingement through turbines or over spillways. Animals inhabiting on riparian areas and depending on fish and other aquatic organisms will be directly affected. The fisher communities which are dependent upon fishing for livelihood might be affected. Reduction of riverine fisheries will influence the livelihood of these communities. Population of fish and other aquatic invertebrates will be maintained to the extent. Besides that, job opportunity will be provided to some of the fishermen based on their skill and intensity of impact.

Social, Economic and Cultural Environment

The project area in Chum Numbri Rural Municipality - 3, Dharche - 1 and Dharche - 3 of Gorkha District is expected to affect some of the key settlements of Salleri village of Chum Numbri -3 by the reservoir, Jagat of Chum Numbri -3, Yaruphant of Dharche 1 and Tatopani of Dharche – 3. The project will be affected due to the reduce water discharge in the Budhi Gandaki river as the water will be diverted by the dam located upstream of Jagat. Indigenous and caste groups to be affected by the project construction include Janajati such as Gurung, Ghale, Tamang and caste group (Karki) in the project areas. The majority of people among the inundated area are Gurungs.

Impacts of the project on the Acquisition of Assets and alteration of social networks

- Acquisition of the household's assets and land is one of the most significant impacts of this project which can affect some families of the project area. The principle of resettlement and rehabilitation initiative is to avoid involuntary resettlement or if unavoidable, minimize acquisitions by providing adequate compensations. The Land Acquisition Act 2034 (1977) is the main legislation to guide the land acquisition in the country. However, since most of the project structures are underground; this project is expected to have minimal impact. The analysis shows the assets which will be mostly be affected are the households near the intake structure i.e. the reservoir of Salleri Village; the access road from tail race outlet to the permanent camp site near Uiya Village and a permanent camp near Uiya Village. A total area to be acquired by the project is approximately 170 ropani. Out of 170 ropani, around 100 Ropani has been used for agriculture.
- The foot trail that passes through Jagat and Salleri is expected to be affected by the construction as well as operation of the proposed project. This trail, at the moment, is an essential part of the Manaslu Conservation trekking route and provides access for the locals to deliver goods and services. The disruption of the trail might also interrupt the social network within close settlements. However, a motarable road is being constructed as the replacement of this trail, which is expected to minimize the disruption for delivery of good and access.

Impacts on livelihoods, general economic condition and local business and industries

- Budhi Gandaki HEP may affect the route to Manaslu Conservation area which is one of the top tourist spots of Gorkha district. The construction of the project requires a large number of workers during the peak

construction period. This might affect and alter the livelihoods of the project affected families due to loss/modification in accessibility to natural resources.

- With the probability in the increase in demand of daily necessities such as food and other basic commodities, people might have to compete to access drinking water and forest resources (such as timber, herbs, shrubs, fruits etc.). Collection increase of such natural resources might result in conflicts amongst project workers and locals. Moreover, chances of illegal hunting of wild animals might also increase.
- Furthermore, the visual impact due to the construction activities might affect the scenic quality of the landscape. This might degrade the natural aesthetic of the area and cause disturbance in trekking which might affect the flow of tourist in the project area.
- The introduction of project workforce will foster the establishment of teashops and restaurants, lodges, hotels, convenience shops. The increased demand for goods and services generated by the construction of the HEP is one of the positive impacts of the project. However, due to the construction activities decline in tourist flow is plausible reducing employment opportunities from the local hotels and lodges.

Impacts on public health, water and sanitation

The project area doesn't have any government hospitals, public health facilities, clinics or medical shops. However, during the construction and operation phase of the project there might be an increase in pressure on the existing health facilities in the nearby rural municipalities. Similarly, increased pressure in existing drinking water sources might also occur due to population growth in the project area creating a negative impact to the local people.

Psychosocial Impacts of the project

The proposed Budhi Gandaki is likely to displace families from the reservoir area in Gorkha District. Involuntary displacements might cause psychological problems with the loss of livelihood and uncertainty of a secure livelihood in a new resettlement place may also create fear among the people.

Mitigation Measures (Construction Phase)

In order to minimize and compensate the negative impacts of the project, a set of compensatory and enhancement measures have been described herein.

- The project will prioritize affected families and the local inhabitants in the recruitment process. Similarly, the project will arrange for a working protocol and include it as a clause in the contractor's agreement. It will further conduct training programs to the project affected families to enhance their skills that can improve the livelihood and capacity of local population, particularly of those affected by the project, women, disadvantaged groups, and children. Training programs are proposed for skill enhancement under a Social and Environmental Management Division (SEMD) of the project.
- The project is expected to affect some of the existing community infrastructures. The project will have to support the existing health facilities and establish health units within the camps. Similarly, the drinking water sources in and around the project facilities sites are likely to face pressure from the influx of project officers, laborers and vendors.
- Furthermore, the project will provide compensation to the affected families for the land acquisition for its different project components. The consultation with local inhabitants during household surveys, as well as, numerous consultations and public hearing meetings has clarified the provision of cash for land by the local populations. The study strongly recommends land for cash compensation as a viable method. Furthermore, the land that is to be acquired temporarily will be on lease which will be restored after completion of the construction phase.
- Incidences of STDs and spreading of contagious diseases among camp population, worker's community and population in the vicinity of working areas and camp areas are likely to occur. Hence, measures should be taken to ensure rapid response with an emergency unit to handle such outbreaks.
- Measures will be placed to provide psychological counseling which will also be facilitated by managing a smooth resettlement process assuring safe and secure livelihoods to the project affected families.

- Mitigation measures will be adopted with a strict code of conduct to be operated to regulate the workforce with awareness generation trainings on the local norms and condition of the project area to avoid any social conflict.
- The project is proposing to support farmers of the project area by assisting in improve their farming capabilities for the loss of their agricultural produce. Similarly, the project will carry out agriculture based livelihood support programs to the locals which includes measures and plans aiming to compensate the production losses, enhance productivity, diversify production and improve marketing in both agriculture and livestock. These measures are organized further into different sub-plans such as Intensification of Food Production, Commercial Poultry and Dairy Farming. A non-agricultural livelihood support is also necessary for the locals in this project area with proper guidelines.

Mitigation Measures (Operation Phase)

In order to maintain the economy of the skilled labors, training sessions will be conducted prior to the project completion. Training programs will be organized particularly targeting the skilled labor force.

- Impact due to sudden release of water in to downstream may cause accidents. Thus, as a mitigation measure, a siren system will be established to make the downstream people aware about the timings of the release of water. Similarly local people will be made aware about the siren system by notifying the concerned communities about the plan of release.
- Mitigation measures will be adopted to control accidents during the operation phase such as the switch yards; surge tank areas will be fenced as a precautionary measure to restrict people's movement in the area; safety signs and posts will be erected at critical areas, and the local people will be made aware of the dangerous project areas. Moreover, after the completion of the project, a certain amount of royalty will be shared to the local body which will help to development activities in the project affected area.

ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) sets out frameworks for implementation of the mitigation measures, including environmental monitoring and auditing to be carried out during construction and operation phases of the project. The primary responsibility for implementation of EMP lies with the proponent. However, the following parties/actors will also have to be involved in this process, which include:

- Ministry of Forest and Environment (MOFE);
- Project Management Unit of the proponent of Budhi Gandaki HEP;
- Supervising Engineers for Budhi Gandaki HEP implementation;
- Construction Contractor; and
- Regional and local level political and governmental institutions (Rural and Urban municipalities)
- District Coordination Committee, Community-Based Organizations (CBOs) *etc.*

Implementation Mechanism

The institutional arrangement has been proposed for implementation of the EMP, which is presented in the figure below. A Social and Environmental Management Division is proposed to be established at the project level under the Project Director Office, which will have four dedicated units:

- Social Management Unit
- Environment Section
- Grievance Redressal Unit
- Monitoring and Evaluation Unit
- EM Unit

Environmental Monitoring

Environmental monitoring is needed (a) to ensure implementation measures of the proposed mitigating measures (b) to assess actual impacts of the project and/or if new impacts have emerged, (c) state of environmental condition of the project area. Monitoring will be done throughout the project life. Apart from

external expert monitoring, an internal monitoring by the project will be done as well as participatory monitoring involving GON or the stakeholders. Below are the main types of monitoring that will be conducted.

The Budhi Gandaki HEP will have the principal responsibility for environmental and social monitoring during the pre-construction phase.

Data and information collected on key physical, biological and social aspects in the direct impacted project area such as inundation area, project structure and activity area and other environmentally sensitive areas, and the data provided by EIA report will be updated. The Budhi Gandaki SEMD will be responsible for baseline monitoring during the pre-construction phase. Physical, biological and social aspects are highlighted. Some of the important monitoring parameters are:

- river water quality,
- air quality,
- storage and construction waste management plan,
- domestic waste management plan,
- health and safety plan,
- emergency medical response unit and other environmental plans.
- trees to be felled, compensatory plantation
- Population of threatened and rare species
- spawning ground and fisheries activity.
- information on land, buildings and other housing structures,
- Land Acquisition, Compensation, Resettlement and Rehabilitation Plan
- Environmental flow
- Reservoir shore erosion due to peaking operation
- Physical stability in and around dam site, powerhouse site and other vulnerable areas
- Siren warning system in low flow area and downstream of tailrace outlet
- Fish population and biodiversity in reservoir, low flow area and downstream of tailrace outlet
- Agriculture production programme such as fruit tree development, intensification in food production and commercial agriculture operation
- Socio-economic status of displaced people resettled in another place.

Environmental Auditing

The Environmental Audit (EA) has been proposed to assess the actual environmental impact of the project, the accuracy of impact predictions, the effectiveness of environmental impact mitigation and enhancement measures applied during construction and operation phase, and the functioning of monitoring mechanisms. It is intended that EA should relate actual impacts with predicted impacts, which help in evaluating the accuracy and adequacy of EIA predictions.

CONCLUSION AND RECOMMENDATION

The BGHEP is planned along a stretch of the Budhi Gandaki River, between Salleri Bazaar and down to Tatopani Village. The project targets to generate 341 MW of electricity. The main anticipated impacts of the project include:

- loss of land and assets of project affected people due to land permanently acquired by the project,
- changes in the river affecting aquatic life and fisheries,
- increase in slope instability and erosion,
- loss of forest and habitat fragmentation.

Mitigation and enhancement measures as part of the environmental management plan are proposed to minimize impacts and enhance community wellbeing and economic opportunities through, among others, plans for immediate catchment management, reforestation of a safeguard buffer area bordering the reservoir, health and safety measures, fisheries, and the provision of livelihood enhancement support. The measures will help minimize the ecological footprint of the project. Safeguard documents include a Resettlement and Rehabilitation Plan and an Environmental Management Plan guided by a public consultation and disclosure program. An

adaptive management process should be adopted to adjust plans according to findings from monitoring, consultations, and audits. A Social and Environment Division (SEMD) of the project will administer the EMP through the establishment of an Environmental Management Division (SEMD).

कार्यकारी सारांश

१ परिचय

बुढीगण्डकी जलविद्युत् आयोजना (३४१ मेगावाट) को सम्भाव्यता र वातावरणीय प्रभाव मूल्याङ्कन अध्ययन गर्न विद्युत् विकास विभागले सर्वेक्षण लाइसेन्स टाइम्स एनर्जी प्राइभेट लिमिटेडलाई प्रदान गरेको थियो। यस आयोजनाको वातावरणीय प्रभाव मूल्याङ्कन, वातावरणीय संरक्षण नियमावली, २०७७ अनुसार गरिएको।

२. आयोजनाको संक्षिप्त विवरण

प्रस्तावित बुढी गण्डकी जलविद्युत् आयोजना पीकिंग रन अफ रिभर (PROR) प्रकारको आयोजना हो। यो आयोजना गण्डकी प्रदेशको गोर्खा जिल्लाको धार्चे र चुमनुब्री गाउँपालिकाहरूमा अवस्थित छ। सर्वेक्षण लाइसेन्सको अनुसार भौगोलिक रूपमा यस आयोजनाको क्षेत्र देशान्तर $८४^{\circ}५५'१५''$ पुर्व देखि $८४^{\circ}५२'४०''$ पुर्व र अक्षांश $२८^{\circ}२२'००''$ उत्तर देखि $२८^{\circ}१७'००''$ को बीचमा रहेको छ। यस आयोजनाको बाँधस्थल र जलाशय चुमनुब्री गाउँपालिकामा पर्दछ, जुन मनसलु संरक्षण क्षेत्रको दक्षिणी सुरुवाती भागमा पर्दछ। आयोजनाको बाकी सबै संरचनाहरू मनासलु संरक्षण क्षेत्रको बाहिर पर्दछन्। आयोजनाका मुख्य विशेषताहरू

- यस आयोजनाको कुल क्षमता ३४१ मेगा वाट हो र यसले १९०४.७ गिगावाट प्रति घण्टाको दरले उर्जा उत्पादन गर्नेछ।
- यस आयोजनाको डिजाइन डिस्चार्ज १००.२७ घन मि प्रति सेकेन्ड हो र यसको जलाधारको क्षेत्रफल ३०७५ वर्ग कि.मी. रहेको छ।
- चुमनुब्री गाउँपालिकाको सल्लेरी गाउँ नजिकै बुढीगण्डकी नदीमा ३६ मि. अग्लो कन्क्रिट ग्रयाविटि बाँध बनाउने प्रस्ताव गरिएको छ, जसको कारणले नदीको हालको पिँधबाट पानीको सतह ३३ मि. ले माथि उठने छ।
- बाँधको कारणले करिब २ कि. मि. लामो जलाशय बन्नेछ। बाँधले पानीको सतहलाई करिब १३२५ मि को उच्चतम नियमित तह (Highest Regulated Water Level) सम्म ल्याउदा, करिब १९०,००० वर्ग मि को जलाशय बन्नेछ, जसमा करिब १७ लाख ६० हजार घन मि पानीको भण्डारण हुनेछ।
- नदीको दायाँ किनारामा ६ वटा इनटेकहरू (४ मि चौडा र ६ मि अग्लो) बनाउन प्रस्ताव गरिएको छ।
- बाँधबाट पानीलाई विद्युत् गृहसम्म पुर्याउन करिब ६,६५४ मि लामो सुरङ्ग (Headrace tunnel)को निर्माण प्रस्ताव गरिएको छ, जुन जगत गाँउबाट शुरु भइ भिन्चेत गाँउमा टुन्गिनेछ।
- उइया गाँउको उत्तरपूर्वी किनारामा करिब २२ मि व्यास भएको सर्जशाफ्ट (Surge Shaft) को निर्माण प्रस्ताव गरिएको छ।
- तातोपानी गाँउ नजिकै बुढीगण्डकी नदीको दायाँ किनारामा भूमिगत विद्युत् गृह प्रस्ताव गरिएको छ, जसमा ६०.४३ मेगावाट क्षमताको ६ वटा पेल्टन टर्बाइनहरू रहनेछ।

- यस विद्युत गृहबाट बुढीगण्डकी नदीमा पानी सुरुङ्गको (Tailrace tunnel) माध्यमबाट फर्काइने छ, जुन तातोपानी गाँउ नजिकैको झुलुङ्गे पुलभन्दा करिब १०० मि माथि रहनेछ ।

३ विधिहरू

यस वातावरणिय प्रभाव मूल्याङ्कनमा स्थलगत अध्ययनबाट उत्पादित प्राथमिक डाटा तथा सूचनाको साथै उपलब्ध भएका तथा प्रकाशित डाटा, म्याप, प्रतिवेदन आदि समावेश गरिएको छ। प्राथमिक सूचना तथा डाटा संकलन गर्ने क्रममा, अध्ययन टोलीले प्रभावित परिवारहरूसंग प्रश्नावली सर्वेक्षण, फोकस ग्रुप विमर्श, परामर्श मिटिङ्गहरू संचालन गरेको थियो। यसको अलावा अध्ययन टोलीले मिति २९ फेब्रुअरी २०२० (१७ फाल्गुन २०७६) मा आयोजना क्षेत्रको जगत बगरमा सार्वजनिक सुनवाई कार्यक्रम संचालन गरेको थियो ।

३.१ आयोजना क्षेत्र

आयोजना क्षेत्र भन्नाले आयोजनाको संरचना(संरचनामा) रहने बुढीगण्डकी नदी र यसका सहायक खोलाहरूको उपत्यका र त्यहाँ अवस्थित खेतबारी, वनजङ्गल, वस्ति आदिलाई बुझाउन्छ जहा आयोजनाले “प्रत्यक्ष” तथा “अप्रत्यक्ष” प्रभाव पार्न सक्छ । आयोजनाको संरचना रहने चुमनुब्री गाउँपालिकाको वडा नं — ३ तथा धार्चे गाउँपालिकाको वडा नं १ र २ लाई यस अध्ययनमा “आयोजनाको प्रभावित क्षेत्र” मानिएको छ। जसलाई विद्युत विकास विभागबाट जारी गरिएको यस आयोजनाको सर्वेक्षण लाइसेन्समा उल्लेख गरिएको छ । आयोजना क्षेत्रलाई २ क्षेत्रहरूमा विभाजित गरिएको छ -“प्रत्यक्ष प्रभावित क्षेत्र” र “अप्रत्यक्ष प्रभावित क्षेत्र । प्रत्यक्ष प्रभावित क्षेत्र- भन्नाले त्यस्तो क्षेत्र बुझिन्छ जहाको वातावरणिय अवस्थालाई आयोजनाले प्रत्यक्ष प्रभाव पार्न सक्छ । मुख्य प्रत्यक्ष प्रभावित क्षेत्रहरू तल उल्लेख गरिएको छ:

- जलाशयले डुवान गर्नसक्ने वा निर्माण स्थल वा निर्माण कार्यले प्रत्यक्ष प्रभाव पार्ने वनजङ्गल, खेतबारी, बाटोधाटो आदि ।
- (स्थायी तथा अस्थायी रूपमा अधिग्रहण गरिने क्षेत्र जहाँ आयोजनाको विद्युत गृह, एडित साइट, आयोजनाको स्थायी तथा अस्थायी शिविर क्षेत्र, खानी, निर्माण फोहर विसर्जन स्थल, पहुच सडक आदी स्थापना गरिनेछ ।
- जगत बगर स्थित बाँधबाट बुढीगण्डकीको पानी headrace सुरुङ्ग मार्फत फर्काइनेछ र यो पानी तातोपानी स्थित विद्युत् गृहमा विजुली उत्पादन गरिसकेपछि पुनं टेलरेस आउटलेटबाट बुढीगण्डकी नदीमा छोडिनेछ । बाँधदेखि टेलरेस आउटलेटसम्म बुढीगण्डकी नदीमा पानीको बाहाव कम हुनेछ । त्यसकारण नदीको यो भागलाई पनि प्रत्यक्ष प्रभाव क्षेत्रमा राखिएको छ ।

अप्रत्यक्ष प्रभाव क्षेत्र भन्नाले आयोजनाको संरचना रहेको वरिपरिका क्षेत्र जहाँ आयोजनाले त्यहाँका बासिन्दाहरूमा आंशिक प्रभाव पार्न सक्दछ । जस्तै: आयोजनाले आफ्नो जमिन वा सम्पतिको केहि अंश वा उपयोग गरिरहेको वनजङ्गल वा चरनको सानो अंश, सामुदायिक संरचनामा केहि आंशिक असर आदी ।

यसमा आयोजनाको कारणले वन्यजन्तुको चरण, हिडडुलमा अवरोध जस्ता कारणले हुनसक्ने वासस्थानको विखण्डिकरणलाई पनि राखिएको छ।

आयोजना प्रभावित परिवार भन्नाले ती परिवारहरू बुझिन्छ जो प्रत्यक्ष वा अप्रत्यक्ष प्रभाव क्षेत्रमा बसोवास गर्छन्, र जसको जमिन, सम्पति, वा जिविकोपार्जनमा आयोजनाको निर्माण वा संचालनले प्रभाव पार्न सक्छ।

जम्मा आवश्यक जमिन

आयोजनाका विभिन्न संरचना निर्माणको लागि जम्मा ५६.२२ हेक्टर जमिन चाहिन्छ। जसमध्ये ४९.६२ हेक्टर स्थायी रूपमा र ६.६ हेक्टर अस्थायी रूपमा आवश्यक छ। यस आयोजनामा जम्मा सरकारी जग्गा ४९.६५ हेक्टर आवश्यक रहेकोमा मनास्लु संरक्षण क्षेत्रको १३.६१ हेक्टर मध्ये १२.०१ हेक्टर स्थायी रूपमा र १.६८ हेक्टर अस्थायी रूपमा रहेको छ। त्यसैगरी राष्ट्रिय वनको ३५.९६ हेक्टर जमिनमध्ये ३१.०४ हेक्टर स्थायी र ४.९२ हेक्टर अस्थायी रूपमा आवश्यक छ। यस आयोजनाको लागि स्थायी रूपमा कूल ६.५७ हेक्टर निजी जमिन आवश्यक रहेको छ।

क्र.स.	स्थायी/ अस्थायी सुविधा	आवश्यक जग्गा (हे.)			कूल (हे)
		राष्ट्रिय वनको जग्गा	निजी	मनास्लु संरक्षण क्षेत्र	
क.	स्थायी	३१.०४	६.५७	१२.०१	४९.६२
ख.	अस्थायी सहायक सुविधाहरू लागि आवश्यक जग्गा	४.९२	०	१.६८	६.६०
(क+ख)	कूल	३५.९६	६.५७	१३.६९	५६.२२

४ विद्यमान वातावरणीय अवस्था

४.१ भौतिक वातावरण

फिजियोग्राफी, टोपोग्राफी र भूमि प्रयोग

आयोजनाले प्रभावित पार्ने गाँउपालिकाहरू मुख्यतया उच्च हिमाली क्षेत्र (५३%) र मध्य पहाडी क्षेत्रमा पर्दछन्। बुढिगण्डकी नदीको उपत्यकामा अधिकांश भागहरूमा ठाडो भिरालाहरू छन् र भिरालोपन ३० देखि ७५ डिग्री सम्म रहेका छन्। यसको माथिल्लो भेगमा धेरैजसो हिमपात हुने गर्दछ भने, तल्लो भेगमा तेज मनसुनी वर्षा हुने गर्दछ। मनसुनी मौसममा यस नदीको उपत्यकामा भू-क्षय र पहिरो जाने गर्दछ। यस नदी उपत्यकाको धेरैजसो भू-भागमा मानिसको बासोवास, बजार व्यवसाय र कृषजन्य गतिविधिहरू न्यून भएको कुरा यहाँको भू-उपयोगले जनाउँछ। यसको मुख्य कारण यहाँको भू-बनोट, कठोर मौसम र कम विकसित पुर्वाधार हुन सक्दछ।

आयोजनालाई यस क्षेत्रका जग्गाजमिनको आवश्यकता स्थायी र अस्थायी दुवै आधारमा पर्दछ। खानी, निर्माण, फोहर विसर्जनको स्थान, कफर बाँध जस्ता संरचनाहरूकोलागी आयोजनालाई अस्थायी आधारमा

जग्गा जमिनको आवश्यकता पर्दछ, जसको लागि कुल क्षेत्रफल करिब ४.८६ हेक्टर सम्मको जग्गा जमिनआवश्यक छ। आयोजनाको मुख्य संरचनाहरू भूमिगत भएको हुनाले स्थायी आधारमा आयोजनालाई थोरै जग्गाजमीनको मात्र आवश्यकता पर्नेछ, जसमा जलाशय, बांध, शिविरहरू, पहुच सडक आदि जस्ता आयोजनाका संरचनाहरू पर्दछन्। स्थायी आधारमा आवश्यकता पर्ने जग्गाजमिनमा ११.८५ हेक्टर नदी किनारको वालुवा-गिटि र ढुङ्गा रहेको क्षेत्र, ९.८७ हेक्टर झाडी र घांस रहेको क्षेत्र, र करिब ८.७ हेक्टर वनजङ्गल रहेको क्षेत्र छ।

आयोजनाले स्थानिय निकाय र समुदायहरूसंग समन्वय गरि आवश्यकता पर्ने स्थायी र अस्थायी जग्गा जमिनहरूको अधिग्रहण गर्नुपर्नेछ। स्थायी आधारमा अधिग्रहणको क्षतिपुर्ति र पुनर्स्थापना आदीको विधिहरू यस रिपोर्टको सामाजिक कार्यक्रमको अंशमा विस्तृतरूपमा छलफल गरिएको छ। अस्थायी आधारमा प्रयोग गरिने जग्गा जमिनको उचित पुनर्स्थापना गर्नुपर्ने हुन्छ। यसको सुरुवाती संरचना बनाउन अघि नै अस्थायी संरचना बनाउने साइटको माथिल्लो उर्वर माटोको संकलन गरिने छ, जसको प्रयोग ति साइटहरूको पुनर्स्थापना गर्न प्रयोग गरिनेछ। आयोजनाले संचालन गर्ने वृक्षारोपन यि साइटहरूलाई प्रथमिकतामा राखि गरिनेछ।

भूविज्ञान तथा भूस्थायित्व

आयोजना क्षेत्र ग्रेटर हिमालयको ortho / para-gneiss क्षेत्रमा अवस्थित छ। यो मुख्य केन्द्रीय थ्रस्ट (MCT) प्रणालीको करिब १-२ किमी उत्तरमा अवस्थित छ। बुढीगण्डकी नदी, मनास्लु हिमालयन रेन्जको crystalline rock हरूको ठाडो भिरालो भएको साधुरो नदी उपत्यकाबाट बग्दछ। साथै यस आयोजनाको सबै संरचनाहरू बुढीगण्डकी नदीको दाँया किनारामा पर्दछ, जहाँ भिरालो चट्टनै चट्टानहरू रहेको छ।

स्थलगत अध्ययनको क्रममा आयोजनाको संरचना रहेको नदीको दाँया किनारामा कुनै स्थानमा पनि पहिरोहरू रेकर्ड गरिएन, तथापि देब्रे किनारामा केहि स्थायी पहिरोहरू रहेको पाइयो। यद्यपि भारी वर्षा र भूकम्पको परिणामस्वरूप colluvium masses हरू भिरहरूमा जम्मा भएकोले निर्माणको क्रममा विस्फोटकको प्रयोग गर्दा अस्थिर भई भू-क्षय र पहिरो जानसक्ने सम्भावना रहेको छ। पहिरोको सम्भावना रहेको ठाँउहरू मध्ये एक जलाशय क्षेत्र हो। हाल सल्लेरी गाँउ पुरानो पहिरोले थुपारेको colluvial deposit मा अवस्थित छ, जुन जलाशय बनिसकेपछि पानीको लगातार सम्पर्कमा आई अस्थिर हुन सक्ने सम्भावना रहेको छ।

- तटबन्ध, ढलान कोण घटाउने, पानिको निकास गर्ने ग्यालरी नालीहरू जस्ता न्यूनिकरणका उपायहरू कार्यान्वयन गरि सम्भावित स्लाइडहरू हटाउने या नियन्त्रण गर्ने।
- सल्लेरी गाँउको भिरहरूको संरक्षण बाहेक त्यहा बसोबास गरिरहेका परिवारहरूलाई अन्य स्थानमा स्थानान्तरण गर्ने विकल्प पनि प्रस्ताव गरिएको छ, जुन यस रिपोर्टको सामाजिक अंशमा वर्णन गरिएको छ।

मौसम

आयोजना क्षेत्रको भू-बनोट र फराकीलो उचाइको दायराको कारणले गर्दा यहा मौसमी बिबिधता पाइन्छ । यस क्षेत्रमा उप-उष्णकटिबन्धीय क्षेत्रदेखि अल्पाइन मौसम पाइन्छ । साथै यहाँको मौसममा मनसुनी वर्षाको बलियो प्रभाव पनि छ । यस क्षेत्रमा पर्ने पानीको करिब बर्षको ८०% मनसुनी वर्षाले ल्याउन्छ । यस क्षेत्रको भू-क्षय तथा पहिरोको मुख्य कारणहरू मध्य मनसुनी वर्षा रहेको कारणले आयोजनाको संरचनाको डिजाइनमा वर्षाको मात्रा र तीव्रतालाई पर्याप्त ध्यान दिनुपर्ने आवश्यकता छ ।

हिमताल विष्फोटन

ICIMOD ले विष्फोट हुने सम्भावना रहेको हिमताल भनि पहिचान गरेको बुढिगण्डकी नदीको जलाधारमा अवस्थित ægabud_gl_0009æ ताल हो, जसलाई स्थानियहरूले “बिरेन्द्र ताल” भनि चिन्दछन । यद्यपि हालैको ICIMOD ले नै प्रकाशन गरेको “हिमनदी तालको इन्भेन्टरी (२०१८)” मा अब विष्फोटको सम्भावना नरहेकोले यसलाई सम्भावित खतरनाक हिमतालको सूचीबाट हटाएको छ । त्यस कारण हाल यस क्षेत्रमा हिमताल विष्फोटको सम्भावना अपेक्षित छैन ।

जलविज्ञान र वातावरणीय प्रवाह

बुढी गण्डकीको बहाबको अध्ययनको खुलासा अनुसार अगस्ट महिनामा नदीको डिस्चार्ज सबैभन्दा उच्च रेकर्ड गरियो जुन ३७७ घन मी प्रति सेकेन्ड रहेको थियो र सबैभन्दा सुक्खा महिनामा (फेब्रुअरी) यसको बहाब घटेर २२.५ घन मी प्रति सेकेन्ड रहेको थियो । बाँधले अधिकांश डिस्चार्ज पावरहाउसमा फर्काउन्छ, जसले गर्दा बाँध र टेलरेसको बीचमा बुढीगण्डकी नदीको डिस्चार्जलाई न्यून पार्दछ । यद्यपि यस भागमा पानीको कुनै किसिमको उपयोग स्थानिय समुदायबाट नभएको स्थलगत अध्ययनमा भेटियो । आयोजनाले नदीको यस भागमा वातावरणीय प्रवाह कायम राख्न अत्यन्त आवश्यक छ । यसैले, आयोजनाले २.३ घन मी /सेकेन्ड डिस्चार्ज कायम राखिनेछ । मनसुन अवधि (जुन - सेप्टेम्बर) मा, डिस्चार्ज ९२ घन मी /सेकेन्ड देखि २७७ घन मी/सेकेन्डको बीचमा हुन्छ ।

ध्वनि, वायु र पानीको गुणस्तर

निर्माणाधिन सडक यस क्षेत्रमा आवाजको प्राथमिक स्रोत हो । यद्यपि सवारी साधन आवागमन निकट भविष्यमा सुरु हुने अपेक्षा गरिएको छ, जसले ध्वनिको तिब्रता बढाउने छ । नदीको पानीमा गरिएको पानी गुणस्तर परिक्षणले प्रदूषण नरहेको देखाएको छ । नदीमा मानव फोहोरको कारणले जगत र यारुफांटको बस्ती नजिकैका स्टेशनहरूमा जैविक प्रदूषण देखिएको थियो । हावाको गुणस्तर अझै पनि आयोजना क्षेत्रमा

सफा छ । हाल यस क्षेत्रमा सडक निर्माणको चरणमा छ, र जसको ड्रिलिंग र ब्लास्टिंगले वायु प्रदूषणको स्तरमा उल्लेखनीय वृद्धि भएको देखिदैन । यद्यपि सडक सञ्चालनले प्रदूषणको स्तर बढाउने अपेक्षा गरिएको छ ।

४.२ जैविक वातावरण

वनस्पतिक विविधता

आयोजना क्षेत्र तुलानात्मक रूपमा वानस्पतिक विविधताका दृष्टीले समृद्ध पाइएको छ । चट्टानयुक्त भू-बनोट भएकाले यहाँ जीव जन्तुकालागि पनि विविध किसिमको बासस्थान रहेको छ । आयोजना निर्माणस्थल र यस सम्बद्ध अन्य निर्माणस्थलहरूमा पाइएका विरुवाका प्रजातिहरूमा सल्ला, टूनी, काफल, खनायो, बकाइनो, खिरो, बैस, उत्तीस, मयल, जामुन, साँदन, चिलाउने, दार, गुंलो, चिउरी, मलातो, हाडे बयर, लोदो, चुलेत्रो, तेजपात, आँखितारे, वन काँगियो, सिरिस, अंकोल, पहाडी मौवा, फलेदो, अमला, आदि रहेका छन् ।

यत्रतत्र पाइएका बुट्यान तथा स-साना झारपातहरूमा चुत्रो, भकिअमिलो, बिलाउने, भोगटे, जंगली गुलाब, धुर्सुल, गूएली, सिस्नु, भलायो, अल्लो, धएरो, ऐसेलु, खरेटो, रातो चुलसी/सेतो चुलसी, तितेपाती, गाँजा, पाखनबेद, निउरो, पंखाफूल, अमिसो, धतुरो, कुमकुम, दुबो, चरी अमिलो, उन्नु, सर्पको मकै, कुरिलो, आदि रहेका छन् । यहाँ कुल ८६ प्रकारका वनस्पतिक प्रजातिहरू भेटिएका छन् जसमध्ये थुप्रै वनस्पतिहरूको औषधीय महत्व तथा जनजातिगत उपयोग रहेको छ । आयोजना क्षेत्रमा साइटिसको अनुसूची II मा पर्ने सुनगाभाका दुइ प्रजातिहरू पनि भेटिएका छन् जसलाई नियमित वा नियन्त्रित व्यापारको आवश्यकता पर्दछ ।

वन व्यवस्थापन प्रणाली

आयोजनाको प्रभाव क्षेत्रमा पर्ने वनहरूको व्यवस्थापन स्थानीय वन उपभोक्तासमूहहरूले गरि आएका छन् । मनास्लु संरक्षण क्षेत्र भित्रका वनहरूलाई, जहाँ आयोजनाको मुख्य संरचना अर्थात् बाँधस्थल रहेको छ, मनास्लु संरक्षण क्षेत्र वन विकास समितिले व्यवस्थापन गरिरहेको छ । चुमनुब्री गाउँपालिकाको वडा नं १, सिर्दिबासमा कमलाडाँडा सामुदायिक वन उपभोक्तासमूहले व्यवस्थापन गरेको छ । न्यूनतम जाला बहाव क्षेत्र र विद्युत गृह क्षेत्रमा सल्लाघारी वन उपभोक्तासमूह र दोभान वन उपभोक्ता समूह (केरौँजा गाउँपालिकाको वडा नं ७, ८ र ९), बेंडराँग सातकन्या सामुदायिक वन उपभोक्तासमूह (उइया गाउँपालिकाको वडा नं १, ३ र ३) ले वन क्षेत्रको व्यवस्थापन गरेका छन् । त्यसैगरी, धार्चे गाउँपालिकाको वडा नं ५ मा गुडदाड सामुदायिक वन उपभोक्तासमूहले वनको व्यवस्थापन गरिरहेको छ ।

कृषि-बालीको विविधता

आयोजना क्षेत्रमा पाइने मुख्य कृषि उत्पादनहरूमा घैया, मकै, कोदो, जौ, फापर, आदि रहेका छन् । यहाँ धानको खेती गरिदैन । प्रायः सबैजसो मसला बाली र तरकारीको खेती गरिन्छ जसमा अदुवा, लसुन, प्याज,

खुर्सानी, आलु, बन्दा, लौका, काँक्रो, टमाटर, फर्सी आदि पर्दछन। फलफूलहरू मध्ये कागती, सुन्तला, आरु, आलुबखडा, केरा, नास्पाती आदि लगाइन्छन्। डालेघाँस हरुमा खनायो, निभारो, चिउरी, आदि प्रचलित छन्। आयोजना संचालनबाट निर्माण अबधिमा निम्न लिखित प्रभावहरू पर्ने देखिन्छ

- आयोजनाको संरचना र अन्य सहयोगी निर्माण कार्यको लागि १६.५२ हेक्टर वन क्षेत्र हटाइने छ जसमा बुट्यानहरू र चरण क्षेत्र समेत पर्दछन। वन तथा बुट्यान क्षेत्रबाट रुख र पोल (उयभि) आकारका गरी जम्मा १६३६ वटा रुखहरू कटानमा पर्ने छन्। यसरी कटान हुने क्षेत्रमा राष्ट्रिय वन, सामुदायिक वन र समुदाय व्यवस्थित संरक्षित क्षेत्रका वनहरू पर्दछन।
- प्राकृतिक वनबाट मानव निर्मित वातावरणमा हुने भू-उपयोगको परिवर्तनबाट वन प्रणालीको गतिशीलतामा उल्लेख्य परिवर्तन आउने देखिन्छ। यसरी एउटै चक्लाबन्दीमा रहेको वन भन्दा पारिस्थितिक प्रणालीबाट पाइने विभिन्न सेवामा कमी आउन सक्ने।
- आयोजना प्रभाव क्षेत्रमा अनेकौं प्रकारका वन पैदावारहरू पाइन्छन जसमा औषधीय महत्व भएका जडीबुटीहरू र सुगन्धित विरुवाहरू पर्दछन। यहाँ पाइने गैर काष्ठ वन पैदावारहरूमा रेसादार वनस्पति, धार्मिक महत्वका साथै शोभनीय बोट विरुवा पर्दछन। यस्ता विरुवाको क्षतिबाट स्थानीय समुदाय परम्परागत रूपमा लामो समय देखि गर्दै आएको उपभोगबाट बन्चित हुन जान्छ।
- आयोजना क्षेत्रमा प्राकृतिक रूपमा हुर्की बढेका अनेकौं वनस्पतिका प्रजातिहरू पाइन्छन जसले पारिस्थितिक प्रणालीलाई सन्तुलनमा राखी जैविक विविधताको महत्व बढाउँदछन। यस्ता वनस्पतिहरू लोप हुँदै गएमा तिनीहरूको जीवन चक्रमाथि असर पर्न सक्ने र पारिस्थितिक प्रणालीको कार्य क्षमतामा हास आउने छ।
- आयोजना निर्माण क्षेत्र, खासगरी खानी या ढुंगा उत्खनन क्षेत्र, पहुँच मार्ग, शिविरस्थल तथा आसपासका क्षेत्रहरू निर्माणकार्यले गर्दा बढी संवेदनशील हुन पुग्दछन। जलाशय क्षेत्र र विद्युतगृहको वरिपरिका ठाँउहरू सम्वेदनशील र सम्भावित भू-स्खलन क्षेत्रहरू हुन। डुबानका कारण वनस्पति र वन्यजन्तुको बासस्थानमा प्रतिकूल प्रभाव पर्न जान्छ जसभित्र दुर्लभ, संकटापन्न, संवेदनशील र संरक्षित वनस्पति र वन्यजन्तुका प्रजातिहरू समेत समावेश भएका हुन्छन। आयोजना प्रभाव क्षेत्रमा साइटिस अनुसूची २ मा परेका सुनगाभाका दुई प्रजातिहरू मात्र भेटिएका छन्।
- ठुलो संख्याका श्रमिकहरूको उपस्थितिले गर्दा दाउराको लागि वन क्षेत्रमा चाप पर्न सक्दछ। साथै अस्थायी छाप्रो तथा टहरा निर्माणका लागि काठहरूको जरुरत पर्न सक्छ। आयोजना क्षेत्रको आसपासमा बस्ने स्थानीय बासिन्दाहरूका हकमा पनि यो कुरा लागु हुन्छ। यस्ता गतिविधिहरूले वनको हैसियतमा हास आउँछ।
- आयोजनाको क्रियाकलापले गर्दा कृषि विविधता तथा कृषि उत्पादनमा हास आउन सक्दछ जहाँ स्थानीयरूपमा पाइने अन्नबाली, दलहन, तरकारी, फलफूलका रुखहरू, डालेघाँस र परम्परागत कृषि कार्यमा उपयोग हुँदै आएका अन्य वनस्पतिहरू पर्दछन। साथै, विकासको बढ्दो क्रियाकलापका कारण परम्परागत रूपमा खेती गरिँदै आएका रोग प्रतिरोधी प्रजातिहरूको बाली लगाउने क्रम घट्दै जान सक्छ। यसले गर्दा सामाजिक प्रचलनमा परिवर्तन आइ नयाँ र विकासे बालीका

प्रजातिहरू लगाउनाले परम्परागत रूपमा संरक्षित हुँदै आएका बंशाणुस्रोतको उपलब्धतामा प्रतिकूल प्रभाव पर्दछ ।

- जानाजान वा अन्जानमा हुन जाने आगलागीबाट वनको ठुलो हिस्सा प्रभावित हुन सक्छ जसबाट त्यस क्षेत्रमा पाइने वा स्थानान्तरित भइ आउने वन्यजन्तुहरूलाई गम्भीर असर पर्न सक्छ। वन्यजन्तु पक्रन र गाइ वस्तुलाई खुवाउने नयाँ घाँस उमार्न पनि आगो लगाइने गरिन्छ। आयोजनाको परिदृश्यमा, आयोजनास्थलका श्रमिकहरूद्वारा जानाजान वा अज्ञानताबस आगो लगाउन सक्ने सम्भावनाहरू देखिन्छन जसलाई नकार्न सकिन्न ।
- आयोजना निर्माण क्षेत्र, मुख्यतया बाँध निर्माण र डुबान क्षेत्र मनास्लु संरक्षण क्षेत्रको किनारामा पर्ने हुँदा निर्माण चरणमा यसमा मध्यमस्तरको मात्र प्रभावपर्न सक्ने पूर्वानुमान गरिएको छ।

संचालन चरणमा

आयोजनाबाट निम्न प्रकारका प्रभावहरू पर्न सक्ने अनुमान गरिएको छः

- संचालन चरणमा पनि आयोजना क्षेत्र, खासगरी निर्माणस्थलको निकटका स्थानहरूमा पहिलेको भन्दा सहज पहुँचका कारण प्रभाव रही रहने छ र आयोजनामा बाँकी रहेका कर्मचारीका साथै स्थानीय बासिन्दाका लागि काठ, दाउरा, वन्यजन्तुको आकर्षण रही रहन सक्नेछ ।
- आयोजना क्षेत्रमा वनस्पतिका दुर्लभ, सकटापन्न, जोखिम—उन्मुख र संरक्षित प्रजातिहरू रहेका छन् जसमा जमीनमा पाइने अथवा रुखका फेद वा हांगामा हुने सुनगाभाका प्रजातिहरू पाइन्छन जसलाई नियन्त्रित व्यापारद्वारा व्यवस्थित गरिएको छ । सहज पहुँचका कारण तिनीहरूको अबैध संकलन र प्रयोगका अवसरहरू अझै बढ्न जाने देखिन्छ ।

निर्माण तथा संचालन चरणमा गरिने न्यूनीकरणका कार्यहरू

निर्माण चरण

- वन क्षेत्रमा हुने नोकसानीका लागि क्षतिपूर्ति स्वरूप गरिने वृक्षरोपण र बाँकी रहेका वन क्षेत्रमा संरक्षण कार्यद्वारा यसमा परेको प्रभावलाई न्यूनीकरण गर्नुपर्ने हुन्छ। निर्माण कार्यका लागि आयोजनास्थलबाट करीब १३१७ वटा रुखहरू कटान गर्नुपर्ने देखिन्छ जसमध्ये ८६ वटा मनास्लु संरक्षण क्षेत्र भित्रबाट र १२३१ वटा संरक्षण क्षेत्र बाहिरबाट हटाउनु पर्ने अनुमान गरिएको छ। यसैले क्षतिपूर्ति स्वरूप गरिने वृक्षरोपणका लागि कूल विरुवाहरूको संख्या १४४६० हुन जान्छ जसमध्ये २१५० विरुवाहरू मनास्लु संरक्षण क्षेत्र भित्र लगाइनेछ भने बाँकी १२३१० विरुवाहरू मनास्लु संरक्षण क्षेत्र बाहिर लगाइने छन। साथै रुखहरू कटान गर्ने, थुपार्ने र ढुवानी गर्ने कार्यका लागि आवश्यक खर्च समेत सम्बन्धित संस्था तथा सरोकारवालालाई उपलब्ध गराइनेछ। जिल्ला वन कार्यालय र मनास्लु संरक्षण क्षेत्र व्यवस्थापन प्रणाली अन्तर्गतका सामुदायिक वन उपभोक्ता समूहका पदाधिकारीहरूसंगको समन्वयमा वृक्षरोपणका लागि उपयुक्त स्थानको छनोट गरिने छ र रोपिएका प्रजातिहरूको संरक्षणका लागि तारबार गर्ने, नियमित रूपमा पानी हाल्ने, स्याहार सम्भार र हेरचाह गर्ने व्यवस्था मिलाइनेछ ।

- आयोजना निर्माण स्थलहरू औषधीय र अन्य गैर काष्ठ वन पैदावरका दृष्टिले समृद्ध पाइएकोले यी स्थानहरू खाली गराउँदा महत्वका विरुवाहरू पनि स्वतः बढारिने छन् । यसैले आयोजना कार्यान्वयन हुनु पूर्व नै यहाँको व्यवस्थापन समूहलाई यी वन पैदावारहरूलाई संकलन गर्न दिईने छ । तर आयोजनाको आसपासमा रहेका वनस्पतिको संरक्षणका लागि सामान्य निर्देशन र सचेतनाका कार्यक्रम संचालन गरी श्रमिकहरूको ज्ञानको स्तर बढाइने छ । तर गैरकानुनी ढंगले अनुचित लाभ लिन चाहने हरुलाई भने आयोजना कार्यान्वयन निकायबाट स्वीकृत आचारसंहिता बमोजिम सजाय गरिने छ ।
- श्रमिकहरूलाई हिंडडुल गर्दा र आयोजनामा कामगर्दा होशियार रहन निर्देशन दिइने छ जसबाट वनस्पतिका प्रजातिहरूमा नोक्सान हुन नहुने । साथै उनीहरूलाई जैविक विविधताको महत्व र वातावरणीय सन्तुलन कायम राख्न यस्ता जैविक प्रजातिहरूको भूमिकाबारे सचेतना कार्यक्रम मार्फत जागरुक बनाइनेछ । तथापि यस्ता निर्माण कार्यमा यहाँ पाइने प्रजातिहरूको पूर्ण सुरक्षण हुन नसक्ने हुँदा आयोजना क्षेत्र आसपासका अनुत्पादक तथा कम हैसियत भएका जमीनहरूमा वृक्षरोपण गरी हरियाली बढाउँदै वनस्पतिका प्रजातिहरू हुर्कन सक्ने उपयुक्त अवस्था निश्चित गरिनेछ ।
- प्रतिकूल भू-बनोटका कारण आयोजना निर्माण स्थलमा संरक्षित प्रजातिमा पर्ने रुखहरू समाहित भएका छैनन् । तथापि, यस्तो समूहमा पर्ने लहरा एवं स—साना वनस्पतिहरूलाई स्थानान्तरण गरी बचाइ राख्न सुझाव गरिएको छ । आयोजनाको सन्दर्भमा यहाँ नियन्त्रित व्यापारभित्र पर्ने केही सुनगाभाका प्रजातिहरू रहेका छन् र तिनीलाई नजिकैको उपयुक्त बासस्थानमा 'स्थानान्तरित संरक्षणका हिसाबले सारिने छ जहाँ तिनीहरू प्राकृतिक रूपमा हुर्कन र फैलिन सक्नेछन् ।
- न्युनीकरणको कार्यलाई दिगो बनाउन वृक्षरोपण, संरक्षण कार्यक्रम र उपयुक्त वातावरण संरक्षणका उपायको अबलम्बन गरेर मात्र उपरोक्त नतिजा हासिल गर्न सकिन्छ । तथापि, सहज पहुँचका कारण उत्साहित भइ श्रमिकहरूद्वारा हुनसक्ने वन्य—स्रोतको संकलन रोक्न दैनिकरूपमा गरिने नियमनका विषयहरू, लक्षित समूह लाइ कठोर
- नियमन र सचेतनाका कार्यक्रम लागु गरेर मात्र सम्भव हुन्छ जसमा कामदारहरूलाई बर्खास्त गर्ने सम्मका कदम पर्दछन् । श्रमिक तथा कामदारहरूलाई मट्टीतेल जस्ता इन्धनका वैकल्पिक स्रोतहरू उपलब्ध गराइनेछ, इन्धनको वैकल्पिक स्रोत पर्याप्त नभएमा मात्र वन क्षेत्रबाट सुकेका मुढा र हाँगाहरूमात्र संकलन गरी ल्याउन अनुमति दिइनेछ । आयोजनामा कार्यरत कर्मचारी र श्रमिकहरूलाई वन वातावरण र स्वस्थ पारिस्थितिक प्रणालीको महत्वका बारेमा सचेतना कार्यक्रम संचालन गरिने छ जसबाट काठ र दाउराको अवान्छित प्रयोगलाई निकै हदसम्म नियन्त्रण गर्न सकिनेछ ।
- सम्भव भएसम्म स्थानीय बासिन्दाहरूलाई परम्परागतरूपमा गरिदै आएका कृषि बाली नै लगाउन प्रोत्साहित गरिने छ. आवश्यक बिउ बिजन र प्राविधिक सहयोगका लागि जिल्ला कृषि विकास कार्यालयसंग परामर्श गरिने छ ।
- आयोजनास्थलको वरिपरी, खासगरी विद्युत गृह र आंशिक रूपमा जलाशय क्षेत्रको वन जंगल वन— डढेलोका हिसाबले बढीनै जोखिमपूर्ण छ र आगलागी भइ हालेमा नियन्त्रण गर्न कठिन छ

। स्थलगत अध्ययनका क्रममा यहाँ कतिपय वन्यजन्तु र चराचुरुङ्गीहरू देखिएका थिए । निर्माण जनशक्तिका लागि मात्र नभइ स्थानीय बासिन्दालाई समेत यसका गम्भीर परिणाम र पूर्वानुमान गर्न नसकिने क्षतिबारे अबगत गराउन सचेतना कार्यक्रम संचालन गरिने छ, यस्ता प्रकोप नियन्त्रण गर्न साधन सम्पन्न जिल्ला वन कार्यालय संग परामर्श गरिने छ ।

संचालन चरण

- आयोजना क्षेत्र, खासगरी आयोजना कार्यान्वयनस्थल वरिपरिका स्थानहरूमा व्यापकरूपमा वृक्षरोपण कार्यक्रम संचालन गरिने छ, जसबाट वन क्षेत्रमा पने प्रभावलाई हदसम्म न्यूनीकरण गरिने छ । यसबाट त्यस क्षेत्रमा रहेका वन्यजन्तुहरूको लागि उपयुक्त वासस्थानको सुनिश्चितता हुन जानेछ । तथापि, गैर कानुनी रूपमा गरिने काठ दाउरा संकलन र चोरीशिकारीलाई निरुत्साहित गर्न सबल सतर्कता संयन्त्रको विकास गरिनुका साथै वन तथा वन्यजन्तुहरूको महत्व बुझाउन सचेतना कार्यक्रम समेत संचालन गरिनेछ ।
- संचालन चरणमा वृक्षरोपण गरिएका रुखका प्रजातिहरू र खासगरी संरक्षणको सूचीमा परेका विरुवाहरूलाई ५ वर्षको अवधिसम्म प्राथमिकतापूर्वक हुर्काइ तत्पश्चात वन अधिकारीहरू समक्ष हस्तान्तरण गरिनेछ ।

४.३ वन्यजन्तु

स्थलचर जनावरको प्राथमिक तथ्यांक प्रत्यक्ष अवलोकन र अप्रत्यक्ष प्रमाणद्वारा आयोजना क्षेत्रका पदमार्गबाट संकलन गरिएको थियो । माध्यमिक तथ्यांक भने परामर्श तथा माध्यमिक साहित्यबाट बटुलिएको थियो । स्थानिय बासिन्दासँग परामर्शको क्रममा वन्यजन्तुको तस्वीर समावेश भएको स्थलगत मार्गदर्शकपुस्तिका (फिल्ड गाईडबुक) देखाइएको थियो । आधारभूत (बेसलाइन) सर्वेक्षणले आयोजना र यसको परिधीय क्षेत्रमा ९९ प्रजातिका स्थलचर वन्यजन्तु पहिचान गरियो जसमा १६ स्तनधारी प्रजाति, ७१ पक्षी प्रजाति र १२ सरिसृप तथा उभयचर प्रजाति समावेश छन् । आधारभूत सर्वेक्षणको आधारमा, यो क्षेत्र प्राकृतिक वा अतिमहत्वपूर्ण (क्रिटिकल) वासस्थान होइन साथै यसले स्थलचर जनावरको वसाइँ सराई गर्ने मार्ग प्रदान गर्दैन । ९९ प्रजातिका स्थलचर वन्यजन्तुमध्ये, १७ प्रजाति साइटिसको अनुसूचीहरूमा, ७ प्रजाति आइयुसिएनको रातो सूचीमा जोखिमग्रस्त (थ्रिटेन्ड) प्रजाति तथा आसामी बाँदरनामक १ प्रजाति राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन, २०२९ को संरक्षित सूचीमा रहेको पाइयो ।

माछा प्रजातिको आधारभूत (बेसलाइन) अवस्था बुढीगण्डकी नदीको ४ वटा नमूना छनौट केन्द्रहरूबाट पत्ता लगाइयो । ति केन्द्रहरूको स्थान बाँध भन्दा माथि, बाँध भन्दा तल, विद्युतगृहभन्दा माथि र विद्युतगृहभन्दा तल निर्धारण गरियो ।

माछाहरू छनौट गर्न हातेजालको प्रयोग गरियो साथै स्थानीय माझीहरूले समातेका माछाहरूको पनि अवलोकन गरियो । स्थानीय माझीहरूसँग परामर्श गरियो । परामर्शको क्रममा माछाहरूको तस्वीर समावेश भएको स्थलगत मार्गदर्शकपुस्तिका (फिल्ड गाईडबुक) देखाइएको थियो ।

बुढीगण्डकी नदीको पानीको कम बहाव भएको क्षेत्र (रिड्युस्ड वाटर जोन) मा जगत खोला र यारु खोला स्थायी खोलाको रूपमा पर्दछन् । यारुटारमा, बुढीगण्डकी नदीमा यारु छाँगो नामक एक गहिरो गल्छी पर्दछ । यसले माछाहरुको बसाइँसराइमा प्राकृतिक अवरोधको काम गरेको हुनसक्छ । सर्वेक्षणको समयमा सडक निर्माण भइरहेको थियो । यसले गर्दा सर्वेक्षणको समयमा जलीय वासस्थान अधिक खलबलिएको अवस्थामा थियो ।

आधारभूत सर्वेक्षणमा, बुढीगण्डकी नदीको प्रभावक्षेत्र भित्र माछाका ३ वटा प्रजाति अभिलेखन (सूचित सहित) गरियो जसमा बुच्चे असला, चुच्चे असला र काभ्रे संलग्न छन् । बुच्चे असला र काभ्रे सबै नमूनाछनौट केन्द्रमा भेटिए भने चुच्चे असला विद्युतगृहभन्दा तलमात्र फेला पर्यो । बुच्चे असला आयोजना क्षेत्रमा सबैभन्दा प्रबल (डोमिनेन्ट) प्रजातिको रूपमा भेटियो ।

बुच्चे असला र चुच्चे असलानामक दुईवटा माछाका प्रजाति मध्यमस्तरको बसाइँसराइ गर्ने खालको अभिलेखन गरियो । सूचित काभ्रे आवासीय प्रजाति हो । सर्वेक्षणको क्रममा अभिलेखन गरिको ३ प्रजातिमध्ये बुच्चे असला संवेदनशील (भल्नरेबल) प्रजाति हो ।

निर्माण तथा सञ्चालनको चरणमा स्थलीय पर्यावरणीय श्रोतमा असर न्यूनीकरण

- आयोजना स्थापनाकालागि बनस्पति फँडानी गरिनेछ । बनस्पति घटेसँगै वासस्थानमा कमी आउनेछ । यसको परिणामस्वरूप वन्यजन्तुहरु नजिककैको वनक्षेत्रमा बस्न बाध्य हुनसक्छन् ।
- वासस्थानको क्षय वा स्तर घटेका कारण नजिककैको वनक्षेत्रमा बस्न बाध्य भएका कतिपय वन्यजन्तुहरु भने वासस्थानको पुनस्थापनापछि फर्किने छन् । असर न्यूनीकरण गर्न, निर्माण कार्य सकिएपछि शोधभर्ना वृक्षारोपण कार्यक्रममार्फत वासस्थानलाई जंगली अवस्थामा फर्काइनेछ ।
- निर्माण गतिविधिले ध्वनि, कम्पन, प्रकाशको उत्सर्जन गर्नेछ जसले वन्यजन्तुलाई तर्साउने अथवा तिनको आवागमनमा बाधा पुऱ्याउने वा तिनको प्राकृतिक वासस्थान क्षय गर्नेछ । यस्तो परिवर्तनप्रति संवेदनशील वन्यजन्तुहरु सुरक्षित वासस्थानमा सर्ने वा त्यही बित्थलिएको वातावरणमा अपनाउन थाल्नेछन् । यो असरलाई कम गर्न निर्माण गतिविधि र प्रकाशलाई रातिको समयमा सीमित अथवा प्रतिबन्धित गरिनेछ । प्रेसर हर्नमा बन्देज लगाइनेछ र आयोजनाका गाडीमा गति सीमा तोकिनेछ । विष्फोटका कार्य राति प्रतिबन्ध गरिनेछ । फोहर पानीको प्रसोधन गरिनेछ भने ठोस फोहरको उचित व्यवस्थापन गरिनेछ ।
- सडकको निर्माणबाट निर्माणकर्मी, कर्मचारी र स्थानीय बासिन्दालाई वन्यजन्तुको आश्रयसम्म सहज पहुँच मिल्छ । यसले वन्यजन्तुको शिकार तथा अवैध शिकारका घटनाहरु बढ्नसक्नेछ र खाद्य तथा औषधीय गुण बोकेका वन्यजन्तु जस्तै मलाया दुम्सी, रतुवा, घोरल, कालिज, आदि को जनसंख्यामा कमी आउनसक्नेछ ।

- असरलाई न्यूनिकरण गर्न, आयोजनाका कर्मचारी र ठेकेदारका लागि करारका लिखतमै वन्यजन्तुको अवैध शिकारलाई रोक्न नियम लगाइनेछ । आयोजनाका कर्मचारी, स्थानीय बासिन्दा र ठेकेदारका निम्ति वन्यजन्तु सचेतना कक्षा चलाइनेछ ।
- जलविद्युत सञ्चालन र सम्बद्ध क्रियाकलापले ध्वनि एवं प्रकाश उत्पादन गर्नेछ जसले निशाचर प्रजातिमा असर पार्नसक्छ । शिविरबाट निस्कने ठोस फोहरको अपर्याप्त व्यवस्थापनले वनस्पति र प्राणीमा प्रतिकूल असर पर्न सक्नेछ ।
- असरलाई कम गर्न, प्रकाशलाई प्रकृतिक बासस्थानतर्फ होइन कि आयोजना क्षेत्रतर्फ फर्काइनेछ । पर्यावरणीय रूपमा संवेदनशील ठाउँमा गाडीको गति सीमा लागू गरिनेछ । प्रेसर हर्ममा बन्देज लगाइनेछ । फोहर पानीको प्रसोधन गरिनेछ भने ठोस फोहरको उचित व्यवस्थापन गरिनेछ ।

निर्माण तथा सञ्चालनको चरणमा जलीय पर्यावरणीय श्रोतमा असर न्यूनीकरण

- बाँध निर्माणको समयमा नदीलाई एक सुरुङ्गमार्फत अन्यत्र मोडिनेछ जसले बुच्चे असलाको बसाइँसराइ खल्बलिने सम्भावना छ । यस अतिरिक्त, निर्माण जनशक्तिले नदीको डाइभर्सनमा माछा मार्न सक्छन् ।
- डाइभर्सनको असरलाई न्यूनिकरण गर्न, हल्का भिरालोपन र नदी डाइभर्सनमा झण्डै ४० सेमीको गहिराई कायम राखिनेछ । माछा मार्ने नियमका बारेमा मजदूरहरूलाई पर्याप्त जानकारी दिलाइनेछ ।
- बाँध र सडकको निर्माण, खानीको काम, नदीको डाइभर्सन तथा नदी किनारमा अरु काम गर्दा तथा निर्माणको समयमा तटीय वनस्पतिको नाशले भूस्खलन एवं नदीमा माटो तथा बालुवाका कणहरू (सिल्ट) जम्मा हुनसक्छ । माटो तथा बालुवाका कणहरूले माछाको गिल थुनिन गई तिनको मृत्यु हुने वा भुरा उत्पादन हुने क्षेत्रको क्षयीकरण हुनसक्छ । निर्माणस्थलबाट बगेको तरल पदार्थ, शिविरबाट निस्कको फोहरपानी र जोखिमयुक्त वस्तु नदीमा जम्मा भई जलचरमा असर पर्नसक्छ ।
- तटीय वासस्थानलाई पुनस्थापना गर्न संभव भएसम्म छिटो हुर्किने, फल र फूल लाग्ने स्थानीय वनस्पतिलाई यथाशीघ्र रोपिनेछ । ठोस फोहरलाई तोकिएका ठाउँमा व्यवस्थापन गरिनेछ । फोहर पानीको प्रसोधन गरिनेछ ।
- अधिकतम कार्यप्रणाली (पिक अपरेशन) र जलाशयबाट पानीको मौसमी निकासले गर्दा नदीमा थिग्रान (सेडिमेन्ट) बढी जलीय जीवनमा बाधा पुग्नेछ । यसको असर कम गर्न सावधानी तथा विवेकपूर्ण निर्माण अभ्यासको माध्यमबाट नदीकिनारको स्थिरता प्रदान गरिनेछ । तटीय क्षेत्रमा रैथाने जातका वनस्पति लगाइनेछ जसले नदीकिनारलाई स्थिर गर्न गर्नेछ ।
- बाँधको निर्माणले गर्दा बाँधको माथिपट्टि बुढीगण्डकी नदीमा एक जलाशय बन्न पुग्छ । एक गहिरा जलाशयमा विभिन्न क्षेत्रको विशेषता हुन्छ जसले त्यहाँ बस्ने प्रजातिमा असर पार्छन् । जलाशयको माथिपट्टि नदीजन्तु पारिस्थितिकीय प्रणालीको अधिक संरक्षणमार्फत नदीजन्तु जलचर जस्तै बुच्चे असलालाई पर्ने असरलाई कम गरिनेछ । जलचरहरूको भूरा उत्पादन गर्ने क्षेत्र र तिनको जनसंख्या

कायम राख्न वर्षभरि नै एक न्यूनतम वातावरणीय प्रवाह कायम राखिनेछ । बुच्चे असला माछाको माथि र तलतिरको बसाइँसराइ पूर्तिगर्न माछा समातेर ढुवानी गरी बाँधपारलगाइनेछ । बुच्चे असलाका लागि एक मत्स्य प्रजनन तथा भुरा उत्पादन केन्द्र (फिस ह्याचरी)को विकास गरिनेछ । माछाको यस केन्द्रबाट निस्केका भुरालाई बाँध तथा विद्युतगृह क्षेत्रको माथि र तल छोडिनेछ ।

- तलतिर बगिरहेका माछाहरु विद्युतसंयंत्रको प्रवेशद्वार (इन्टेक) को बहावमा तानिन सक्छन् र टर्बाइनमा परी मर्न सक्छन् । टेश —याकसहितका एक भौतिक जालीको प्रयोग गरी टर्बाइन वा स्पीलवेमा माछालाई तानिनबाट जोगाइनेछ । तटीय क्षेत्रमा बसोबास गर्ने र माछा तथा अन्य जलीयजन्तुमा निर्भर हुने जनावरहरुलाई प्रत्यक्ष असर पर्नेछ । माझी समुदाय, जो जीविकाका लागि माछा मार्नमै निर्भर छन्, लाई असर पर्नसक्नेछ । तटीय माछाको संख्यामा आउने कमीले गर्दा यी समुदायको जीविकामै असर पर्नेछ । माछा तथा अन्य जलीय ढाड नभएका जीवको जनसंख्यालाई संभव भएसम्म कायम राखिनेछ । यस अतिरिक्त, केही माझीहरुलाई तिनको सीप र परेको असरको गहनता हेरी रोजगारीको अवसरसमेत उपलब्ध गराइनेछ ।

४.४ सामाजिक, आर्थिक र सांस्कृतिक वातावरण

आयोजनाले गोरखा जिल्लाको चुमनुव्री गाउँपालिकाको, धार्चे -१ र धार्चे -३ मा मुख्य प्रभावित पार्ने छ । यस आयोजनाको जलाशय निर्माणले चुमनुव्री गाउँपालिकाको सल्लेरी गाउँ, र जगत लाई प्रभावित पार्ने छ । जलाशयका कारण बुढी गण्डकी नदीमा पानीको बहाव कम भएको कारण धार्चे १ को यारु र धार्चे ४ को तातोपानी लाई पनि प्रभावित पार्ने अनुमान छ किनकि जगतको माथिल्लो भागमा बाँध हुनेछ । आयोजना निर्माणबाट मुख्य रूपमा आदिवासी जनाजाति प्रभावित हुनेछन । मुख्य प्रभावित आदिवासी जनजातिहरुमा गुरुङ् , घले , तामाङ् हुन् भने ढुबान क्षेत्रमा अधिकांश मानिसहरु गुरुङ् समुदायका छन् ।

सम्पत्तीको अधिग्रहण र सामाजिक नेटवर्कको परिवर्तनमा आयोजनाका प्रभावहरु

- व्यक्तिगत सम्पत्ति र जग्गाको अधिग्रहण यस आयोजनाको सबभन्दा मुख्य प्रभाव मध्ये एक हो जसले आयोजना क्षेत्रका केही परिवारहरुलाई असर गर्न सक्छ । त्यसकारण प्रभावित पारिवारलाई पुनर्वास र पुनःस्थापना गर्नु आयोजनाको मुख्य प्राथमिकता हो । पुनर्वास र पुनःस्थापना पहलको सिद्धान्त भनेको अनैच्छिक पुनर्वासबाट जोगिनु हो वा अपरिहार्य छ भने पर्याप्त क्षतिपूर्ति प्रदान गरी अधिग्रहणलाई न्यूनतम पार्नु हो । भूमि अधिग्रहण ऐन २०३४)भनेको देशको जग्गा अधिग्रहणका लागि निर्देशन दिने मुख्य कानून हो र आयोजनाले यस कानून बाट पूर्ण रूपमा निर्देशित हुनेछ । यद्यपि अधिकांश आयोजनाका संरचनाहरु भूमिगत छन् त्यसकारण आयोजनाका न्यूनतम प्रभाव हुने अपेक्षा गरिएको छ । यथापि इन्टेक संरचनाको नजिकका घरपरिवारमा भने असर गर्न सक्छ, सल्लेरी गाउँको जलाशयका कारण सल्लेरी गाउँका २४ घर ढुबानमा पर्नेछन, एक स्थायी शिविर र पहुँच मार्ग बनाउनको लागि ग्थब गाउँमा केहि किता जमिन अधिग्रहण गर्नु पर्ने हुन्छ, यसकारण आयोजनाले लगभग १७० रोपनी अधिग्रहण गर्नेछ , जसमध्ये, करिब १०० रोपनी जमिन कृषिका लागि प्रयोगमा छ ।

- जगत र सल्लेरी हुँदै जाने पदमार्ग प्रस्तावित आयोजनाको निर्माण र सञ्चालनबाट प्रभावित हुनेछ। यो पदमार्ग यस समयमा मनास्लु संरक्षण ट्रेकिंग मार्गको अत्यावश्यक अंश हो र स्थानीयलाई सामान र सेवाहरू पुऱ्याउन पानि यस मार्ग प्रयोगमा छ। पदमार्ग अवरोधले निकट बस्तीमा सामाजिक नेटवर्कमा बाधा पुऱ्याउन सक्छ। यद्यपि यस पदमार्गको प्रतिस्थापनको रूपमा एक मोटेरेबल सडक निर्माण हुँदैछ, जुन राम्रो र पहुँचको वितरणको लागि अवरोध कम गर्ने अपेक्षा छ; यदि यो समयमा निर्माण भएन भने वैकल्पिक सडक नजिकै निर्माण हुनेछ।

आजीविका, सामान्य आर्थिक अवस्था र स्थानीय व्यापार र उद्योगहरूमा असर

- बुढी गण्डकी जलविधुतले मनास्लु संरक्षण क्षेत्रमा जाने मार्गलाई असर गर्न सक्छ जुन गोरखा जिल्लाको शीर्ष पर्यटन स्थल मध्ये एक हो। आयोजनाको निर्माणको अवधिमा ठूलो संख्यामा कामदारहरू आवश्यक हुन्छ, यसले प्राकृतिक स्रोतहरूको पहुँचमा घाटा या परिमार्जनका कारण प्रभावित परिवारको जीविकापार्जनमा परिवर्तन गर्न सक्दछ।
- खाद्यान्न र अन्य आधारभूत वस्तुहरू जस्ता दैनिक आवश्यक चीजहरूको माग बढ्ने सम्भावनाको साथ, मानिसहरूले खानेपानी र वन स्रोतहरू (जस्तै काठ, जडिबुटी, झाडी, फलफूल आदि) पहुँच गर्न प्रतिस्पर्धा गर्नुपर्ने हुन सक्छ। त्यस्ता प्राकृतिक स्रोतहरूको संकलन वृद्धिले आयोजना कर्मचारी र स्थानीयहरू बीचको द्वन्द्व निम्त्याउँन सक्दछ। यसबाहेक, जंगली जनावरहरूको अवैध शिकारको सम्भावना पनि बढ्न सक्छ।
- यसबाहेक, निर्माण कार्यको प्रभावले प्राकृतिक मनोरहा गुणवत्तालाई असर गर्न सक्छ र प्राकृतिक सौन्दर्य बिगार्न सक्छ जसले आयोजना क्षेत्रमा पर्यटकको प्रवाहलाई असर गर्न सक्छ।
- आयोजनाका श्रमशक्तिको कारण यस क्षेत्रका रेस्टुरेन्ट, लज, होटल, र पसलहरूको स्थापनालाई बढावा दिनेछ; निर्माणबाट उत्पन्न वस्तु र सेवाहरूको बढ्दो माग आयोजनाको सकारात्मक प्रभावहरूमध्ये एक हो। यद्यपि निर्माण गतिविधिका कारण पर्यटक प्रवाहमा कमी आएको कारण स्थानीय होटल र लजबाट रोजगारीका अवसरहरू घटाउन पनि सक्दछ।

सार्वजनिक स्वास्थ्य, पानी र सरसफाइमा प्रभाव

आयोजना क्षेत्रमा कुनै सरकारी अस्पताल, सार्वजनिक स्वास्थ्य सुविधाहरू, क्लिनिक वा चिकित्सा पसल छैन। यद्यपि यस आयोजनाको निर्माण र सञ्चालनको चरणमा नजिकका ग्रामीण नगरपालिकाहरूमा अवस्थित स्वास्थ्य सुविधामा दबाव बढ्न सक्छ। यसैगरी, खानेपानीको स्रोतमा बढ्दो चाप पनि आयोजना क्षेत्रमा जनसंख्या वृद्धिका कारण हुन सक्छ जसले स्थानीय जनतालाई नकारात्मक असर पार्छ।

आयोजनाको मनोवैज्ञानिक प्रभाव

प्रस्तावित बुढी गण्डकीले गोरखा जिल्लाको सल्लेरी गाउँका २४ घर डुबानमा पर्नेछन र जलाशय क्षेत्रबाट परिवारलाई विस्थापित गर्ने सम्भावना छ। अनैच्छिक विस्थापनले आजीविकाको क्षतिको साथ मनोवैज्ञानिक

समस्याहरू निम्त्याउन सक्छ र नयाँ पुनर्वास ठाउँमा सुरक्षित आजीविकाको अनिश्चितताले पनि मानिसहरूमा डर पैदा गर्न सक्छ।

न्यूनीकरणका उपायहरू (निर्माण चरण)

यस आयोजनाको नकरात्मक प्रभावहरूलाई कम गर्न र क्षतिपूर्ति दिनका लागि क्षतिपूर्ति दिने उपायहरूको वर्णन यस प्रकार छ

- आयोजनाले प्रभावित परिवार र स्थानीय बासिन्दाहरूलाई रोजगारिमा प्राथमिकता दिनेछ। यसका लागि आयोजनाले प्रोटोकलको व्यवस्था गर्दछ र यसलाई ठेकेदार संगको सम्झौताको एक धाराको रूपमा समावेश गरिने छ। आयोजनाले प्रभावित परिवारहरूलाई उनीहरूको सीप वृद्धि गर्न तालिम कार्यक्रमहरू अगाडि बढाउनेछ जसले स्थानीयहरूको जीवन र क्षमता सुधार गर्न सक्छ, विशेष गरी आयोजनाबाट प्रभावित महिला, महिला, विपन्न वर्ग र बालबालिकाहरू लाई प्राथमिकता दिनेछ। यसका लागि प्रशिक्षण कार्यक्रमहरू आयोजनाको सामाजिक र वातावरणीय व्यवस्थापन अन्तर्गत सीप वृद्धि गर्न प्रस्ताव गरिएको छ।
- यसबाहेक, यस आयोजनाले प्रभावित परिवारलाई जग्गा अधिग्रहणको लागि यसको विभिन्न आयोजना अवयवहरूको लागि क्षतिपूर्ति प्रदान गर्दछ। घरेलु सर्वेक्षणको क्रममा स्थानीय बासिन्दाहरूसँग गरिएको परामर्शका साथै धेरै परामर्श तथा सार्वजनिक सुनुवाईका बैठकहरूले स्थानीय बासिन्दाहरूले भूमि जग्गाको लागि नगद उपलब्ध गराउने कुरा स्पष्ट गरेका छन्। अध्ययनले एक व्यावहारिक विधिको रूपमा नगद क्षतिपूर्तिको लागि सिफारिस गरेको छ। यसका साथै अस्थायी रूपमा अधिग्रहण गर्नुपर्ने जग्गा लीजमा हुनेछ जुन निर्माण चरण पूरा भएपछि पुनःस्थापना हुनेछ।
- क्याम्पका श्रमिक र शिविर क्षेत्रहरूको वरिपरिको जनसंख्या बीच क्त्मक का घटनाहरू र संक्रामक रोगहरूको फैलावट हुने सम्भावना छ। तसर्थ, यस्तो प्रकोपहरू ह्यान्डल गर्न द्रुत प्रतिक्रिया सुनिश्चित गर्ने उपायहरू र आपतकालीन एकाईको स्थापना गरीने छ।
- मनोवैज्ञानिक परामर्श मार्फत आयोजना प्रभावित परिवारहरूलाई सुरक्षित र सहज पुनर्वास प्रक्रियाको प्रबन्ध गरीने छ।
- कुनै सामाजिक द्वन्द्व हुन नदिन स्थानीय स्तर र आयोजना क्षेत्रमा चेतना अभिवृद्धि तालिमको साथ, काम गर्नेलाई नियमित कडा आचार संहिताका साथ न्यूनीकरणका उपायहरू अवलम्बन गरिनेछ।
- यस आयोजनाले आयोजना क्षेत्रका किसानहरूलाई कृषि उत्पादनको नोकसानीका लागि खेती गर्ने क्षमता सुधार गर्ने कार्यक्रम प्रस्ताव गरेको छ। यसै गरी आयोजनाले स्थानीय बासिन्दालाई कृषिमा आधारित जीविकोपार्जन समर्थन कार्यक्रमहरू संचालन गर्नेछ जसमा उत्पादन क्षतिपूर्ति, उत्पादकत्व वृद्धि, उत्पादनको विविधीकरण र कृषि र पशुपालन दुबै बजारिकरणमा सुधार ल्याउने उपाय र योजनाहरू सम्मिलित छन्। यी उपायहरू विभिन्न उप-योजनाहरू जस्तै खाद्य उत्पादन, र डेअरी फार्मिगको ईन्टेन्सिफिकेशनमा संगठित छन्। यस आयोजना क्षेत्रका स्थानीयहरूका लागि उचित दिशानिर्देशहरूको साथ एक कृषि आजीविका सहयोग पनि प्रस्ताव गरेको छ।

न्यूनीकरणका उपायहरू (संचालन चरण)

दक्ष मजदुरहरूको अर्थव्यवस्था कायम गर्न आयोजना सम्पन्न हुनु अघि दक्ष श्रम शक्तिलाई लक्षित गरी तालिम कार्यक्रमहरू आयोजना गरिनेछ।

- पानीको बहावमा अचानक पानी छोड्दाको असरले दुर्घटना हुन सक्छ। यसका लागि शमन उपायका रूपमा, बग्ने पानीको बहावको समयको बारेमा जनतालाई सचेत गराउन साइरेन प्रणाली स्थापना गरिनेछ। सम्बन्धित समुदायलाई सूचित गरी साइरेन प्रणालीका बारे सचेत गराइनेछ।
- संचालन चरणको बखत दुर्घटनाहरू नियन्त्रण गर्ने उपायहरू अपनाइने छ जस्तै कगचनभ तबलप क्षेत्रमा जन आवागमन प्रतिबन्ध गरिनेछ, तेसका लागि तेस क्षेत्रहरूमा पर्खालमा राखिनेछ; सुरक्षा संकेत र पोष्टहरू महत्वपूर्ण स्थानहरूमा खडा हुनेछन्, र स्थानीय मानिसहरूलाई खतरनाक आयोजना क्षेत्रहरूको बारेमा सचेत गराइनेछ। यसबाहेक, आयोजना सम्पन्न भएपछि रोयल्टीको केही रकम स्थानीय निकायलाई बाँडफाँड गरिनेछ, जसले आयोजना प्रभावित क्षेत्रमा विकास कार्यहरूमा सहयोग पुऱ्याउनेछ।

५.वातावरणिय व्यवस्थापन योजना

वातावरणीय व्यवस्थापन योजना (Environmental Management Plan) ले आयोजनाको निर्माण र सञ्चालनका चरणहरूमा हुने वातावरणीय अनुगमन र परीक्षण सहित न्यूनीकरणका उपायहरूको कार्यान्वयनको खाका तयार गर्छ। कार्यान्वयनको लागि प्राथमिक जिम्मेवारी प्रस्तावकले लिएको हुन्छ। निम्न सरोकारवालाहरू पनि यस प्रक्रियामा संलग्न हुनुपर्छ:

- वन तथा वातावरण मन्त्रालय
- आयोजना व्यवस्थापन एकाई — बुढी गण्डकीको प्रस्तावक
- आयोजना कार्यान्वयनका लागि पर्यवेक्षण ईन्जिनियरहरू;
- निर्माण व्यवसायी र
- स्थानीय तह, क्षेत्रीय र स्थानीय स्तरको राजनीतिक र सरकारी संस्था जिल्ला समन्वय समिति, समुदाय आधारित संगठनहरू आदि।

कार्यान्वयन संयन्त्र

EMP कार्यान्वयनको लागि संस्थागत संयन्त्र तल प्रस्ताव गरिएको छ। आयोजना निर्देशक कार्यालय अन्तर्गत आयोजना स्तरमा एक सामाजिक र वातावरणीय व्यवस्थापन प्रभाग स्थापना गर्ने प्रस्ताव गरिएको छ, जस भित्र चार समर्पित इकाईहरू हुनेछन्।

- सामाजिक व्यवस्थापन एकाई Social Management Unit
- वातावरण एकाई Environment Unit
- गुनासो समाधान एकाई Grievances Redressal Unit
- अनुगमन तथा मूल्यांकन एकाई Monitoring and Evaluation Unit

६ वातावरणिय अनुगमन

वातावरणिय अनुगमनको मुख्य उद्देश्य निम्न छन्:

- प्रस्तावित वातावरणिय न्यूनिकरणका उपायहरूको कार्यन्वयन सुनिश्चित गर्नमा सहयोग गर्दछ
- आयोजनाको वास्तविक प्रभावहरूको मुल्यांकन गर्न र नयाँ प्रभावहरू देखा परेमा तिनीहरूको लेखाजोखा गर्दछ
- आयोजनाको क्षेत्रको वातावरणीय अवस्था स्थिति अनुगमन तथा मूल्याङ्कन गर्दछ

वातावरणिय अनुगमन आयोजनाको जीवन अवधि भरि संचालन गरिन्छ । यसमा आन्तरिक विशेषज्ञ लगाएत बाह्य विशेषज्ञले पनि समावेश गरिने प्रवधान छ, जसमा नेपाल सरकार तथा सरोकारवालाहरू पनि संलग्न हुन सक्छन् । आयोजनाको यस प्रक्रियामा प्रमुख दायित्व हुनेछ ।

प्रत्यक्ष प्रभावित आयोजना क्षेत्रमा मुख्य भैतिक, जैविक र सामाजिक पक्षहरूको डाटा र जानकारीहरू जम्मा गरिने छन्, जस्तै डुबान क्षेत्र, आयोजना संरचना, गतिविधि क्षेत्र र अन्य वातावरणीय रूपमा संवेदनशील क्षेत्रहरूको वातावरण मुल्यांकन रिपोर्टद्वारा प्रदान गरिएको डाटा अपडेट हुनेछन् ।

भैतिक, जैविक र सामाजिक पक्षहरू हाइलाइट गरिएका छन् ।

- नदीको पानीको गुणस्तर
- वायुको गुणस्तर
- भण्डारण र निर्माण अपशिष्ट व्यवस्थापन योजना
- घरेलु फोहोर व्यवस्थापन योजना,
- स्वास्थ्य र सुरक्षा योजना,
- आपतकालीन चिकित्सा प्रतिक्रिया इकाई र अन्य वातावरणीय योजनाहरू
- रूखहरू ढालिने, क्षतिपूर्ति रोपण
- दुर्लभ र खतरामा परेका प्रजातिहरूको जनसंख्या
- माछाको जमिन र पालन गतिविधि
- जग्गा, भवनहरू र अन्य आवास संरचनाहरूको बारेमा जानकारी,
- जग्गा अधिग्रहण, क्षतिपूर्ति, पुनर्वास र पुनर्वास योजना
- वातावरणीय प्रवाह
- पीकिंग अपरेसनले गर्दा रिजर्वायर किनारको क्षति
- बाँध साइट, पावरहाउस साइट र अन्य कमजोर क्षेत्रहरूमा र यसका वरपर शारीरिक स्थिरता
- कम पानी को बहाव भएको क्षेत्र र टेलरेस आउटलेटको तल तिर साइरन चेतावनी प्रणाली
- माछाको जनसंख्या र जलाशयमा जैवविविधता,
- कम प्रवाह क्षेत्र र टेरेस आउटलेटको डाउनस्ट्रीम

- कृषि उत्पादन कार्यक्रम जस्तै फलफूलको बृद्धि, खाद्यान्न उत्पादनमा तीव्रता र वाणिज्यिक कृषि सञ्चालन
- विस्थापितहरूको सामाजिक—आर्थिक स्थिति अर्को स्थानमा पुनः बसोबास गराउने

७ वातावरणिय परिक्षण

वातावरणीय परिक्षण लाई यथार्थ वातावरणिय प्रभाव, प्रभाव पूर्वानुमानहरूको प्रमाणिकरण, निर्माण र सञ्चालन चरणको अवधिमा लागू हुने वातावरणीय प्रभाव न्यूनीकरण र बृद्धि गर्ने उपायहरूको प्रभावकारिता र अनुगमन संयन्त्रहरूको कार्यको मुल्यांकन गर्न प्रस्ताव गरिएको छ। वातावरणीय परिक्षणले यथार्थ प्रभाव र भविष्यमा पर्ने प्रभावलाई वर्णन गरेर वातावरणिय प्रभाव मूल्यांकनले उचित र पर्याप्तता निर्धारण गर्ने छ।

८ निष्कर्ष तथा सिफारिस

बुढीगण्डकी जल विद्युत योजना बुढीगण्डकी नदिमा रहेको छ, जुन चुमनुब्री गाँउपालिकाको सल्लेरी बजार देखि धार्चे गाँउपालिकाको तातोपानी गाउँमा छ रहेको छ । यस आयोजनाले ३४९ मेगावाट जलविद्युत उत्पादन गर्नेछ । यस आयोजनाले पार्नसक्ने मुख्य प्रभावहरू यस प्रकारका छन्

- जग्गा जमिन र निजि सम्पतिको अधिग्रहण
- नदिमा आउने परिवर्तनले जलचरलाई असर पर्ने छ
- भिरालाहरूको अस्थिरता बढाउने
- वनजंगल र बासस्थान को खण्डन हुने सम्भावना छ ।

वातावरणीय व्यवस्थापन योजनालाई न्यूनीकरण र बृद्धि गर्ने उपायहरू प्रभावमा ल्याउनको लागि कम भन्दा कम असर गर्न र समुदायको कल्याण र आर्थिक अवसरहरू बढाउँदै तत्काल नाला व्यवस्थापनको योजना, जलाशयको सिमानामा रहेको सुरक्षा बफर क्षेत्रको पुनः स्थापना, स्वास्थ्य तथा सुरक्षा उपायहरू, मत्स्यपालनको प्रस्ताव र आजीविका बृद्धि समर्थनको प्रावधानहरूको योजना बनाइएको छ। यस उपायहरूले आयोजनाको पर्यावरणिय पाहिला कम गर्न मद्दत गर्दछ। सेफगार्ड दस्तावेजमा एक पुनर्वास र पुनःस्थापना योजना र पर्यावरण व्यवस्थापन योजनालाई एक सार्वजनिक परामर्श र प्रकटीकरण कार्यक्रम द्वारा निर्देशित भएको छ।

अनुगमन, परामर्श, र लेखा परीक्षाहरूको अन्वेषण अनुसार योजनाहरू समायोजन गर्न अनुकूलन प्रबन्धन प्रक्रिया अपनाउनु पर्छ। एक अनुकूलन प्रबन्धन प्रक्रियालाई समायोजित गर्न अपनाएर निष्कर्ष अनुसारको अनुगमन, परामर्श, र लेखा परीक्षा गर्न सकिन्छ। आयोजनाको एक सामाजिक र वातावरण प्रभाग ले प्रबन्धको रूपमा EMP लाई माध्यम बनाएर वातावरणीय व्यवस्थापन प्रभागलाई प्रसासन गर्नेछ।

Abbreviations

BGHEP	Budhi Gandaki Hydroelectric Project
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CDO	Community Development Officer
CPUE	Catch per Unit Effort
DOED	Department of Electricity Development
D/S	Downstream
DLSO	District Land Survey Office
DFO	District Forest Office
DADO	District Agriculture Division Office
DHM	Department of Hydrology and Meteorology
EIA	Environmental Impact Assessment
EHS	Environment, Health and Safety
EMP	Environmental Management Plan
EPA	Environmental Protection Act
EPR	Environmental Protection Rules
ECD	Early Childhood Development
ESMMP	Environmental and Social Management and Monitoring Plan
FSL	Full Supply Level
GON	Government of Nepal
GWh	Giga -watt Per Hour
GLOF	Glacial Lake Outburst Floods
HRWL	Highest Regulated Water Level
HEP	Hydroelectric Project
HH/hh	Household
HRUs	Hydrologic Response Units
HPP	Hydropower Project
IUCN	International Union for Conservation of Nature
ICIMOD	International Centre for Integrated Mountain Development
LRWL	Lowest Regulated Water Level
LDC	Least Developed Countries
MOFE	Ministry of Forests and Environment
MT	Metric Ton
MW	MegaWatt
MOPE	Ministry of Population and Environment
MCT	Main Central Thrust
MCA	Manaslu Conservation Area

NPWC	National Parks and Wildlife Conservation
NGO	Non-Governmental Organization
NEA	Nepal Electricity Authority
PROR	Peaking Run of the River
PCDF	Public Consultation and Disclosure Plan
PAF	Project Affected Family
PM	Particular Matter
PPE	Personal Protective Equipment
RRP	Resettlement and Rehabilitation Plan
RM	Rural Municipality
SPAF	Severely Project Affected Family
SPSS	Statistical Package for Social Science
SWAT	Soil and Water Assessment Tool
TMS	Total Management Service
TOR	Term of Reference
TSP	Total Suspended Particles
U/S	Upstream
VDC	Village Development Committee
WHO	World Health Organization

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CHAPTER 1. ORGANIZATION RESPONSIBLE FOR PREPARATION OF EIA

1.1 Proponent

The name of the project is Budhi Gandaki Hydroelectric Project. The proponent of the proposed Times Energy Pvt. Ltd.

The address of the proponent is:

M/S Times Energy Pvt. Ltd
Baneshwar, Kathmandu, Nepal
Phone: 01-4460606, 9851024986

1.2 Institution Responsible for Preparing the Document

The Nepal Rural and Advancement Committee (NRAC) Private Limited, a consulting firm registered with the GoN, has been entrusted to undertake the EIA study of the Budhi Gandaki Hydroelectric Project for and on behalf of the Times Energy Pvt. Ltd as per the provision of EPR 2077. The address of the NRAC is:

Nepal Rural Advancement Committee (NRAC) Pvt. Ltd.

Bijulibazar, Kathmandu, Nepal
E-mail: info.nracnepal@gmail.com
Contact: 9771-9851149216

1.3 The rationale of EIA

As per Schedule 3, Rule (cha) Energy, Water Resources and Irrigation, sub rule (1) Hydropower generation (ka) and Rule (ka) Forest Sector, sub rule (5) and (8) of Environment Protection Regulations, 2020, it is mandatory to carry out an Environmental Impact Assessment (EIA) for the construction of hydroelectric projects exceeding an installed capacity of 50 MW. The proposed BGHEP has an installed capacity of about 341MW (as per the current license) and using forest area of 49.65 hector inside and outside of PA forest. thus, requiring a full-fledged EIA. Furthermore, due to the location of headworks within the Manaslu Conservation Area also environmentally sensitive area criteria for requiring EIA study, thus, this EIA study is being carried out.

1.4 Objectives of the SEIA Study

The objectives of the EIA study are to:

- Collect baseline data on physical, biological and socio-economic and cultural environmental conditions in the project area;
- Review GON and International policies and regulatory mechanisms relevant to the development of hydroelectric project, including its components;
- Identify and assess the potential positive and negative impacts of the project activities on physical, biological, socio-economic and cultural resources and predict their magnitude, extent and duration; examine the significance of environmental impacts;
- Identify critical environmental problems that require further studies and/or monitoring;
- Suggest mitigation measures for adverse impact and enhancement measures for beneficial impacts;

- Recommend preventive, curative and compensatory mitigation measures, including benefits augmentation and environmental management plan;
- Consult and familiarize stakeholders with the EIA through public consultation and public hearings and incorporate their relevant concerns and issues;
- To provide information for decision-makers and affected parties about the environmental implications of the proposed project implementation and associated cost for the implementation of mitigation of adverse impacts.
- Advise decision makers on the environmental implementation of the project.

While fulfilling the above objectives of the study, the proponent shall collect and analyze environmental and social information within the project defined area, including the head works area, headrace tunnel and powerhouse, and other infrastructures of the project.

1.5 Scope of the Study

This EIA intends to meet the requirements of the Environmental Protection Act 2019 and Environmental Protection Regulations 2020. Prior to making a funding decision, it is necessary to be satisfied that: As per Schedule 3, Rule (cha) Energy, Water Resources and Irrigation, sub rule (1) Hydropower generation (ka) and Rule (ka) Forest Sector, sub rule (5) and (8) of Environment Protection Regulations, 2020, it is mandatory to carry out an Environmental Impact Assessment (EIA) for the construction of hydroelectric projects exceeding an installed capacity of 50 MW. The proposed BGHEP has an installed capacity of about 341MW (as per the current license) and using forest area of 49.65 hector inside and outside of PA forest. thus, requiring a full-fledged EIA. Furthermore, due to the location of headworks within the Manaslu Conservation Area also environmentally sensitive area criteria for requiring EIA study, thus, this EIA study is being carried out.

The EIA study is being carried out for the purpose of power generation. The scope of this study includes the issues associated with both the operational and construction phases of the hydropower project. The Environmental Impact Assessment process, after screening, includes scoping, public participation and involvement, impact identification and prediction, analysis of alternatives, development of a mitigation plan and preparation of an Environmental Management Plan (EMP) that includes environmental monitoring and auditing. All the associated beneficial and adverse impacts during construction and operation phases of the project are under the scope of the EIA study. The issues are studied based on physical-chemical, biological and socio-economic environmental aspects of the project. The SEIA includes the presentation of additional impacts and mitigation due to changes in the design. However, the SEIA doesn't include the transmission line for this project.

1.6 Statutory Requirement of Report Preparation in the English Language

As per EPR, 2077 Clause 7 Sub Clause (8), the foreign investment project's report can be prepared in the English language.

CHAPTER 2. GENERAL INTRODUCTION OF THE PROJECT

2.1 Project Description

The proposed BGHEP is a peaking run-of-the-river (PROR) type of hydroelectric project, which can synchronize electricity generation with fluctuating energy demand. This is achieved by creating a daily pondage of water at the headwork's, particularly for the dry season when water discharge in the river is lower than the design discharge. During the wet season, the river has sufficient discharge, thus, the plant shall operate like the run-of-the-river plant, also facilitating the bed load flushing.

The BGHEP is extends in some parts of Dharche (ward 1 and 3) and Chum Nubri (ward 3) Rural Municipalities, Gorkha District of the Gandaki Province. Geographically, license area of the project lies between longitudes 84°55'15" E to 84°52'40" E and latitudes 28°17'00" N to 28°22'00" N. The headwork's of the project fall within the Manaslu Conservation Area, more precisely in its southern boundary, while other structures and facilities lie outside the Conservation Area.

Table 2-1: Project Details of BGHEP

Province	Gandaki Pradesh
District	Gorkha District
Municipalities/ Wards	Chumnuhari 3 (Sirdibas), Dharche 1(Kerauja) and Dharche 3 (Uiya)
Longitudes	84°55'15" E to 84°52'40" E
Latitudes	28°17'00" N to 28°22'00" N

2.2 Project Location and Accessibility

The proposed BGHEP is located in Dharche and Chum Nubri Rural Municipalities of Gorkha District in Gandaki Province. Geographically, the license area of the project lies between longitudes 84°55'15" E to 84°52'40" E and latitudes 28°17'00" N to 28°22'00" N. The headwork's of the project fall within the Manaslu Conservation Area, while other structures lie outside of the Conservation Area.

The project area lies about 200 km from Kathmandu. The nearest motor head to the project is Macchkhola Gaun of Gorkha District, which is about 183 km from Kathmandu. The road up to Arkhet is currently is all weather road, after that point the road is currently under construction, thus it can be considered as dry season earthen road. The dam site of the project, located near of Jagat of Dharche RM, can be accessed on foot from Machhakhola. The length of this foottrail is about 17 km. Currently alignment opening for the motorable road is under way in this portion as well.

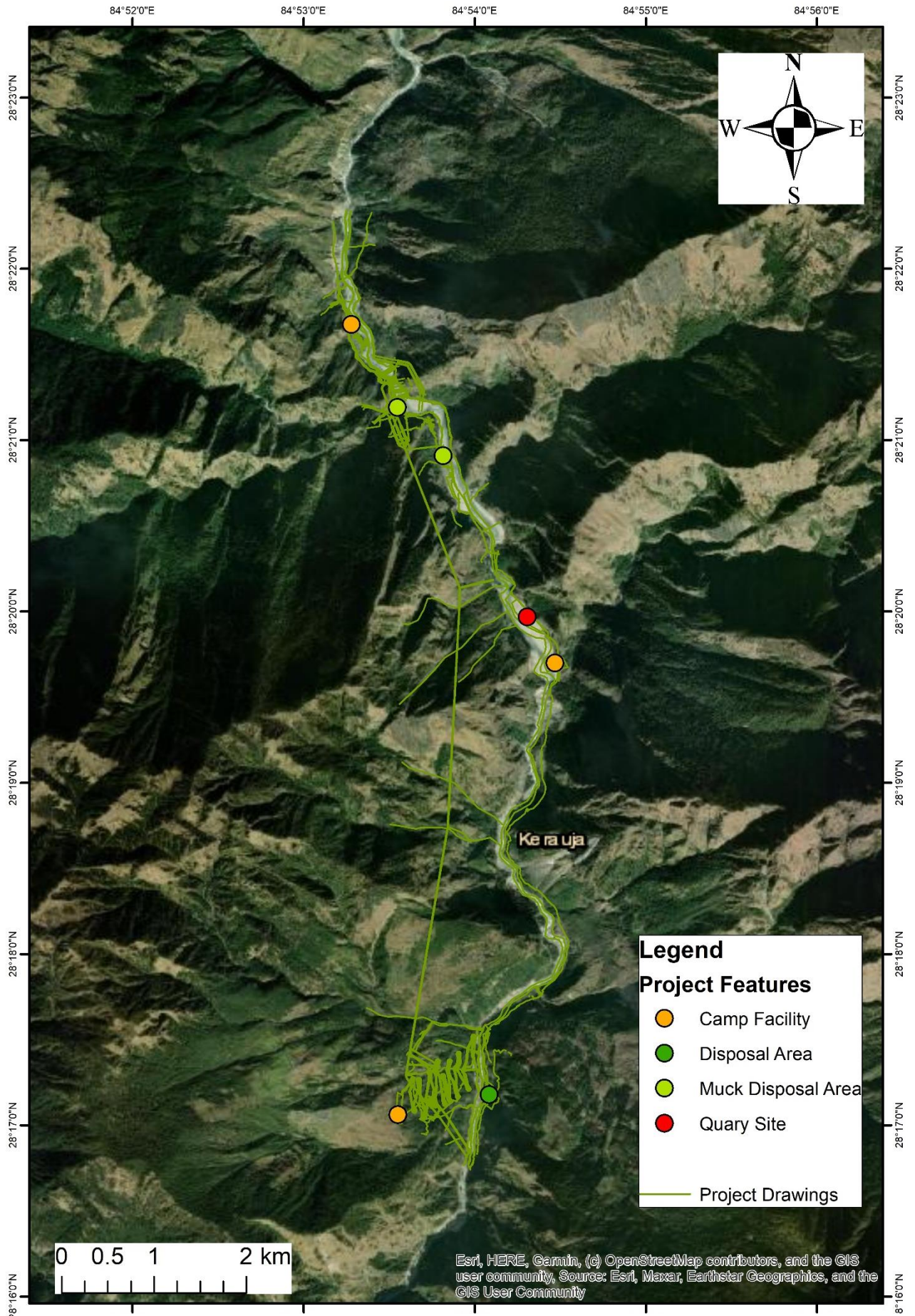
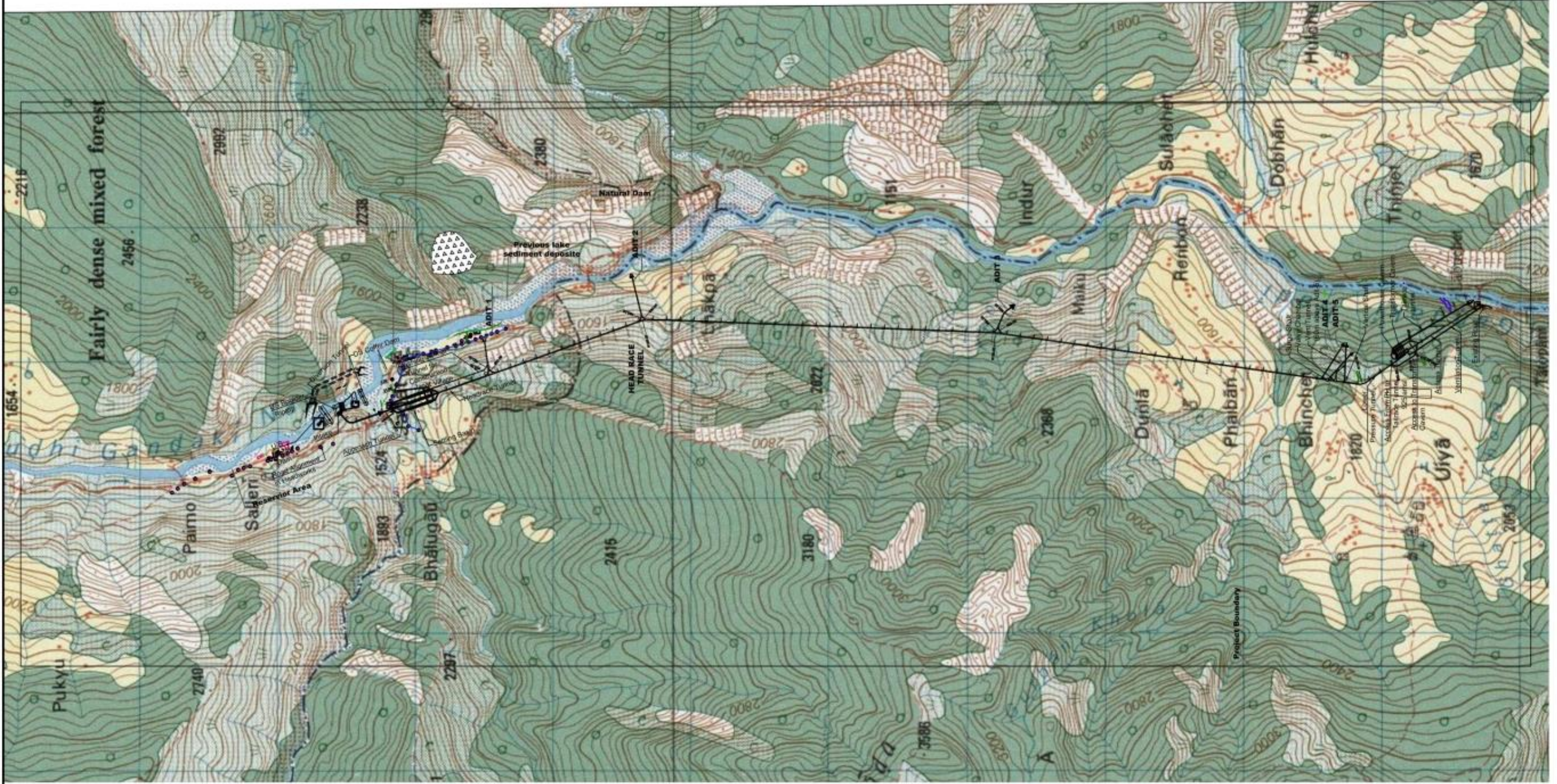
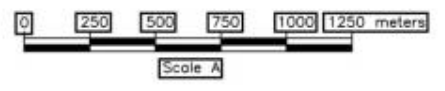


Figure 2-2: Project Facility in Google Earth



LEGEND			
<ul style="list-style-type: none"> Water Waterfall Stream Canal Drainage ... 	<ul style="list-style-type: none"> Forest Open land ... 	<ul style="list-style-type: none"> Settlement ... 	<ul style="list-style-type: none"> ...

NOTES:
 1. All co-ordinates are in meter with reference to National Bench Marks, levels are in m above mean sea level and dimensions are in meter unless specified.



Rev	Amendments	Design	Checked	Approved
PROJECT: BUDHI GANDAKI HYDROELECTRIC PROJECT				
CLIENT: TIMES ENERGY P. LTD				
CONSULTANT: TMS & Hydro Tunnelling and Research Pvt. Ltd.				
TITLE: Geomorphological Map of Project Area				
Particulars	Name	Initials	Date	
DESIGNED BY	R.H. Sharma			
DRAWN BY	V. Thapa			
CHECKED BY	P. K. KC			
APPROVED BY	J. K. Shrestha			
				DRAWING NO.: BGHEP-03-G04

Figure 2-3: Topographic Map of Study Area

2.3 Salient Features of BGHEP

The salient features of the project are presented below.

Table 2-2: Salient features of the BGHEP

	Final Salient Features	Salient Features in TOR/ Scoping	Reason for Change
Project Location	Gorkha district	Gorkha district	
Type of Project	PRoR	RoR	Changed after the Optimization Study
Project Municipalities	Chumnubri 3 (Sirdibas), Dharche 1(Kerauja) and Dharche 3 (Uiya)	Dharche and Chum Nubri gaaupalika, Gorkha District Gandaki Province, Nepal	
District	Gorkha district	Gorkha district	
Province	Gandaki	4	
Headworks site	Between Jagat and Salleri village	Located around 1.5 km of confluence of Yaru with Budi Gandaki River	
Powerhouse site	Uiya and Tatopani VDC. (17.0 Km upstream from the present road head at Machha Khola VDC.)	Uiya Village, Right bank of Budhi Gandaki Rive	
Name of the River	Budi Gandaki River	Budi Gandaki River	
Access Road			
From Kathmandu to Arughat	127 km (highway)		
Arughat to Machha Khola	25 km (seasonal road)		
Machha Khola to Jagat	18 km foot trail (Road under construction)		
Hydrology			
Catchment Area	3044 sq. km at Intake	3628 km²	Changed after the Optimization Study
Design Flood	3786 m³/sec (1 in 1000 yrs. return period)	3510m³/sec	
Diversion flood	1249 m ³ /sec (1 in 10 yrs. return period)		
Design Discharge	100.27m ³ /sec		
Annual average flow	128.67 m³/sec	96.74m³/sec	
Dry flow	22.49 m ³ /sec	18.5 m ³ /sec	
Environmental flow	2.2 m ³ /sec	1.26 m ³ /sec	

Probable Maximum Flood	9837.4 m ³ /sec		
Reservoir			
Inundation area	190,000 sq meter		
Full Supply Level	1325 masl	1275 masl	
Minimum Operation Level	1315 masl	1270 masl	
Maximum Water Level	1330 masl		
Gross Capacity (at FSL)	3.25 million m ³		
Diversion Headworks			
Type of Dam	Concrete Gravity with Spillway		
Length of dam at crest	54 m		
Dam height from river bed	36 m		
Bottom width of dam	31m		
Dam Crest Level	1333 masl		
Dam Foundation Level	1254 masl		
Spillway Crest level	1325 masl		
Undersluice Crest Level	1297 masl		
Power Intake			
Intake Sill Level	1307.0 masl	1262.0 masl	Changed after the Optimization Study
Flow	107.9 m ³ /sec (including 10% flushing)		
No. of intake Openings	6 nos.		
Size of an intake Opening	4m x 6m (W x H)	9 x 6 (W x H)	
Intake undersluice Sill Level	1305.3 masl		

Undersluice Opening	31.5 m x 0.7m (W x H)		
Approach Tunnel		Feeder Channel	
Shape	Inverted D		
No. of tunnel	one		
Size	7.2 m (finished Dia.)	9m x 6 m (W x H)	Changed after the Optimization Study
Length	390 m	150 m	
Invert level of Tunnel	1298.0 masl		
Intel Pond			
No. of Inlet pond	3 nos.		
Invert Level of Inlet pond	1303.0 masl		
Size	7.2m x12m x 30m (W x L x H)		
Connecting Tunnel			
Shape	Inverted D		
No. of tunnel	Three		
Size	6 m (finished Dia.)		
Length	138 m		
Settling Basin			
Type	Underground with intermittent flushing		
No. of Settling basin	3 nos.	2 nos.	Changed after the Optimization Study
Size a basin	150m x 16.5m x 25m (L x B x H)	240m x 18m x 20 m	
Bed Slope	0.111		
Flow in a Basin	32.7 m ³ /sec		
Depth of flow	24.25 m during FSL & 17.75 m during MDL		
Headrace Tunnel			
Type	Circular	Modified Horse Shoe	Changed after the Optimization Study
Length	6.65 Km	5.8 km	
Finished Diameter	6.5m	6.5m	
Surge Shaft			
Type	Circular- Restricted Orifice	Restricted Orifice	Changed after the Optimization Study
Effective Size	22 m internal diameter; Height =60 m (Vent tunnel level)	15.0 m dia , 85m Height	
Orifice	diameter = 3.3m; Height = 4m		

Normal Water Level	1325 masl		
Vertical Shaft			
Total Vertical length	349m	400 m	Changed after the Optimization Study
Horizontal Penstock tunnel	257m		
Internal Diameter	5m	4 m	
Thickness of Penstock	10 mm to 32mm		
Powerhouse			
Type	Underground	Underground	
Dimension	(110.5 x 16.5 x 37) m	(120 X 20X 45) m	Changed after the Optimization Study
Generator Setting Level	933 masl		
Turbine Setting Level	927 masl		
Type of Turbine	Pelton	Francis	Changed after the Optimization Study
No. of unit	6	4	
Capacity of each unit	60.43 MW		
Tailrace Conduit			
Type	Free Flow inverted D shape		
Length	Tunnel = 670 m	150 m	
River Tail Water Level	918.86 masl	915 masl	
Transmission Line			
Voltage of Transmission Line	220 KV double circuit	220 kV	
Length of Transmission line	45 Km	45 km	
Power and Energy Generation			
Gross Head	398 m		
Net Head	385.3m		
Installed Capacity	341 MW		
Energy			
Dry Peak	349.06 GWh		
Dry Off Peak	207.49 GWh		
Total Dry Energy	556.56 GWh		

Wet Energy	1280.6 GWh		
Total	1837.16 GWh		
Effeciency	89.32%		
Generation Capacity	341 MW		
Project Cost Estimate			
Project Base Cost	NRs. 55,579 Million		
Economic Evaluation Summary			
Net Present Value (NPV)	NRs. 12,060,114 thousand		
Internal Rate of Return (IRR)	13.81%		
Simple Payback Period	5.54 years after COD		
Equity Payback Period	6.60 years after COD		
Return of Equity	15.12%		
Construction Period	5 years		

2.4 Project Components

2.4.1 Dam

The river valley is comparatively narrow at the proposed dam site, which is about 35 m. The river is flowing from north to south direction and is almost in a straight reach. The proposed dam axis of the head works is located on the sound bedrock on either bank of the river. Gravel deposit with sandy matrix and occasional boulder deposit is found on the surface. It is expected that the depth of such deposit material will be more than 40.0 m considering the geology and the topography of the diversion site.

The total height of the dam is 30 m from the riverbed, which is at the elevation of about 1295 *masl*. 4 under sluice openings are proposed to be fixed, the dam at the level of 1297 *masl*. Furthermore, two overflow spillways are proposed at an elevation of 1325 *masl*.

The dam can safely pass the discharge of 3786 m³/s which corresponds to 1000 years return flood. This flood will create 5m afflux. The crest level of the spillway is fixed at an elevation of 1325 *masl*. Hence the highest water level during 1000 years returns period flood will reach up to 1330 m *asl*. The top level of the dam was fixed up to 1333 *masl* including 1.5 m free board and 1.5m width of service bridge over the spillway. The overall length of the dam along river cross section is 54m. Dam foundation is extended up to river bed profile which corresponds to 43m below crest level of undersluice and corresponding elevation at 1259 *masl*. The 20m deep pressure grouting will be done further in the rock foundation. The height of dam from the river bed will be 38m. The full supply level

is fixed at 1325 masl and minimum regulated drawdown level at 1315 masl. A stilling basin of 70m long is provided for energy dissipation of jumps. The floor level of stilling basin is fixed at 1290 masl. The upstream apron is provided up to intake level. The upstream and downstream boulder stone pitching is also provided.

2.4.2 Pondage

The dam will raise the water level by about 33 m above the river bed, thereby creating a head pond extending about 2 km upstream from the dam. At the Highest Regulated Water Level (HRWL) of 1325 masl, the surface area of the head pond will be about 190,000 m², and the live storage volume between HRWL and LRWL is about 1.76 million m³ which will be sufficient for the peaking volume requirement for 6 hours generation with full installed capacity. With normal peaking plant operation in the dry season, the daily water level fluctuations in the head pond will be limited to between HRWL and LRWL. In the wet season, when the river flow exceeds the hydropower plant discharge capacity, the head pond water level will be maintained at LRWL in order to minimize sedimentation in the pond which would reduce the live storage capacity.

2.4.3 Intake

The intake on the right river bank is an integral part of the dam structure. The intake has six inlets (4 m wide × 6 m high) provided with trash racks to prevent entry of trashes, undersluice structure for sediment flushing and trash sluice inlet provided on the left wall. The rail mounted trash rack cleaner operates from the platform at the top of the intake at elevation 1,333.0 masl. The water flowing into the six inlets combine into a single bell-shaped intake flume, controlled by a roller gate (7.2m wide × 7.2m high) to control the flow into the approach tunnel.

2.4.4 Approach Tunnels

The 390 m long approach tunnel with 7.2 m diameter will convey the water from the intake to the inlet pond of the settling basin. The approach tunnel will be able to carry discharge of 107.9 m³/sec from the intake with velocity of 3.57 m²/s. The inlet portal will be constructed at the intake near the *Bhalu Khola* during the excavation of the tunnel. The approach tunnel will also include 97 m long siphon that connect the tunnel with inlet pond of settling basin.

2.4.5 Inlet Pond and Connecting Tunnels

An inlet pond will collect the water conveyed from the approach tunnel. As the settling basin is underground, three connecting tunnels will be excavated. The inlet portal will be constructed to excavate the three settling basins. So, the inlet pond will trifurcate into three connecting tunnels towards three settling basins. The inlet pond will be 30 m high and about 15.65 m wide. Three gates are provided at the inlet of connecting tunnel which regulate the flow coming into settling basin.

2.4.6 Underground Settling Basin

The settling basin is proposed as underground of the Jagat village. Three settling basins, each of 14.5 m high, 16.5m wide and 150m long, will settle particles sizes of 0.2 mm and more than that. The settling basin is expected to trap 90% of 0.2 mm particles.

2.4.7 Headrace Tunnel

A headrace tunnel (HRT) of 6,654 m long will be the major water conveyance conduit of the project. The modified horse shoe shaped tunnel will be 6.5 m in finish diameter. The headrace tunnel will start from the Jagat village and end at the Bhinchet village. The invert level at the start is fixed at 1289.25

masl to ensure sufficient submergence. At the start, around 800 m reach of the underground settling basin is taken towards the West direction deep into the hills of Jagat village to ensure sufficient overburden and favorable geology. The tunnel then follows the shortest possible route towards south avoiding the inhabited villages directly above it. The tunnel will be supported by shotcrete, steel ribs and occasionally concrete lining. The headrace tunnel will have four adits for construction. Adit-1 will be at the upstream end nearby Jagat Village and just after settling basin at chainage Ch 0+813.98 m and will connect the headrace tunnel with settling basin. Adit-2 will connect the headrace tunnel at Ch 2+384.83 m near Dharche Yaruphant. It will be 1570.85 m in total length. Adit 3 will connect headrace tunnel at Ch 4+965.93 m upstream of Dovan with length of 2581.1 m long. Adit-4 will connect at chainage Ch 7+467.13 m with length of 2501.2 m. Adit- 4 will connect headrace tunnel to surge shaft at Ch 7+500 m near Uiya Village. The head race tunnel is designed in such a way that the draining and construction can be done from both ends. The tunnel elevations have been so provisioned that it will fulfill sufficient submergence requirement at the surge shaft end. The invert slope of the tunnel will be such that the seepage and water inflow in the tunnel during construction will be drained out by gravity flow. The segment between two adit is divided equally and is slope in either direction. In the section between Adit-1 and Adit-2, upward slope of 1:300 is maintained towards Adit-1 and downward slope of 1:200 towards Adit-2 at an elevation of 1282.94 masl. Similarly, between Adit-2 and Adit-3, down slope of 1:300 is maintained towards Adit-2 and down slope of 1:200 is maintained towards Adit-3 at an elevation of 1280.79 masl. Similarly Invert slope of 1:300 is positioned upwards from Adit-3 and downslope of 1:200 towards Adit-4 at chainage Ch 7+467.13 at 1278.7 masl. A rock trap is provisioned below the surge shaft to collect any fallen shotcrete or rock lumps and will be periodically emptied in the duration of 2-5 years. The adits will be plugged by concrete but will have bulkhead gates for inspection and maintenance of the tunnel. The bulkhead gate will be of 3.5 mx 3.5 m opening.

2.4.8 Surge Shaft

The surge shaft will be underground with 22 m finish diameter and hence will be circular in shape. The surge shaft is located lies in East Northern edge of Uiya village and South of Bhinchet village, which will be accessed through a 152 m long Ventilation Tunnel. The surge shaft will be 73 m high from the crown of the headrace tunnel. It will have 3.3 m diameter throttle at bottom to minimize the height of the shaft. A bell mouth shape is provisioned at this throttle for smooth uprising of water level. The upsurge water level will be at 1342.54 masl and the down surge level will be 1296.89 masl. The normal water level will be 1325 masl. The surge shaft will be concrete lined of thickness 80, 60 and 40 cm, thickness decreasing with height but will be supported by shotcrete and rock bolts during excavation.

The ventilation tunnel of dimension (3.8 × 3.8) m will have 1 in 100 upward slopes from the portal. The invert level of the tunnel at the dome will be 1346.89 masl whereas the portal will be at 1348.41 masl. The tunnel will be supported by shotcrete lining and the portal will be concrete lined. The technical description of the surge shaft is mentioned below:

Table 2-3: Physical parameters of the surge shaft

Diameter of Surge Shaft	22.0 m
Height of Surge Shaft (vent tunnel level)	60 m

Top Elevation	1346.89 <i>masl</i>
Bottom Elevation	1286.89 <i>masl</i>
Full supply Level of Reservoir	1325 <i>masl</i>
Minimum Drawdown of Reservoir Level	1315 <i>masl</i>
Upsurge Elevation	1342.54 <i>masl</i>
Down Surge Elevation	1296.89 <i>masl</i>
Tunnel Bottom Elevation	1278.40 <i>masl</i>

2.4.9 Rock Trap

A rock trap of 27 m long is placed so that it ends just below the surge shaft. Beam (0.4m × 0.25m) mesh is placed over the rock trap section so as the trapped rocks does not get disturbed once they are settled. An access to future rock trap flushing is also designed in accordance to bulkhead gate.

2.4.10 Valve Chamber

Valve chamber is installed just after the surge shaft at distance 15 m from the right wall. It is designed in a rock cavern, which has dimension of 14 m in length, 8 m width and 14 m in height. It includes EOT Crane at height of 11.5 m from the cavern invert. Staircase is placed beside the penstock to get access to the crane and Valve operation.

2.4.11 Flushing Tunnel (Adit 4)

An access tunnel to rock trap and surge chamber is designed, which also provides facilities such as flushing and rock trap flushing. Bulkhead has the purpose of future access through the steel gate placed with it. Tunnel exits at an elevation of 1278.26 *masl*, with length of 220.64 m from bulkhead. Access tunnel to valve chamber has length of 140 m in connection with main flushing tunnel.

2.4.12 Vertical Shaft and Penstock (Pressure) Tunnel

Between the Valve house and the powerhouse, the waterway shaft/tunnel will be lined with steel embedded in concrete. A vertical shafts and penstock tunnels have been provisioned in consideration of the steep topography near the powerhouse area. Vertical shaft (VS) starts at Ch 7+670.74 at 1278.7 m. This shaft will connect horizontally arranged penstock tunnel which will connect powerhouse. There is an anchor block VIP 1 at the start of the vertical shaft supporting a 110.3° bend. This shaft goes 349 m deep vertically to 924.45 *masl*. The circular vertical shaft has a 6.4 m excavation diameter. It is supported by shotcrete lining and rock bolts. The space between 5m diameter penstock and shotcrete lining is filled with C15 concrete. There is another anchor block VIP 2 at the end of the shaft, housing a 95.7° bend. VS connect to the horizontal penstock tunnel of 255.77 m length. This circular tunnel has diameter 5 m and slopes 1 in 100 downwards. This tunnel will have steel penstock pipe of diameter 5 m that will be supported by saddles at 40 m c/c. It has been assumed that the vertical penstock shaft will be excavated by raise-boring. The pilot hole will be drilled from the invert of the headrace tunnel down to the bottom level of the shaft, and excavation of the penstock tunnel at the bottom will then be completed to the exact position of the shaft. The shaft will be opened out to a

diameter of 2 m by raise-boring, and the full 6.0 m diameter of the shaft will finally be excavated by drill and blast from top to bottom. All spoil will be loaded from the bottom of the shaft and transported out through the tunnel system associated with the powerhouse. At Ch-7+868 m, the penstock bifurcates into six 2 m diameter pipe each about 50 m long.

2.4.13 Powerhouse

General Arrangement:

The power house site is located underground within the steep walled rock mass about 1 km upstream of Tatopani village on the right hill side of Budhi Gandaki River. There is no surface area available to accommodate the powerhouse and other associated structures. Hence, the powerhouse will be an underground cavern type with underground drainage, access tunnel, ventilation and lighting etc. It will be divided into two caverns i.e. Generation cavern and Transformer cavern. The main cavern i.e. powerhouse/generator cavern consist of six Pelton turbines with same number of generator units. This cavern consists of erection bay for installation and maintenance of electromechanical equipment. The powerhouse structure and associated infrastructures comprise the following main components:

- Generation Cavern
- Transformer Cavern
- Ventilation tunnel
- Access tunnel
- Drainage tunnel

Generation cavern: The generation cavern is the major component of the powerhouse. This cavern contains major mechanical and electrical equipment for power generation such as turbine, generator, control valves, governor and hoisting equipment. The generation cavern is connected by the main accesses tunnel. The size of the cavern is 110.5 m in length and 16.5 m wide. The turbine axis level is maintained at 927.0 *masl* and the generator floor level as 933.0*masl*. With crane beam level of 945.5 m *masl*, the height provided will help for lifting of equipment and maintain sufficient ventilation. At the main entrance area, erection bay is separated as maintenance floor inside the cavern. After energy generation, flow is discharged to tailrace with water level maintained at 917.0 *masl*.

Transformer cavern: The location of the transformer cavern is by the side of powerhouse generation cavern. This cavern is small in size as compared to the main cavern and house five transformers. It is 97.5 m long, 14.0 m wide and 18.0 m high. From transformer cavern, generated energy is transferred to the surface switchyard, located at the right bank of Budhi Gandaki River.

Service Repair Bay: The service/repair bay accommodates turbine and generator components during initial, consecutive erection of the units and during maintenance periods in future. A 16.4 m × 9.85 m area is provided for vehicular access, assemblies of generator. This area serves as a lay down area for the runner. The space below the service bay slab will be used as a store unit for the powerhouse. The service bay floor will have an extra hard finish.

Control Room, Transformer Block and Switchyard: Control room building, transformer block and space for switchyard have been fixed based in the space requirements and topographical convenience. Control room, transformer block and switchyard are provided d/s and adjacent to the powerhouse at

an elevation of 982.0 *masl*. The control room, though isolated in foundation, will have a direct access to the powerhouse. A metal staircase will be used to access the machine floor. Waffle slab has been designed as the roof for the control room and transformer block to prevent the structures from possible rock fall hazards. The control room will be 16 m long, 9 m wide and 4.15 m tall. Next to control room is the transformer block 22.5 m long, 6 m wide and 6.15m tall. The transformer block will house four transformers in separate compartments with shear walls. The tentative area required for this purpose is approximately 80 m × 40 m including fencing.

2.4.14 Tailrace and Outlet Structures

Tailrace tunnel outlet is located about 100m upstream of the existing suspended bridge at Tatopani village. The tailrace tunnel will operate under free flow conditions. The flow discharged from the six draft tubes will be connected by first 100 m long and 3.2 m inverted D shaped tailrace tunnels to the main tailrace tunnels of about 670 m long 6.2 m diameter inverted D shaped tunnel. A gate is provided at the outlet of each individual unit and an extra gate is provided at the end of tailrace to prevent the entry of flood. Slope of tailrace canal is fixed at 1:500 considering the water level at outlet for the annual years return period of flood. Water depth of 4 m will be maintained in the tailrace culvert during the operation of all six units at 100% load. The invert level of tailrace culvert at outlet is 918.86 *masl*.

2.5 Project Requirements

Other project requirements include construction materials such as aggregates and sand, steel, cement, and various mechanical equipment including vehicles, batching plants, crushing plants, excavators, and a range of support items such as fuel, lubricants, blasting materials, construction power etc.

2.5.1 Construction Materials and Equipment

The key construction material input is sand and aggregates of adequate quality apart from cement and reinforcement steel for concrete works, these have been revised as per the construction requirement.

2.5.2 Manpower Requirement

On an average daily basis, about 1200 workforces will be engaged for the project construction. Of the total about 25 % will be skilled, 35% semi-skilled and the remaining 40 % unskilled manpower. Most of the unskilled workforce required for the project will be sourced from the local area if available. Semi-skilled and skilled workforce will be employed from among the Nepalese nationals as far as possible. For the operation phase, a total of 60 human resources are estimated for the uninterrupted operation of the project. Of the Total nearly 70% will be technical manpower while 30% will be administrative and other non-technical human resources.

2.5.3 Land Requirement

The land required for the installation of the permanent project structures and support facilities is described in table below

Table 2-4: Comparison table of Land Use and Land Requirements

Project Component	Location	Municipality	Acquisition	Landuse Type					Remarks
				Forest	Water/Sand/G ravel/Boulders	Agriculture-Level Terrace	Shrubland /Grassland	Built up	
Headwork									
Pondage	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent	9.68	12.49	5.87		0.42	Government (Forest + Water Body); Private (Agricultural land and Built up)
Coffer dam(s)	Salleri	Chum Numbri - 3 (Sirdibas)	Temporary	0.43	1.1				Government
Main dam	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent	0.43	0.46				Government
Headwork Camp	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent – inundates by pondage			0.25		0.03	Private
Access Road									
Adit Site	Tatopani	Dharche-3 (Uiya)	Permanent	0.34	0.25		2.19		Private (Forest + Shrubland)
Intake	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent	0.61	0.13		1.24		Government
Power House	Tatopani	Dharche-3 (Uiya)	Permanent	6.78	0.02		0.84		Government
Quarry Site									
De-water Zone	Yaruphant	Dharche-1 (Kerauja)	Temporary		3.39				Government
Disposal Area									
Disposal Area 1	Tatopani	Dharche-3 (Uiya)	Permanent		0.16		0.06		Government
Disposal Area 2	Jagat	Chum Numbri - 3 (Sirdibas)	Permanent	0.11	1.44		1.16		Government
Disposal Area 3	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent				2.08		Government
Camp Site									
Camp Site 1	Tatopani	Dharche-3 (Uiya)	Permanent				0.29		Government
Camp Site 2	Yaruphant	Dharche-1 (Kerauja)	Temporary	0.04		1.30	0.34		Government
Camp Site 3	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent		2.29				Government

CHAPTER 3. DATA REQUIREMENT AND STUDY METHODOLOGY

3.1 General Approach

The EIA procedure adopted follows the GON requirements including the Environment Protection Act 2019, Environment Protection Rule 2020, National EIA Guidelines 1993, and other manuals and guidelines. Furthermore, methods provided in the approved TOR have strictly been followed in this study, and the environmental issues raised in the approved scoping document have also been investigated by this study.

The policy and legal documents of GON have been followed to prepare this EIA report. In a nutshell, this study has based on the primary data generated from the field studies, consultations with project affected people and other relevant local, district and national level stakeholders, and also secondary data collected from published and unpublished literature relevant for this project. The WBG and ADB guidelines on environmental assessment and management, indigenous people, and involuntary resettlement have been considered while preparing the report. Efforts are made to structure the report meet the international standards so as to make it bankable.

Micro-level environmental planning approach has been adopted while assessing the baseline condition of the project area including a large number of local community and stakeholders who participated during the field survey. Attempts were made to involve project affected people, institutions and municipality in the EIA process, through consultation and their participation. The baseline conditions were assessed, project impacts were identified and measures were recommended to mitigate the impacts. The people from the project affected areas were employed to assist in the study, particularly in the field surveys. The major issues related to forest conservation and wildlife, fisheries, farming, local infrastructure and facilities, land acquisition, compensation, resettlement and rehabilitation as well as the overall environment management were discussed with project affected people and institutions during field survey.

3.2 Project Impact Area Definition

3.2.1 Project Area

The 'project area' refers to the river valley of the Budhi Gandaki Rivers and its tributaries with the adjoining farmland, forest and settlement areas where project impacts are both 'direct' and 'indirect'. These impacts would also include;

- the primary project sites and related facilities that the proponent (including its contractors) develops or controls;
- areas potentially impacted from further planned development of the project;
- areas potentially affected by impacts from unplanned but predictable developments caused by the project.
- other associated facilities that are not funded as part of the project (funding may be provided separately by the proponent or a third party including the government),

The area of influence does not include potential impacts that would occur without the project or independently of the project. The area within the boundary of affected municipality ward mentioned in the survey license issued by DoED of GON for BGHEP is considered as the project influenced area and will be hereafter referred to as the project area (see Appendix A for Survey License). A total of 3 wards of 2 municipalities (Chum Numbri-3, Dharche-1 and Dharche-3) were identified within the project area.

Table 3-1: Severely Affected Rural Municipalities

District	Local Level
Gorkha	Chum Nubri Rural Municipality - 3
	Dharche Rural Municipality -1
	Dharche Rural Municipality – 3

The project area comprises and is further classified into two areas the ‘Direct Impact Area’ and the ‘Indirect Impact Area’ on the basis of the magnitude and extent of impacts.

3.2.2 Direct Impact Area

Direct impact area refers to a direct alteration in the existing environmental condition as a consequence of project activity (National EIA Guidelines-1993). In general, the project areas to be inundated by the pondage, areas to be occupied by project structures and facility sites, quarry sites, spoil disposal area, low flow area downstream from the dam, physically high-risk area, and the access and haul road to various sites areas are categorized as Direct Impact Areas. This study considers three types of areas as Direct Impact Area:

Inundation Area: This is the permanent impact area where the local inhabitants will lose their land and assets on land, and physical and productive infrastructures and facilities. There could be irreversible losses to natural resources requiring re-establishment in another area.

Project Structure and Activity Area: The ‘Project Structure and Activity Area’ would include areas with permanent and temporary project structures/activity such as power house site, adit sites, permanent project camps, temporary campsites, quarry and spoil disposal sites, access road, rig areas etc.

Low Flow Area: The ‘Low Flow Area’ includes the stretch of the Budhi Gandaki River between the dam site and the tailrace outlet where the flow will be significantly reduced during project operation. The local inhabitants using riverine resources for their socio-cultural and economic activities are directly affected are. The major concern is the aquatic ecosystem and the fisheries.

3.2.3 Indirect Impact Area

As per the definition of the National EIA Guidelines 1993 the areas with environmental component having repercussions by other environmental component affected/changed by the project component or its activity are considered as the ‘Indirect Impact Area’. The areas of the project influenced district, where project structures are proposed to be placed are regarded as indirect project impact area. People in the indirect impact area may partially lose their land or dependable natural resources such as forests and grazing lands or partially or fully deprived of community infrastructure and facilities, built-in structures, religious or cultural sites, market centers etc. which could be permanently lost in the reservoir area or in other direct impact area. Habitat fragmentation in such areas may result and influence wildlife mobility and limit food resources.

3.2.4 Project Affected Families

Families in the direct or indirect impact areas whose land, properties or livelihoods may be affected due to construction or operation of project components are considered as ‘Project Affected Families’. The members of these families are usually considered as Project Affected Families (PAF). Project Affected Families include, depending on the case, those affected by the involuntary taking of land resulting in:

- relocation or loss of shelter;
- loss of assets or access to assets; or
- Loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or
- the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

In addition to the generic PAF category, the entitlement matrix presented in the RRP does classify the affected families under different classes depending on the degree of affect. One of these categories is represented by the Severely Project Affected Families (SPAF) defined in accordance to practices and guidelines of the GoN. SPAF include those families who are physically displaced from their residences or commercial establishments and those who are severely affected through loss of agricultural land as defined in the “Entitlement Matrix”.

3.2.5 EIA Scoping, TOR and Environmental Issues

The major environmental issues of the project implementation were outlined in the Scoping document and Terms of Reference (ToR) approved by the Ministry of Environment. These documents have provided primary guidance to this EIA study, however, not necessarily limited investigations.

3.2.5.1 Physical Environment

Construction Phase

Land use change was considered as the major issue particularly in the pondage area and in permanent project structures and facilities, in which farmlands, forests and settlements were expected to convert into a permanent water body and project structure respectively. The quarry sites, borrow pits and spoil disposals will temporarily change the land use, however, these areas will be restored after construction completes.

Sanitary waste from the campsites and open defecation by the workforce, construction wastes including hazardous chemicals, and spoil disposal in riverine areas can pollute both the land and water body in the project area. These activities can impact the river water quality increasing pollution and turbidity.

Furthermore, the movement of vehicles and heavy machinery such as drilling, blasting, excavation works, and other related activities can cause air and noise pollution. There could be impact on houses and other structures due to vibration and blasting. There could be also be the chances of disruption of local drainage during dam construction and changes of drainage pattern and river hydrology and morphology are also anticipated.

Operation Phase

The primary anticipated impact of the project to the physical environment of the operational phase is due to formation of the pondage. The interaction of the water with the banks is expected to erode the pondage shores. The terrace on the right bank of the pandage, on which the Salleri Village is located, is most vulnerable to erosion due to water interaction.

The plant operation might change runoff and in the drainage pattern, both below the dam as well as below tailrace, thus changing the overall morphology of the river. There will also be flow alterations of the river in relation to the baseline condition. These might also impact the low flow area between dam and tailrace outlet and the high flow fluctuation area downstream of tailrace outlet due to peaking releases.

3.2.5.2 Biological Environment

Construction phase

Relatively speaking, we are expecting lower damage to the vegetation by this project considering its scale, mainly because of two factors (a) most of the project structure are proposed to be underground, and (b) the project area is mainly project in the rocky cliffs. However, we still expect vegetation damage from the project constructions, such as removal of vegetation from pondage area and the sites like quarry, spoil disposal, portals, and construction camps. Mainly thinly populated pine forest (*Pinus roxburghii*) and some mixed broad-leaved forest patches and few plant species including few endangered, rare, threatened and protected species grown in such forest types in the riverine area can be lost. Similarly, the loss of forest trees due to harvesting of timber and fuel wood for project construction, workforce and harvesting of medicinal plants and other NTFPs during the project construction phase is anticipated.

The breeding, feeding and movement of wildlife and birds might be disturbed due to construction activities as well as removal of vegetation. Also there might be loss and disturbance of habitat due to blasting and heavy vehicular movement. These could further lead to hunting and poaching by workforce and local people along with the impoundment of water body in the inundation area is anticipated. Some of the Threatened (Endangered, Vulnerable) and protected species of wild animals could be affected. There might also be some impacts on fish species, spawning grounds, and fisheries due to water pollution and increased turbidity caused by spoil and solid waste disposal and release of wastes into the river.

Operation Phase

The forests and vegetation loss is expected to be lost prominently by this project in two locations - pondage area and access road. The small patch of forest on the left bank of the Budhi Gandaki River will be inundated, has been marked as Ghoral grazing by MCAP. Furthermore, the road alignment to access the permanent camp in the powerhouse site location passes through a private forest.

The most critical issue of this project is the dam blocking migration of the fishes. However, this issue has been studied in length by this study. A natural dam, near the Yaru Phat, about 3 kilometers downstream of the proposed dam, has been blocking the fish migration already. The fishes are thus expected to lose habitat between this stretches only, which is about 3 km of stretch. Similarly, impacts of annual flushing on the loss of induced fish habitat and fisheries in reservoir area, along with spawning, feeding ground and fingerlings in low flow zone are anticipated. Furthermore, the construction might impact on feeding and rearing of fry, fingerlings and small size resident species downstream of the tailrace outlet due to peaking releases.

3.2.5.3 Socio-Economic Environment

Construction Phase

As mentioned above, majority of this project's structures are proposed to be underground, thus, relatively loss of infrastructures/properties is expected to be lower. However, some families, particularly, from the intake area, pondage area, and permanent camp in the powerhouse area will still lose their land and assets. These families are categories as Severely Project Affected Families (SPAF), within them, some could also belong to the disadvantaged and marginalized indigenous communities. The SPAFs would require resettlement and rehabilitation plans. Loss of prime arable land mostly irrigated on riverbanks and agriculture production particularly the food grains due to permanent land acquisition for the project will be impacted. Similarly, there will be some adverse effects on the economic activities and rise in the price of commodities due to influx of workforce. Disturbances,

damage and loss of cultural assets, cremation, and religious sites could be anticipated in the project area. Similarly, loss and disruption of community infrastructures and facilities such as irrigation, drinking water, trails, roads, bridges, water mills, health centers, schools and other services etc. could also be expected.

Due to the influx of workforce adverse impacts might be observed on food supply, service requirements, fuel wood supply, social disturbance and conflicts, social disharmony, social security and crimes, harassment to women and children are anticipated. There could be incidence of water, air and noise borne diseases; psychological effects on women-headed households, aged people, and disabled people; occupational health and safety, sanitation, and spread of HIV AIDS/STDS and related diseases in the project area.

Operation Phase

Decrease in farm production from the temporarily acquired land by the project due to deterioration in the quality of land is anticipated. The safety to people in low flow zone during sudden release of water from headworks and in downstream of the tailrace area due to peaking release might be affected during the operation phase of the project.

3.2.6 Enhancement in Environment Resources

Construction Stage

Generation of employment opportunities for local people, increase in trade, business and establishment of market centers along with an up gradation of local infrastructures and resources with stabilized slopes and protected river bank cuttings are anticipated.

Operation Stage

The project can lead to an enhanced quality of life for the local residents due to rural electrification, industries, trade, business and employment. With the availability of transport access to the local people there are chances of the establishment of new market centers/towns, change in attitude of the local people due to new development activities and increased economy. These would also attribute to the improvement of an overall socio-economic status of the local people and enhancement of the development of the district due to sharing of electricity revenue. The resettlement and rehabilitation of project affected families with the basic socio-economic infrastructure and facilities will enhance the quality of life of the displaced people as well.

This project will develop a strong base in project district for all round development. The access road to the reservoir area, electricity supply, and navigational facilities developed along with road infrastructure in the project district could enhance potential for development of new economic activities such as industry, trade, new market centers, income generating activities, commercialized agriculture, social benefits, tourism and local employment. A large reservoir and densely vegetated safeguard buffer area could provide new habitats for migratory bird species and other wildlife, provide opportunity for reservoir fishery as well as provide navigational facility and open up a new ecotourism venue. The development of community protected forest areas in the reservoir shores will enhance biodiversity status, and the pond fisheries will build up the economy of fishermen community even in the low flow area.

3.2.7 Cumulative Impacts

Cumulative impacts of the proposed project BGHEP and other land use and management activities in the immediate catchment and adjoining areas on the physical, biological, socio-cultural and economic environment are anticipated. These would require in-depth studies and further investigations to establish their significance.

3.3 Review of relevant documents and existing information

Desk studies included the gathering and reviewing of project relevant information on flora and forestry, wildlife, water quality, aquatic life, fisheries, and social-economic and culture, agriculture and health. Literature reviews were carried using a range of sources of published journals, books, articles and unpublished reports, annual reports of government and non-government organizations. Data published by the Central Bureau of Statistics, and District/ Rural Municipality profile data of Gorkha district including annual reports of District Development Committees and other line agencies such as District Health Offices, Division Forest Offices, and District Agricultural Offices were studied. A review feasibility studies and detail design of Budhi Gandaki Hydropower Project was done. Information on practices in Nepal from other HEP projects was reviewed, where available. Acts, rules, policies and national plans of the GON were assessed, including international requirements/obligations CITES appendices and IUCN lists.

The EIA team collected and studied 1:25,000 scale analogue (paper) topographical maps before the field visit. They were used to verify the inferences obtained from field studies such as change of land use, vegetation and forest types.

3.4 Field Study

The major part of the field work was started with a reconnaissance field work in April 2019, and continued through July. Specific data were obtained by going to the field, district headquarters whenever the need was there.

Table 3-2: Major Field periods of the different themes covered by the EIA

Field Study dates (2019)	Themes Studied
May (2 nd -6 th)	Project Site Monitoring
July (28 th -31 st)	Meeting with Development Committees of Gorkha District
Feb (27 th - 2 nd)	Project Site Monitoring

3.5 Physical Environmental Data Collection

Land Use and Topography

Geographic information systems (GIS) and remote sensing (RS) technologies were used to analyze the spatial status of land use in the project influence area. Field surveys were conducted by a team consisting of expert and research assistants to collect land cover/ use data from the field.

Geology, Soils and Erosion

Detailed study on the project geology of the whole project site and immediate catchment is presented as part of the Feasibility study. Details of the methods used and location of sampling points and areas are also elaborated in the expert report of the Geology and Geotechnics.

Hydrology and Sediment

For use in the hydrological analysis, both for technical and environmental purposes, watersheds for the different discharge gauging stations, the proposed dam site, and most of the larger and more important tributaries were delineated (see Feasibility report and expert report on Hydrology and Sedimentology). A more elaborate hypsographic analysis has been done for the catchments of the hydrometric gauging stations and the catchment down to the intake for the BGHEP.

Air Pollution

Visual observations and analysis of the sources causing deterioration in air quality such presence of industries and quarry sites, frequency of vehicular movement etc. were made, and qualitative information on air quality was taken. Air quality (PM10 and Total Suspended Particulate Matter, TSPM) and sound levels were measures at 3 stations/points at Jagat, Yaru Phat, and Dobhan.

Equipment used for sampling was High Volume Sampler, model: APM 460 NL, SBA – 32, SCALTEC Spectrophotometer, SSI – 1104. The methodology for Particulate Matter: Filter paper and cup were put under conditioning (desiccation) for 24 hours and used for sampling. A four decimal-digit electron balance was used for recording the initial weight. A 24-hour averaging sampling was carried out, and exposed filter paper and cup were again desiccated for final weighing.

Methodology for NO₂: An absorbing solution was used in an impinge, and 1.5 lps flow were maintained in the rota-meter of the sampler. A 24-hour sampling regime was followed, and the absorbing solution was stored in a freezer until it was analyzed in the laboratory for recording absorbance at 540 nm in the above specified spectrophotometer.

Water Pollution

Water quality of 5 sample points in the Dudh Koshi River were collected and tested for physical, chemical and microbial parameters at (a) Pondage (Sallei), (b) Upstream of the Dam site, (c) Down Stream of the Dam Site, (d) Yaru Phat, (e) Tailrace near Dobhan.

The samples were analyzed in SchEMS laboratory. Six physical parameters including temperature, pH, turbidity, total dissolved solids (TDS), total suspended solids (TSS) and electrical conductivity; 4 chemical parameters including total alkalinity, nitrate, ammonia and total hardness; 3 microbial parameters including total coliform, fecal coliform and Giardia were tested. The parameters like pH, temperature and electrical conductivity were tested both in the field and in laboratory, while all other parameters were tested in laboratory. The results of the analysis are compared with the National Drinking Water Quality Standards (NDWQS), 2006 (though it was NDWQS, 2023) for their suitability as drinking water.

Noise Pollution

Sound levels were measures at five stations/points at Tatopani, Yarutar, Doban, Jagat and Salleri; these locations will have major activities during construction phase and they will be prone to noise pollution.

Sound level Leq:

$$L_{eq} = 10 \log_{10} \left(\frac{1}{N} \sum_{i=1}^N f_i \times 10^{0.1 \times L_i} \right)$$

where, N = number of discrete sound level measured
f_i = fraction of the time
L_i = Sound level at the ith time

3.6 Biological Environmental Data Collection

Forestry data

The primary forestry data were collected using combination of questionnaires and checklists for interview, focus group discussion and field measurements. It conducted biological survey and forest inventory by fixing the sample plots. The data obtained from the field study has been processed and then analyzed through triangulation with field observations, discussions and review of related documents to draw inferences on environmental impacts and proposals for mitigation measures.

Information is also obtained from several consultation and meetings held and are incorporated in this report.

Survey location and field study methodology

To grasp the status of forest vegetation and existing biodiversity forest areas covering the inundation sites i.e., dam and reservoir area were surveyed thoroughly along with the downstream sites including power house site.

In most of the cases namely inundation area, desanding inlet portal, sedimentation access tunnel portal, outlet connecting tunnel portal, adit, muck disposal, power house tunnel entrance, total enumeration of the trees (tree and pole size together) was done for assessing the number of trees of the project construction sites. All these sites were thinly populated due to rocky environmental setting.

The quantitative data from total count of forest was used for the analysis of frequency, density, basal area, relative basal area, crown coverage, and wood volume. Similarly, the data for wildlife, birds and aquatic life were used for the estimations of abundance, range, typical habitats for feeding, breeding and nesting requirements within the project area.

All the data such as basal area, volume, timber, fuel wood (Growing Stock) as well as tree species, diameter of tree and poles in cm, height of tree and poles in m, grade of tree (first, second, third and fourth) were entered in the Excel sheet. Different layers of collected data from different sources were processed and analyzed through an integrated approach. Qualitative data were analyzed in descriptive manner and quantitative data were analyzed by using appropriate models and appropriate statistical tools such as GIS and Excel software.

The following formula is used to calculate the basal area (BA), biomass, volume and carbon storage of the standing trees, poles and sapling:

Volume Equations (Sharma & Pukkala, 1990)

Stem Volume Formula = $EXP(a+b*Ln(d+c*Ln(h)),$

Where, d = dbh in cm,

h = height in m,

a,b,c are constant values.

Branch Volume Formula = Stem Volume*R-value

R-value (R<10, R10-40, R40-70, R70+) = Branch Volume/Stem Volume

Gross Timber Volume = Stem Volume * Ratio

Ratio (R-top) = Tree volume above 10 cm Top Dia/Stem Volume

Above Ground Carbon t per ha = Stem biomass of all species x 0.47 + branch Carbon (stem Carbon t x 35.1%) + foliage (stem Ct *5.95%)

Total Carbon tone per ha = above ground Carbon per ha + Below Ground carbon (Above ground Carbon x 3.05%) per ha

1.1.1.1 R<10= $[(d-40)*b+(70-d)*m]/30$
 $R_{10-40} = [9d-10]*m+(40-d)*s/30$
 $R_{40-70} = [(d-40)*b^3+(70-d)*m]/30$
 $R_{70+} = b^3$
 Ratio = $Exp(a+b*Ln(d))$

Carbon dioxide tone per ha = Total Carbon tone per ha x 3.67

Terrestrial Wildlife

Both primary and secondary data were used for the collection of information. Primary data were collected from direct observation along walking trails (Sutherland, 1997) of the project area. Observation on the walking trail was performed mainly in early morning and evening (Paudel, 2003). Each walking trail was visited two times and each visit lasted for about five hours. Wild animals seen on either side of the trail were noted. Besides that, burrows, pugmarks/footprints, droppings/pellets, ground digging and uprooting, tree scratching and marking, remains (skin, fur, feathers, bones, horns/antlers and carcasses), nests, holes and burrows, etc. were also used for data collection. In addition, call counts, cries, smell/odor, leftover food, trampling of plants, flowers and fruit bunches were also recorded (Sutherland, 1997). Secondary data were collected through consultations and literature reviews. Consultations were conducted with local people, forest-goers or cattle grazers, community forest user group etc. Field guide books containing photographs of wild animals were shown during consultation to collect information. Data recorded from the field were compared with the available secondary literature, reviewed. Field guide books Shah (2004) for herpetofauna, Grimmet et al. (2003) for birds and Baral & Shah (2006) for mammals were followed.

Fish

To unravel the baseline status of fish fauna, four sampling stations were selected along the Budhi Gandaki River. Each sampling station extended to a length of about 2000 m along the river stretch, covering the potentially impacted section of the river. Cast net (radius 155 cm, mesh size 2 cm×2 cm, metal pellets of 220, weight 5200g) was used for sampling fish. Fish caught by local fishermen were also observed. Catch per unit effort (CPUE) was used to generate indices of abundance (Cowx, 1991). The collected fish species were identified at site to the extent possible. The measurements of total length, weight and other morphological characteristics were recorded and the sampled fish were again released back in the sampling station after the measurements. Consultations were conducted with local fishermen to know the habits, habitat and diversity of fish and to assess potential impact due to project in the future. The key concerns of fisherman about the projects were discussed and noted. The field guidebook by Shrestha (2019) was followed.

Planktons and Aquatic Invertebrates

Planktons and benthos were sampled from three fish sampling stations Upstream of Dam area, between dam and Tailrace area and Below Tailrace area. Samples were preserved immediately after sampling. Preserved samples were later identified in the lab. For aquatic invertebrates, 1m² substrate was collected from three sites in each sampling station mentioned earlier (Moore, 1990). The substrate was placed in water bucket and sieved, starting with a 4 mm mesh size to 0.5 mm mesh size. Species thus obtained were preserved in 5% formalin (Sutherland, 1997).

For zooplankton sampling, 200 liters of river water from different area of sampling stations was filtered through 30 µm plankton net. The zooplankton collected at the bottom plankton was preserved by using 5 % formaldehyde solution.

Besides animals, phytoplankton were also sampled which acted as a source of food for the aquatic animals. For phytoplankton, 10-L of composite sample was prepared by mixing the samples collected from 10 different areas (1 liter from each area) of a sampling station. 250 ml of sample was taken for identification and 1% Lugol's solution was added for the preservation.

3.7 Socio-Economic Data Collection

In order to gather the required socio-economic data and social impacts, several methods were used such as

- structured interviews using the Questionnaires,
- public consultation and focus group discussions,
- meetings with concerned agencies such as Nepal Electricity Authority, District Coordination Council Office, District Survey Office, Division Forest Office and Local Government Agencies at the District level, research through review of various statistical reports, Project related documents, Government Decrees, Decisions and regulations.

Socio-economic survey was done using structured interviews with prepared Questionnaire. This is administered to the Project Affected Person/Households within the direct and indirect impact zone of Project area to determine the socio-economic condition. (See Annex. Questionnaire 1: Socio-Economic and Resettlement Survey Questionnaire)

Inventory of Losses (IOL) was gathered through a separate Questionnaire. This was administered to determine the project impact and losses to land, household structures and above ground improvement, crops and trees, income and livelihood (See Annex. Questionnaire 2: Inventory of Losses).

Focus Group Discussion (FGD) were conducted to the Indigenous Peoples (IP) or ethnic groups living within the project area to gather the basic information on their location, ownership of land, their characteristics, sources of livelihood and income, their views on the perceived effects and impacts of the Project to their way of life and their suggestions on mitigating these impacts. (See Annex 1: FGD Form for IPs)

Focus Group Discussion (FGD) were conducted to women and other vulnerable groups living within the project area to gather their views and suggestions on perceived impact of the Project and the mitigation measures. (See Annex: FGD Form for Women and other Vulnerable Groups)

Meetings and discussion with concerned agencies and offices were also conducted to interview Officials at the central, district and local levels to gather the necessary data.

Both the quantitative and qualitative data that were gathered from the structured interviews and FGDs conducted were processed using the computer software Statistical Package for Social Sciences (SPSS). The processed data were entered in the Tabulation Formats for the socioeconomic data, the inventory of losses and the FGDs. The secondary data gathered from statistical reports and other sources were entered in tabulation formats.

3.8 Data Processing, Analysis and Interpretation

All the relevant secondary and primary data collected from literature review and field survey were tabulated and analyzed. Existing environmental conditions were examined by using standard methods such as matrices, charts and expert judgment. The information was processed and tables, maps and illustrations were included at appropriate places in the text. The data collected from the field were processed with the application of Statistical Package for Social Science (SPSS) and Excel. Wherever possible, charts, diagrams, photographs, maps, matrices, bar chart and other methods of presentation were used in order to make the final report more informative and illustrative.

3.9 Impact Identification, Prediction and Evaluation

The impacts used under the study were based on the standard evaluation criteria of National EIA Guidelines of 1993. This is the most widely used method of the evaluation criteria in Nepal. Positive and negative impacts on the social, economic, biological, physical parameters associated with the proposed HEP were identified and assessed. The nature of impacts was classified into direct, indirect, short-term, long-term or cumulative impacts.

In order to address these requirements of impact assessment, the whole process can be represented by three stages, namely:

- impact identification,
- impact evaluation, and
- impact prediction (National EIA Guidelines 1993).

3.10 Impact Identification

Impacts are categorized as (a) physical, (b) biological, and (c) socio-economic impacts based on thematic environmental components which are likely to be affected by the project. Furthermore, these impacts are also categorized as (a) direct, (b) indirect, and (c) cumulative impacts based on extent of interaction between project component and affected environmental component. An interaction matrix is used to display link between the proposed project activities and potentially affected environmental components.

3.11 Impact Analysis

The environmental impact assessment process has to consider a variation of impacts from low to high intensity. The National EIA Guidelines (1993) elaborate the intensity of impact based on three criteria; magnitude, extent, and duration. In addition, in this EIA, the criterion of importance is included, where relevant. The Magnitude of Impact is defined as the severity of impact and indicates whether it is reversible or irreversible. It indicates the estimated potential rate of recovery. The magnitude of impact is often expressed as high (H), moderate (M) and low (L).

Furthermore, the extent of impact refers to the spatial extent or the zone of influence of an impact. An impact can be site-specific (SS) or limited to the project area, as a locally occurring (L) within the watershed of the proposed project, as a regional impact (R) that may extend beyond the watershed, as a national impact (N) affecting resources on a national scale, or as a transboundary impact (T) affecting resources of more than one country. Similarly, the duration of impact refers to temporal dimension and might be categorized as short-term (ST), medium term (MT), and long term (LT).

Importance of impact refers to what extent “does it matter to” i.e. its value (biodiversity, ecosystem per se, ecosystem service, cultural) (H, M, and L). The Magnitude, extent, duration and importance of the impact are weighed mutually to provide its significance, where realistically possible. The ranking of impacts to provide their significance characterizes the overall predicted impact and its potential significance for mitigation and project decision makers.

Table 3-3: Numerical scale for impact analysis

Magnitude	Numerical Scale	Extent	Numerical Scale	Duration	Numerical Scale
High (H)	60	Regional (R)	60	Long Term (LT)	20

Medium (M)	20	Local (L)	20	Medium Term (MT)	10
Low (L)	10	Site Specific (SS)	10	Short Term (ST)	5
Source: National EIA Guideline, 1993					

For the impacts ranging in cumulative score from 45 to 75 will be termed significant/ moderate while the impacts ranging in cumulative score above 75 will be termed as highly significant (**Table 9**).

Table 3-4: Cumulative score and description of impacts

S.N.	Cumulative Score	Description
1	< 45	Insignificant
2	45 to 75	Significant (Moderate)
3	>75	Highly Significant

3.12 Public Consultation, Public Hearing and Workshop

The planning, approval and planned public consultation follow the requirements of the EPR, 2020, and as prescribed by the WBG and thus complies with IFI policies. The proponent had prepared and submitted the Scoping Report and TOR for the EIA to DOED which was approved by the Ministry of Energy and Ministry of Environment. Opinions and suggestions were collected from the project affected people and institutions and public consultations were conducted in the project area to identify impacts and major issues due to the implementation of the proposal. These opinions and suggestions have been considered in this EIA and its supporting reports and safeguards plans. The consultative process followed has been used to develop a Public Consultation and Disclosure Plan in line with that required for IFI.

CHAPTER 4. REVIEW OF ACTS, POLICIES, LAWS AND GUIDELINES

Environmental and social policies and legislative provisions related to hydropower development and management are described in this chapter. Hydropower development affects terrestrial and aquatic resources, flora and fauna, agriculture production, physical and community infrastructures and facilities, socio-cultural lifestyle and traditions, socio-economic conditions and livelihoods of people etc. in the project influence area, and causes involuntary resettlement of displaced people. The hydropower development is a multi-sectoral action involving sectors such as forestry, wildlife, agriculture, irrigation, road and transport, public health, community development, population and culture.

The Government of Nepal has passed Sectoral National Policies, enacted Acts and Regulations, developed Guidelines and Manuals, and has signed International Agreements and Conventions related to use and management of social and biological resources. The GoN has set aside environmental requirements for the planning, approval and implementation of hydropower or thermal projects generating electricity. Besides, the multilateral and bilateral agencies financing hydropower projects ensure that their environmental and social policies, guidelines and directives are integrated in planning or implementation of the project. Policies, Acts and Rules relevant to hydropower development, Guidelines and Manuals for preparation of EIA, and International Conventions relevant to hydropower sector have been reviewed by EIA team and briefly described here.

Constitution of Nepal

Constitution	Related Provisions
Constitution of Nepal	<ul style="list-style-type: none"> ❖ Article 50 (2) Directive Principles of State: The economic objective of the State shall be to achieve a sustainable economic development, while achieving rapid economic growth, by way of maximum mobilization of the available means and resources through participation and development of public, private and cooperatives, and to develop a socialism-oriented independent and prosperous economy while making the national economy independent, self-reliant and progressive in order to build an exploitation free society by abolishing economic inequality through equitable distribution of the gains. ❖ Article 25 Right to Property: Article 25 (3) – Acquisition of the private property legally and through compensation for carrying out the activities stated in 25 (4) ❖ Article 27 Right to Information: All of the citizens are entitled to get informed on the issues of public interest and hence the locals should be informed on every stages of the project ❖ Article 30 Right to Clean Environment: 30(1) provides right to citizens to live in clean environment, 30(2) makes provision for Polluters pay for the environmental damages caused ❖ Article 34 Right to Labor: 34(2) makes provision to all labors to

proper wage and contribution based social security

Plans and Policies Attracted by the Project

Policies	Related Provisions
15 th Plan (2076/077-2080-081)	<ul style="list-style-type: none"> ❖ The State will make such arrangements as may be required to keep the environment clean. The State will give priority to the prevention of adverse impacts in the environment from physical development activities, by increasing the awareness of the general public about environmental cleanliness, as well as to the protection of the environment. The plan also emphasizes the need of sustainable utilization of natural resources of Nepal.
National Biodiversity Strategy and Action Plan (2014-2020)	<ul style="list-style-type: none"> ❖ The National Biodiversity Strategy and Action Plan has been prepared with a 35-year vision of have been prescribed to facilitate its implementation. ❖ The strategies for managing protected area and forest biodiversity aim at reducing or managing human pressures on natural resources, reducing human-wildlife conflict, controlling invasive alien species, mitigating climatic threats to ecosystems, species and their habitats, and addressing economic and social concerns of local and indigenous communities through targeted programmes, enabling policy and legislative environment. ❖ Reducing the rate of loss and degradation of forest habitats, improving biological connectivity, enhancing knowledge and understanding about forests, promoting conservation of species and genetic diversities, enhancement of forest-based livelihoods are some of the focused areas.
National Environmental Policy, 2076	<ul style="list-style-type: none"> ❖ Five policy principles apply, including: a) to manage efficiently and sustainably natural and physical resources; b) to balance development efforts and environmental conservation for sustainable fulfillment of the basic needs of the people; c) to safeguard natural heritage; d) to mitigate adverse environmental impacts of development projects and human actions; and e) to integrate environment and development through appropriate institutions, adequate legislation and economic incentives, and sufficient public resources
National Climate Change Policy, 2076	<ul style="list-style-type: none"> ❖ Includes climate adaptation and disaster risk reduction; low carbon development and climate resilience; access to financial resources and utilization; capacity building, peoples' participation and empowerment; study, research, technology transfer, climate friendly natural resources management and institutional set up with legal provisions, and importance of monitoring and evaluation.
National Forest Policy 2076	<ul style="list-style-type: none"> ❖ Land use planning and change in land use categories, conservation of bio-diversity, eco-systems and genetic resources. ❖ The policy also aims to conservation of water, soil on basin level studying and planning based on catchment level. ❖ To reduce and mitigate the adverse impacts of climate related hazards and enhance climate change adaptation measures and resilience in

	Nepal.
National land use policy, 2072	<ul style="list-style-type: none"> ❖ The policy is formulated to improve social and economic status of project affected families by providing fair and adequate compensation, appropriate resettlement and rehabilitation assistances/allowances while acquiring land for infrastructure development projects. ❖ It aims to ensure the optimum use of land and portions of land, and aims to encourage optimal use of land for agriculture. ❖ The policy also talks of adopting the concept of aggregating parcels of land to acquire land for development projects.
Land Acquisition, Rehabilitation and Resettlement Policy, 2071	<ul style="list-style-type: none"> ❖ Recognize the need for resettlement and rehabilitation plan to ensure the livelihoods of project-affected persons or households be at least above the pre-project conditions; ❖ Emphasize that the project development agency conducts meaningful consultation with project- affected persons, communities and sensitive groups, particularly poor, landless, senior citizens, women, children, indigenous / Janajati groups, disabled, helpless and persons having no legal rights on the operated land while preparing land acquisition, resettlement and rehabilitation plan; ❖ Employment opportunities to seriously project-affected households and Vulnerable groups (Dalit, Janajati or marginalized Indigenous, single women, helpless, disabled, senior citizens, etc.) based on their skills and capabilities, and ❖ Requires an adequate mechanism to listen to, register and resolve the grievances of the project-affected persons and communities;
Land Use Policy, 2069 B.S.	<ul style="list-style-type: none"> ❖ The policy is formulated to improve social and economic status of project affected families by providing fair and adequate compensation, appropriate resettlement and rehabilitation assistances/allowances while acquiring land for infrastructure development projects. ❖ It aims to ensure the optimum use of land and portions of land, and aims to encourage optimal use of land for agriculture. ❖ The policy also talks of adopting the concept of aggregating parcels of land to acquire land for development projects.
Forest Encroachment Control Strategy, 2068	<ul style="list-style-type: none"> ❖ This Strategy emphasizes achieving 40 percent forest coverage through avoidance and control of forest encroachment and reclaiming of encroached forest areas.
Hydropower Development Policy 2058 B.S.	<ul style="list-style-type: none"> ❖ Section 5, sub-section 5.7 – environmental protection,, sub-section 5,8 - mitigation planning of the affected resources, sub-section 5.20 – opportunity for local people in employment); Section 6, sub-section 6.1 - environmental release, assistance in the land and property

	<p>acquisition, responsibility for resettlement and rehabilitation of project-affected people; sub-section 6.5 – provisions of HEP transfer to Government of Nepal, sub-section 6.12 - Royalty payments to local area, licensing provisions for survey and generation, terms of license, sub-section 6.13 – fee provisions. The policy also recommends riparian release of 10% of the average minimum monthly flow or as recommended by the study.</p>
National Water Plan, 2058 B.S.	<ul style="list-style-type: none"> ❖ The National Water Plan emphasizes the need for Strategic Environmental Assessment. ❖ Section 7 of the NWP highlights the Environment Management Plan (EMP) as a strategic document for the implementation, monitoring and auditing of environmental protection programs.
Nepal Environmental Policy and Action Plan, 2050 B.S.	<ul style="list-style-type: none"> ❖ Five policy principles apply, including: a) to manage efficiently and sustainably natural and physical resources; b) to balance development efforts and environmental conservation for sustainable fulfilment of the basic needs of the people; c) to safeguard natural heritage; d) to mitigate adverse environmental impacts of development projects and human actions; and e) to integrate environment and development through appropriate institutions, adequate legislation and economic incentives, and sufficient public resources.
National Wetlands Policy 2012	<ul style="list-style-type: none"> ❖ Envisions healthy wetlands for sustainable development and environmental balance. ❖ Aims at conserving and managing wetlands resources sustainably and wisely. ❖ Objectives are to conserve biodiversity and protect environment by conservation of wetlands, involving local people in the management of wetlands, and conservation, rehabilitation and effective management of wetland areas; supporting the wellbeing of wetland dependent communities; and enhancing the knowledge and capacity of stakeholders along with maintaining good governance in management of wetland areas.

Acts Attracted by the Project

Acts	Related Provisions
Environment Protection Act, 2076	<ul style="list-style-type: none"> ❖ Article 3 mandates IEE/EIA study for development projects; Article 4 prohibits implementation of projects without approval; Articles 5 and 6 describe the approval procedures; Article 7 prohibits emission of pollutants beyond the prescribed standards; Articles 9 and 10 stipulate provisions for the protection of natural heritage and Environmental Protection Area; Article 17 stipulates compensation provisions arising from the discharge of waste and pollution; Article 18 includes provision of punishment for actions against the Act and rules, guidelines and standards formulated under the Act; Article 19 stipulates the rights to appeal to the concerned Appellate court against the decision of concerned authority.

Forest Act, 2076	❖ The Act aims to control the encroachment into forests and forest areas, illegal cutting, falling, hunting and trading of flora, fauna and forest products. It aims to attain social and economic development and to promote a healthy environment and to ensure the development and conservation of forest and the proper utilization of forest products and extend co-operation in the conservation and development of private forest by managing the national forest in the form of government managed forest, protected forest, community forest, leasehold forest and religious forest.
❖ Labour Act, 2075	❖ Describes classification of job postings; makes provision of appointment letter and prohibition on child labour and restriction on minors and women; Section 10 - job security; section 12 - retrenchment and reemployment; Section 16, 17, 18 and 19 - working hours; Sections 20, 21, 22, 23, 25 and 26 - remuneration; Sections 27 to 36 - occupational health and safety; Sections 37 to 44 - welfare arrangements; Section 46 - special arrangements for construction sites; Sections 50 to 60 - conduct and penalties; Sections 72 to 82 - settlements of labour disputes.
❖ The Foreign Investment and Technology Transfer Act, 2075	❖ Speaks of foreign investment and technology transfer in order to make national economy competitive, strong and employment-oriented through mobilization to the maximum extent of the available means and resources for economic prosperity of the country, and to achieve sustainable economic growth through industrialization while creating investment friendly environment to attract foreign capital, technology and investment in the sectors of import substitution, export promotion, through increase in productivity, and of infrastructure development and production of goods or services
❖ Disaster risk Reduction and Management Act, 2074 BS	❖ This act aims to the reduction of disaster risks and management to protect human lives and properties of the public, private and individual, to preserve natural and cultural heritage, and to keep physical infrastructures safe from natural and non-natural disasters by effectively coordinating and managing all activities on reduction of disaster risk and management.
❖ Muluki Debani Samhita, 2074	❖ A meeting of the Legislature-Parliament passed the Muluki Ain (Civil Code) Bill, 2074 BS. The bill includes provision on division of property. Earlier, the parliament had directed the committee concerned to incorporate this provision instead of the provision of granting will on parental property to be effective 19 years after the granting of the will. The provision of will on parental property was in the bill when it was first presented in parliament.
❖ Muluki Aparadh Samhita, 2074	❖ The Criminal Code was adopted in 2017 alongside five other Acts, designed to replace the Civil Code, 2021. It outlaws the practice of Chhaupadi as was as the evangelization of citizens to other religions.
❖ Performance Based	❖ It ensures the social security rights of labourers based on their

<p>Social Security Act, 2074</p>	<p>contribution.</p> <ul style="list-style-type: none"> ❖ Every listed employer should deposit funds regularly as per their contract or deposit additional amount to the labourer's contributable income as mentioned in Article 7. According to sub-section 1, the amount should be deposited from the day the labour is listed to the last day of his/her employment. ❖ If a situation arises where the labour does not receive remuneration and cannot deposit the amount to be deposited by him/her then the listed employer should deposit the funds for a maximum of 3 months. ❖ The listed employer can deposit the amount by deducting from the labourer's remuneration, allowance or other facility as prescribed. If the employer does not deposit the fund within the cited period, then s/he will have to pay an interest of 10% of contribution amount in addition to the contribution amount.
<ul style="list-style-type: none"> ❖ Local Government Operation Act, 2074 	<ul style="list-style-type: none"> ❖ This Act states the roles of local bodies in Nepal. The jurisdiction, roles and responsibilities of personnel appointed in local bodies are clearly mentioned in this Act. Clause 11 and 12 of Local Government Operation Act ensure the function, right and duties of Municipalities & Rural Municipalities and ward committees.
<ul style="list-style-type: none"> ❖ International Trade Control Act for Endangered Species of Wild Fauna & Flora, 2073 	<ul style="list-style-type: none"> ❖ This Act provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES, is implemented at the national level.
<ul style="list-style-type: none"> ❖ The Sexual Harassment at Workplace Prevention Act, 2071 	<ul style="list-style-type: none"> ❖ The Act affords protection to employees, and workers employed by the entities (including contract workers), as also to customers (and persons accompanying such customers) who may visit the workplace to avail of any services. According to section 5, management of the company should make workplace free of any kind of harassment. ❖ It also describes that company should appoint grievance handling officer to deal with such kind of issues.
<ul style="list-style-type: none"> ❖ Forest Protection Act 2070 	<ul style="list-style-type: none"> ❖ The Act aims to control the encroachment into forests and forest areas, illegal cutting, falling, hunting and trading of flora, fauna and forest products.
<ul style="list-style-type: none"> ❖ Solid Waste Management Act, 2068 	<ul style="list-style-type: none"> ❖ Solid Waste Management Act aims to manage solid waste and mobilize resources related thereto and ensure the health convenience of the common people by controlling the adverse impact on pollution from solid waste. The commercial or industrial establishments should adhere to the clauses mentioned in the act during the

	<p>construction and operation phases of the projects.</p>
<p>❖ Right to Information Act, 2064</p>	<ul style="list-style-type: none"> ❖ 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 make the access of citizens to the information of public importance held in public bodies simple and easy and to protect sensitive information that could have an adverse impact on the interest of the nation and citizens. ❖ Clause 3 of the act ensures the Right to Information. It says that every citizen shall, subject to this Act, have the right to information and they shall have access to the information held in the public Bodies unless confidentiality has been maintained by laws. ❖ Clause 4 of the act describes the Responsibility of a Public Body to disseminate information. It mentions that each Public Body has to respect and protect the right to information of citizens. Public Bodies shall have the following responsibilities for the purpose of protecting the right to information of citizens: - to classify and update information and make them public, publish and broadcast to make the citizens' access to information simple and easy; to conduct its functions openly and transparently;0020to provide appropriate training and orientation to its staffs. ❖ Public bodies may use different national languages and mass media while publishing, broadcasting or making information public. A Public Body shall arrange for an Information Officer for the purpose of disseminating information held in its office. ❖ The clause 7 of the act prescribes the Procedures of Acquiring ❖ Information. It states that a Nepali Citizen, who is interested to obtain any information under this Act, shall submit an application before a concerned Information Officer by stating the reason to receive such information.
<p>❖ National Foundation for Upliftment of Aadibasi/Janjati Act, 2058</p>	<ul style="list-style-type: none"> ❖ The Act prescribes a number of provisions to overall improve the lot of the Aadibasi / Janjati by formulating and implementing programs relating to the social, educational, economic and cultural development through: ❖ Creating an environment for social inclusion of disadvantaged and indigenous people ensuring participation of disadvantaged groups in the mainstream of overall national development of the country, by designing and implementing special programs for disadvantaged groups; ❖ Protecting and preserving their culture, language and knowledge and promoting the traditional knowledge, skills, technology and special knowledge of the Aadibasi / Janjati and providing assistance in its

	vocational use.
Electricity Act 2049 BS	❖ Mandates to develop electric power by regulating the survey, generation, transmission and distribute the survey, generation, transmission, and distribution of electricity and to standardize, and safeguard the electricity services.
Water Resources Act 2049 B.S.	❖ Article 3 stipulates the water resource rights of Government; Article 4 prohibits use of water resources without obtaining a license, except for specified uses under the Act; Article 7 establishes the order of priority for the utilization of water resources; Article 8 stipulates procedures for water resource licensing; Article 16 empowers Government to utilize the water resources and acquisition of other lands and property for the development of water resource as stipulated in the Act; Article 18 stipulates the right of the Government to fix the quality standards of water; Article 19 prohibits pollution of water resources above prescribed pollution tolerance limits; Article 20 prohibits causing harm and adverse effects on the environment while developing a water resource project.
	❖
Soil and Watershed Conservation Act 2039 B.S.	❖ Article 10 prohibits actions within any protected watershed area declared pursuant to Article 3 of this Act; Article 24 stipulates there are no obstacles for the Government of Nepal to use and develop of waters resources.
Land Acquisition Act 2034 B.S.	❖ Article 3 grants power to the Government to acquire any land anywhere for public purposes, subject to compensation under the Act; Rule 4 empowers Government to acquire land upon request by institutions subject to the payment of compensation and all other expenses under the Act; Rules 5, 6, 7 and 8 stipulate provisions and procedures for initiating initial land acquisition process and estimating compensation rates; Rules 8 and 9 stipulate procedures and provisions for notification of land acquisition; Rule 11 provides for the right to file complaints by those affected by public notice with regard to the land rights; Rules 13, 14, 15 stipulate procedures and provisions of setting compensation; Rules 16 and 17 stipulate criteria for setting compensation; Rule 19 stipulates disclosure of compensation entitlement through public notification; Rule 25 includes provision of complaints against the compensation rates to the Ministry of Home affairs. The decision of the Ministry of Home affairs on the complaint is final.
National Parks and Wildlife Conservation Act 2029 B.S.	❖ Article 5, includes provisions to restrict damage to forest products and to block, divert any river or stream flowing through a national park or reserve, or any other source of water, or restrict the use of any harmful or explosive materials without obtaining written permission; Article 9 lists protected wildlife species that are prohibited from being hunting; Article 13 prohibits collection of

	samples from National parks and Reserves without obtaining a license.
Plant Protection Act, 2029	<ul style="list-style-type: none"> ❖ Plant Protection Act is a legal provision for preventing the introduction, establishment, prevalence and spread of pests while importing and exporting plants and plant products, promoting trade in plants and plant products by adopting appropriate measures for their effective control. ❖ Section 22 (a-k) of the act is relevant for the project as it prohibits import and export of plants, plant products, biological control agents, beneficial organisms or soil without obtaining the entry permit except as otherwise mentioned in this Act. Any person who commits the offenses set forth in various clauses of Section 22 shall be liable to the penalties.
Land Act 2021 B.S.	<ul style="list-style-type: none"> ❖ Section 7 - land ceiling and rights of tenant; Section 12 - exemption from upper ceiling; Sections 25, 26, and 29 - tenancy rights; Section 51 relating to land use, control of land fragmentation and plotting.
Explosives Act 2018 B.S.	<ul style="list-style-type: none"> ❖ Section 2 - defines explosives; Section 4 - permission for the production, storage, use, transportation and import of explosives.
Aquatic Animal Protection Act 2017 B.S.	<ul style="list-style-type: none"> ❖ Section 5 (5B) - provisions of fish ladder and fish hatchery while constructing water diversion structures and requirement of prior permission from the government.
Ancient Monument Protection Act 2013 B.S.	<ul style="list-style-type: none"> ❖ Section 2 defines the ancient monuments; Sections 3, and 17 empower Government to declare any place or area as a monument site / area; Section 13 restricts transfer, transaction, export or collection of ancient monuments and archaeological objects or curio without prior approval of the government.

Rules and Regulations Attracted by the Project

Rules and Regulations	Related Provisions
Environment Protection Regulation, 2077 B.S.	<ul style="list-style-type: none"> ❖ The newly formed regulation have included three types of environment examination concise environment study for project under schedule 1, Initial environment examination for the project that comes under schedule 2 and Environment impact assessment for the project that come under schedule 3. Section 4 of chapter 2 guides for the scoping works and section 6 guides for conducting the public hearing. Section 7 guides to develop the report with reference to annex 10 for concise environment study report, annex 11 for initial environment examination report and annex 12 for environment impact assessment report. Section 10 mentions about the strategic environment assessment. Section 16 mentions about the hazardous substance management. Chapter 3 mentions provision related to the pollution control. Schedule 1 includes thresholds to conduct concise environment study, schedule 2 includes thresholds of project to carry out initiation environment examination and schedule 3 includes thresholds of project to carry out environment impact assessment.

Performance Based Social Security Regulation, 2075	<ul style="list-style-type: none"> ❖ Section 2 provides the provision for involvement in the program in the formal and informal sectors.
Labor Regulation, 2075	<ul style="list-style-type: none"> ❖ Section 11 (3) of the Labor Act provides for the employment contract and the matters to be covered under the employment contract. ❖ The Labor Rules requires the Employer to provide notice to the Employees for lay off. The Notice should cover (a) reason of lay off and its duration, (b) details of Employee such as name, position, branch or division and job description, (c) information that mentions payment of half remuneration during lay off, (d) other matters as required by the Employer. The Labour Rules also requires the Employer to lay off the Employee on rotation if the layoff is partially enforced. ❖ The Labour Rules specifies the documents requirement for work permit. The application for work permit may be submitted by the Employer or by the foreign national in individual capacity.
Solid Waste (management & resource mobilization), Regulation, 2070 B.S.	<ul style="list-style-type: none"> ❖ Solid Waste Management Rules, 2070 has enforced the responsibility of managing of solid wastes generated during project activities. It has restricted mixing of hazardous wastes with ordinary waste to be dumped in municipality waste containers. Punishment measures for not complying have also mentioned.
Conservation Area Management Regulation, 2053 B.S.	<ul style="list-style-type: none"> ❖ The concerned conservation officer shall constitute a conservation area management committee in each Village Development Committee within the Conservation Area for the effective implementation of the construction works related to the community development activities in the Conservation Area, protection of the natural environment of that area and management program related to the balanced utilization of natural heritage,
Forest Regulations, 2051 B.S.	<ul style="list-style-type: none"> ❖ Rule 7 prohibits forest cutting without obtaining a license; Rule 8 stipulates the procedures of licensing for forest products; Rule 65 makes a national priority project developer that uses national forest areas responsible for the compensation of the loss or harm to any local individual or community due to the project, and also makes the developer responsible to cover all expenses required for the cutting, milling and transporting the Forest Products in a Forest Area to be used.
Water Resources Regulations 2050 B.S.	<ul style="list-style-type: none"> ❖ Rules 12 to 21 specify the provisions and procedures of licensing for water resource utilization; Rules 32 to 35 specify provisions, procedures and responsibilities for the acquisition of land and property for the development of water resources.
Electricity Regulation 2050 BS	<ul style="list-style-type: none"> ❖ This Act is related to provision related to licenses related to electricity survey, and distribution, to issue license for survey

	<p>(format and template for license applications etc)</p> <ul style="list-style-type: none"> ❖ Stipulated requirements for production of electricity ❖ Permission for import of electricity ❖ Regarding the design and construction of electric circuit ❖ Safety provisions to be followed during electrical works
National Park and wildlife Conservation Regulation, 2034 B.S.	<ul style="list-style-type: none"> ❖ Rule 4 stipulates provision of entry pass to enter into the Parks or Reserve, Rule 6 stipulates restricted activities within the Parks and Reserves, Rule 11 stipulates prior approval for any research activities or study within the parks or reserves.
Explosives Regulation 2020 B.S.	<ul style="list-style-type: none"> ❖ This regulates the Production, Storage, Use, Sale, Transportation and Import of Explosives

Guidelines and Manuals

Guidelines and Manuals	Related Provisions
Procedure for the Use of Forest for National Priority Projects, 2076 B.S.	<ul style="list-style-type: none"> ❖ The procedure allows the projects, built by the private sector under public-private partnership model, projects relating to goods or services for public use like roads, drinking water and electrification projects, to pay the government in cash in case of its inability to provide compensation in the form of land for the used forest land.
Hydropower Licensing Guideline 2075 B.S.	<p>This guideline states all the criteria, rules and regulation regarding the survey license who want to generate the electricity. This directive has been framed by the former Ministry of</p> <ul style="list-style-type: none"> ❖ Energy utilizing the power conferred by the Electricity Regulation, 2050 and describes in details the procedural requirements for issuing or obtaining/amending/renewing/withholding survey license for electricity generation, transmission or distribution, electricity generation license and transmission or distribution license. It lists the information and document requirement for these processes.
Guidelines for Handing Over the Forest Area for National Priority Projects, 2074 B.S.	<ul style="list-style-type: none"> ❖ The guideline addresses conditions required to make forest lands available to development projects and required compensatory measures for the loss of forest land use and forest products. ❖ The proponent has to afforest the area equal to the forest area lost at the minimum, if the forest area occupied by the project is a barren land. The land area for afforestation will have to decide based on the discussion with the Division Forest Office. Or the proponent could deposit the required amount as per forest norm to the Division Forest Office. ❖ The proponent should plant 25 trees for every lost tree of above 30cm DBH in areas designated by the Division Forest Office and look after the plantation for 5 years to ensure their protection and growth of every planted tree. Or the proponent deposit the required amount for plantation and protection for five years to the Division Forest Office.
Hydropower	<ul style="list-style-type: none"> ❖ Generic information on the procedures for EIA Scoping, ToR

Environmental Impact Assessment Manual, 2018 A.D.	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.
Forest Products Collection, Sale and Distribution Guidelines 2073 B.S.	The guidelines specify various procedure and formats for getting approval for vegetation clearance, delineation of lands for vegetation clearance, evaluation of wood volume, etc.
MoPE Guide to Environmental Management Plans of Hydropower Projects 2063 B.S.	<ul style="list-style-type: none"> ❖ MoPE has published guidelines for conducting IEE / EIA of hydropower development projects, which detail methods and procedures for the preparation of environmental management plans, environmental auditing and environmental monitoring plans. ❖ A Guide to Environmental Management Plans of Hydropower Projects (MoEST, 2006) ❖ A Guide to Environmental Auditing of Hydropower Projects (MoEST, 2006) <p>A Guide to Environmental Monitoring of Hydropower Projects (MoEST, 2006).</p>
Community Forest Inventory Guidelines 2062 B.S.	Community Forest Inventory Guidelines detail the process and procedures for evaluating the forest stock and its harvesting potential in Community Forests.
EIA Guidelines for Forestry Sector, 2051 B.S.	<ul style="list-style-type: none"> ❖ The guideline specifies the EIA procedures to be followed while undertaking environmental studies that involve forest areas.
Community Forest Guidelines 2058 B.S.	<ul style="list-style-type: none"> ❖ Guideline sets 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.
Environmental Management Guidelines (Road) 2056 B.S.	<ul style="list-style-type: none"> ❖ The guideline for roads focuses on the major issues for environmental management while developing or upgrading a road corridor. It sets procedures for environmental assessment and highlights the potential impacts and mitigation measures for road projects.
EIA Guidelines for Water Resource Sector 2050 B.S.	<ul style="list-style-type: none"> ❖ The guideline sets procedures for: a) identification of positive and negative impacts of water resource projects over both short-term and long-term periods on natural and human environments; b) development of mitigation management and monitoring plans; and c) public hearings and interaction with affected groups, NGOs, donors and relevant government agencies.
Department of Electricity Development Manuals	<ul style="list-style-type: none"> ❖ Specific environmental manuals for hydropower development studies. A total of 7 manuals have been prepared by DoED to cover different components of EIA, environmental management and monitoring. These include: ❖ Manual for preparing Scoping Document for Environmental Impact Assessment (EIA) of Hydropower Project (2001)

	<ul style="list-style-type: none"> ❖ Manual for Public Involvement in the Environmental Impact Assessment (EIA) Process of Hydropower Project (2001) ❖ Manual for Preparing Terms of References (ToR) for Environmental Impact Assessment (EIA) of Hydropower Projects, with Notes on EIA Report Preparation, (2001) ❖ Manual for Preparing Environmental Management Plan (EMP) for Hydropower Projects, (2002) ❖ Manual for Developing and Reviewing Water Quality Monitoring Plans and Results for Hydropower Projects, (2002) ❖ Manual for Conducting Public Hearings in the Environmental Impact Assessment Process for Hydropower Projects (2004) ❖ Manual for Addressing Gender Issues in Environmental impact Assessment / Initial Environmental examination for Hydropower Projects, (2005)
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Directives Attracted by the Project

<ul style="list-style-type: none"> ❖ Social Security Schemes Operational Directives, 2075 	<ul style="list-style-type: none"> ❖ Section 4: Grace Period for coverage of Medical Treatment, Health and Motherhood Protection Scheme ❖ Section 6(6): Permissibility to obtain similar benefits from other Schemes. ❖ Section 10(2), 10(3): Coverage of Employment related accidents and occupational diseases ❖ Section 10(1), 11(2): Coverage of Non Employment related accidents ❖ Section 15(1) (2): Scope of entitlement ❖ Section 19(3) (4): Provision of Provident Fund and Gratuity of the past period ❖ Section 20(b): Participation in the pension scheme, ❖ Section 23(1): Retirement Benefit ❖ Section 24(A): Foreign employees allowed to withdraw the amount under Old Age Protection Scheme
Directives on waiver of land holdings 2074 B.S.	<ul style="list-style-type: none"> ❖ This order has made various provision for use of excess land different industries, institution, hydropower project and other projects to acquire, use land more than limit if such land is essential for them. ❖ The land acquired in such way shall be used for any other proposes. This order has made provision that if any industries, institution, hydropower project and other projects require land more than limit delineated by Land Act 2021, they have to apply for their authoritative agencies with all the information related to required land and proper documentations.
Conservation Area	<ul style="list-style-type: none"> ❖ This sets different guideline for the management of the conservation

Management Directives 2056	area.
Electricity Licensing Directive, 2075 BS (2018 AD)	<ul style="list-style-type: none"> ❖ Section 2 determines the capacity of the hydropower projects. ❖ Section 3 determines the licensing of the project based on financial and technical capability. ❖ Section 5 determines the provision for the storage type project. ❖ Section 6 determines the project on the project bank.

International Conventions Attracted by the Project

Conventions	Related Provisions
United Nations Declaration on the Rights of Indigenous Peoples, 2007 A.D.	<ul style="list-style-type: none"> ❖ The Declaration sets out the individual and collective rights of indigenous peoples, as well as their rights to culture, identity, language, employment, health, education and other issues (Article 1-4). It also "emphasizes the rights of indigenous peoples to maintain and strengthen their own institutions, cultures and traditions (Article 5) and to pursue their development in keeping with their own needs and aspirations (Article 23)". It "prohibits discrimination against indigenous peoples" (Article 21), and it "promotes their full and effective participation in all matters that concern them and their right to remain distinct and to pursue their own visions of economic and social development" (Articles 25-30).
United Nations Framework Convention on Climate Change 1992 A.D.	<ul style="list-style-type: none"> ❖ Article 4 (f) - impact assessment to avoid or mitigate or adapt to climate change.
Convention on Biological Diversity, 1992 A.D.	<ul style="list-style-type: none"> ❖ Article 14 of the Convention to introduce appropriate procedures requiring project EIA.
Convention (No.169) Concerning Indigenous and Tribal Peoples in Independent Countries 1989 A.D.	<ul style="list-style-type: none"> ❖ Article 7 - the right of the indigenous and tribal people to decide their own priorities for the process of development; Articles 12, 13, 14 and 15 - the safeguards of rights of the indigenous people in the land and natural resources in territories traditionally occupied by them; Article 16 - participation in the decision-making process and resettlement process with full compensation of the resulting loss or injury.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973 A.D.	<ul style="list-style-type: none"> ❖ Article II of the convention classifies species as Appendix I, II, and III species which are subjected to regulation in order not to endanger their survival. The convention classifies species according to criteria where access or control is important (e.g. I - species threatened with extinction; II - species which could become endangered; III - species that are protected; E - Endangered; V - Vulnerable, R – Rare (CITES 1983)). The project will have to minimize impacts to the CITES species as far as possible.

Standards to be Maintained by the Project

Standards	Related Provisions
❖ Occupational, Health and Safety Management System Requirements- OHSAS 18001:2007	❖ OHSAS 1800:2007 Occupational Health and Safety Management Certification is an international standard which provides a framework to identify, control and decrease the risks associated with health and safety within the workplace.
Nepal Vehicle Mass Emission Standard, 2069	❖ Compliance to Type I to Type V tests for vehicles fuelled with gasoline and diesel while importing vehicles for a project.
Nepal Ambient Air Quality Standard, 2069	❖ Limits of ambient air quality parameters around construction sites. The new National Ambient Air Quality Standard (NAAQS) 2012 that came into effect requires effective monitoring and collection of eight-hour and 24-hour samples of air pollutants like Total Suspended Particulates (TSP), Particulate Matter (PM10 and PM 2.5), carbon monoxide, lead and ozone levels for at least 347 days out of a 365-day year. The NAAQS further states that no particular place should fail to monitor air samples for two consecutive days. TSP consist of solid and liquid particles in the air that are harmful to health while PM10 is an air particle with a volume less than 10 micron that can easily enter into the end of the respiratory tract and cause serious health impacts. Both TSP and PM10 are considered major air pollutants. The project during its construction and operation will have to comply with the set standards for the ambient air quality.
National Diesel Generators Emission Standard, 2069	❖ The then MoFE introduced in October 2012 the National Diesel Generator Emission Standard (NDGES) for new and in-use diesel generators. In doing so they followed the Indian standards for construction equipment rather than for diesel generators. Hence the Nepal emission standards for new and in-use diesel generators are less stringent than in India. The emissions standards set for new diesel generator imports is equivalent to Bharat Stage III standards and, for in-use diesel generators, is equivalent to Bharat Stage II.
National Noise Standard, 2069	❖ Noise levels for different land use categories and noise generating equipment. It states the noise level criteria for different noise generating equipment. The standard requires effective monitoring and collection of Daytime and Night-time noise level permitted limits.
❖ National Indoor Air Quality Standard (NIAQS), 2066	❖ The time weighted (1~24hrs) standards are given for PM10, PM _{2.5} , CO & carbon dioxide (CO ₂) for indoor environments. The units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m ³), and micrograms per cubic meter of air (µg/m ³). Monitoring of carbon dioxide is to ensure the adequacy of the ventilation of the

	<p>monitoring sites. The provision for measurement of PM_{2.5} is preferred; the PM_{2.5} values can be converted to the corresponding PM₁₀ values by application of a PM_{2.5}/ PM₁₀ ratio of 0.5.</p>
<p>National Drinking Water Quality Standard, 2079</p>	<p>❖ Quality of drinking water supply in the project camps and construction sites. The water suppliers should follow the provisions of Implementation Directives for National Drinking Water Quality Standards for maintaining Drinking Water Quality Parameters as per NDWQS.</p>

CHAPTER 5. DESCRIPTION OF THE EXISTING ENVIRONMENT

5.1 Physical Environment

5.1.1 Physiography, topography and land use

The BGHEP lies in the upper stream of the Budhi Gandaki River in the Gorkha District at the middle of the mountainous region and geologically among the higher Himalayan crystalline zone of western part of Nepal. It includes hills, river valleys, escarpments, spurs, saddles, river plain and terrace etc. The Budhi Gandaki project rural municipality wards are distributed over two physiographic zones of Nepal, namely High Mountain, and Middle Mountain. Almost 53% of the project area lies in High Mountain zone and 47% in Middle Mountain. Most of the rivers originate from the high mountainous area; hence they are perennial in nature.

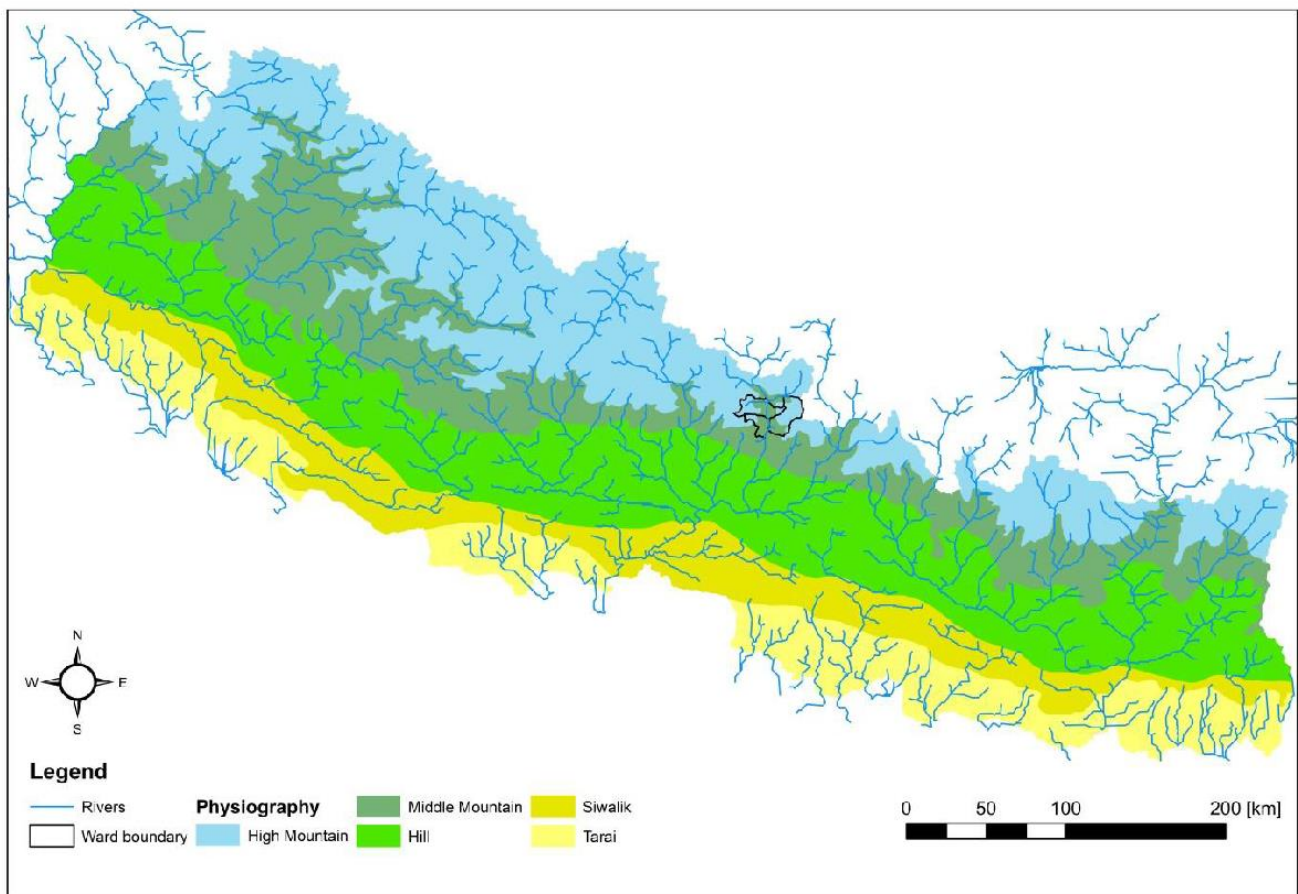


Figure 5-1: Physiography of Nepal including the HEP

The land use pattern of the project municipality-wards reflects the low human activities and harsh climatic conditions. The majorities of area remain covered by snow and are thus categorized as barren land. The BGHEP Project influence area is highly influenced by tourist activities along with a good forest cover for floral diversity serving wildlife habitats. The forest area is the largest land use type in the project area. A small area of about 2096 ha is cultivated, which is located mostly in the valley of Budhi Gandaki River. The land use of the affected area is presented in the table below:

Table 5-1: Land use of affected municipality-wards [ha]

Municipality-ward	Cultivation	Forest	Bush	Grass	Barren land	Cliff	Sand	Water Body	Glacier	Total
Chum Nubri-3	891	7580	1273	9267	5529	268	203	56	686	25,753
Dharche-1	290	6,056	1292	3741	17204	148	104	17	1169	30022
Dhrche-3	914	6816	771	2400	1153	55	28	40	482	12659
Total	2096	20452	3335	15409	23886	471	335	114	2336	68435

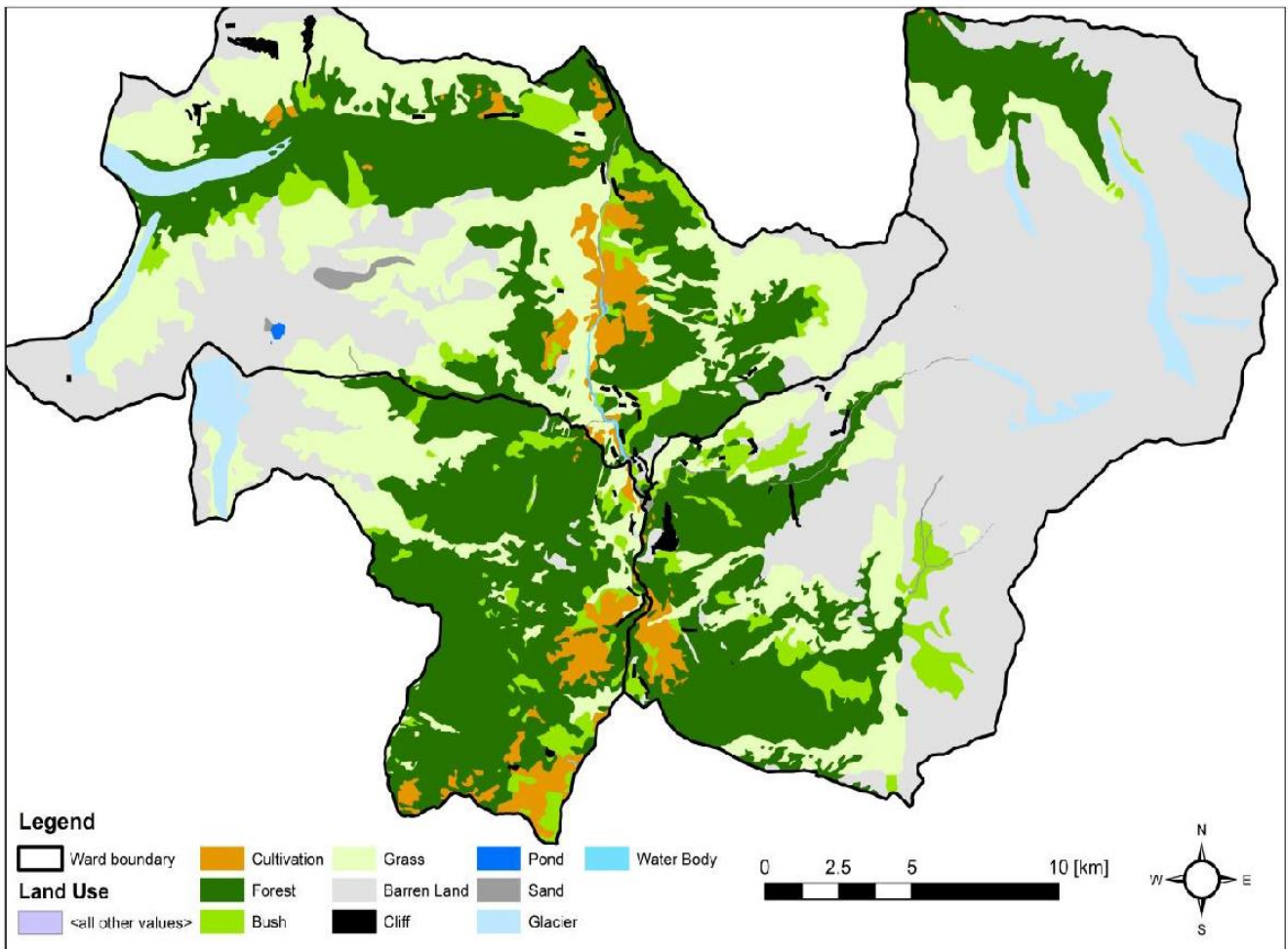


Figure 5-2: Land use of the affected project area

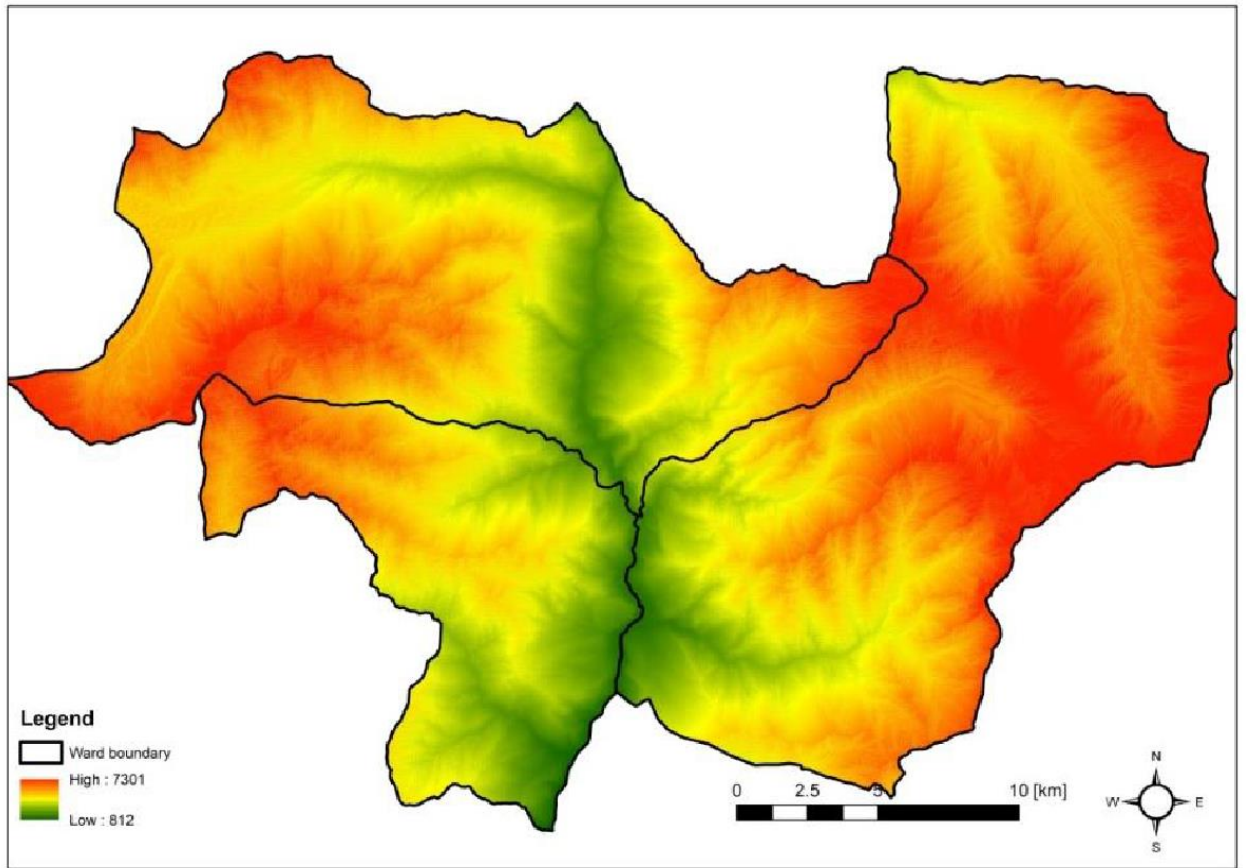


Figure 5-3: Topographic distribution of the affected R.Municipalities-wards

The project area belongs to the Higher Himalayan crystalline gneiss which displays rugged topography, high relief, steep hill slopes and difficult approaches. The higher valleys are glaciated and have experienced significant post glacial down cutting. The study site is situated within the Budhi Gandaki drainage with its tributaries to Trishuli. This hydropower area is characterized by steep slopes at an angle ranging from 300 to 750. An intense seasonal rainfall here is often interrupted by landslides of heterogeneous debris materials resulting in mass wasting process within the loose colluvial and alluvial deposit, which involves few hundreds of thousands of cubic meters of mainly fine to coarse materials deposited.

Table 5-2: Elevation masl of Project Structures

S.No	Project Structures	Activity area	Elevation masl		
			Mean	Max	Min
Intake Area					
1	Access Road (Headworks)	Salleri	1335	1349	1321
2	Disposal Area 2	Jagat	1297.5	1300	1295
3	Disposal Area 3	Salleri	1287.5	1290	1285
4	Camp Site 3	Salleri	1331	1334	1328
Adit Site					
5	Access Road (Adit 2)	Lhakpa	1293.5	1307	1280

6	Access Road (Adit 3)	Maiku	1277.5	1280	1275
De-water Zone					
7	Quarry Site	Yaruphant	1267.5	1270	1265
8	Camp Site 2	Yaruphant	1260	1265	1255
Power House					
9	Access Road (Adit 4 & 5, Vent tunnel, Camp Site)	Tatopani	1245	1530	960
10	Disposal Area 1	Tatopani	957.5	985	930
11	Camp Site 1	Tatopani	1542.5	1560	1525

5.1.2 Geology and Soils

The Budhi Gandaki Hydroelectric Project area is entirely located into the ortho-and para-gneiss of the Greater Himalaya and it is located about 1-2 km North of main central Thrust (MCT) system representing one of the ductile deformation features in the Himalayan region. The river is a carved steep walled gorge and narrow V-shaped valley across the Greater Himalayan crystalline rocks to the south of Manaslu peak (8125 m a.s.l). It flows in a broader valley across lesser Himalayan meta sediments, characterized by much lower relief and gentler hill slopes. The area within the project site between Tatopani to Salleri is characterized by steep rock walls and slightly gentler slope with accumulated colluvial deposits.

5.1.2.1 Geological Structure of the project area

The geology of the reservoir bank is characterized by fine grain schistose gneiss of the Greater Crystalline Himalaya with a valley floor filled with about 10 to 30 m thick alluvial and lacustrine deposit at an average permeability of about 7.0×10^{-3} cm/s. This is determined during constant head permeability test carried out in the descending stages in the boreholes. No major faults or weak zone has been identified during the geological mapping site activity in the reservoir area. Local quaternary deposit covers the bedrock, alluvial and lacustrine deposit which is still found on the valley floor and colluvial fans outcrop on both the left and right banks of the river.

5.1.2.2 Bedrock of the project

The Budhi Gandaki Hydroelectric project from Tatopani to Jagat village of Budhi Gandaki valley is located in the tectonic domain of the Greater crystalline Himalaya. The southern boundary of this domain, the Main Central thrust (MCT), lies at about 2 km south of the powerhouse site. The main lithological units represent are the following;

- The fine grain gneiss in the dam site area,
- The zone of HRT alignment where the augen gneiss shows a more abundant presence of augite (ferromagnesian pyroxene), and
- The garnet-kyanite schistose paragneiss with abundant mica content at the powerhouse site.

Rising the mountain flanks from the river, the loose materials disappear to leave the place to steep to very steep slightly weathered rock walls belonging to the Greater Himalayan Crystalline. As a result of various surface processes of erosion and sediment transport, the following quaternary deposits are represented at site.

Fluvial deposit: They represent the sediments found in the river bed, deposited and continuously transported and rearranged by the water following energy of the river. These deposits constitute of predominant rounded, medium to high sphericity, mainly gneiss clasts with a sandy soil matrix.

Alluvial deposit: These materials outcrop at the bottom of the valley floor to constitute morphological terraces slightly raised above the riverbed. They fill the entire Marsyangdi valley floor mainly forming the plain formed upstream of the natural dam. The constitutes are well rounded with medium to high sphericity, heterometric clasts embedded on a silty sandy matrix.

Lacustrine Deposit: The fine sediment deposition in the lake upstream of Yarupant natural rock slide dam has found these deposits which are found mixed up with the alluvial deposits. The deposition occurs mainly due to low energy depositional environment created by the lake and they are constituted by fine particles as clay and silt.

Colluvial deposit: These materials originate from the down slope movement by erosion and/or force of gravity. Over the project area, colluvial deposit have been observed along the right and left flanks of the Budhi Gandaki River valley.

5.1.3 Hydrological features

5.1.3.1 River system and basin characteristics

The Budhi Gandaki River is a part of the Gandaki Basin, which is one of three major river basins of Nepal that drains almost all of the central Nepal and some parts of the western Nepal. It is a perennial river system fed by snow as well as rain. Its origin lies in Tibet and flows towards southward direction to Nepal. As per physiographic regions, the catchment lies in between the Higher and the Lesser Himalayas. The total area of the catchment is 3075 km², out of 1375 km² lies in the Tibet, and 1700 km² in Nepal.

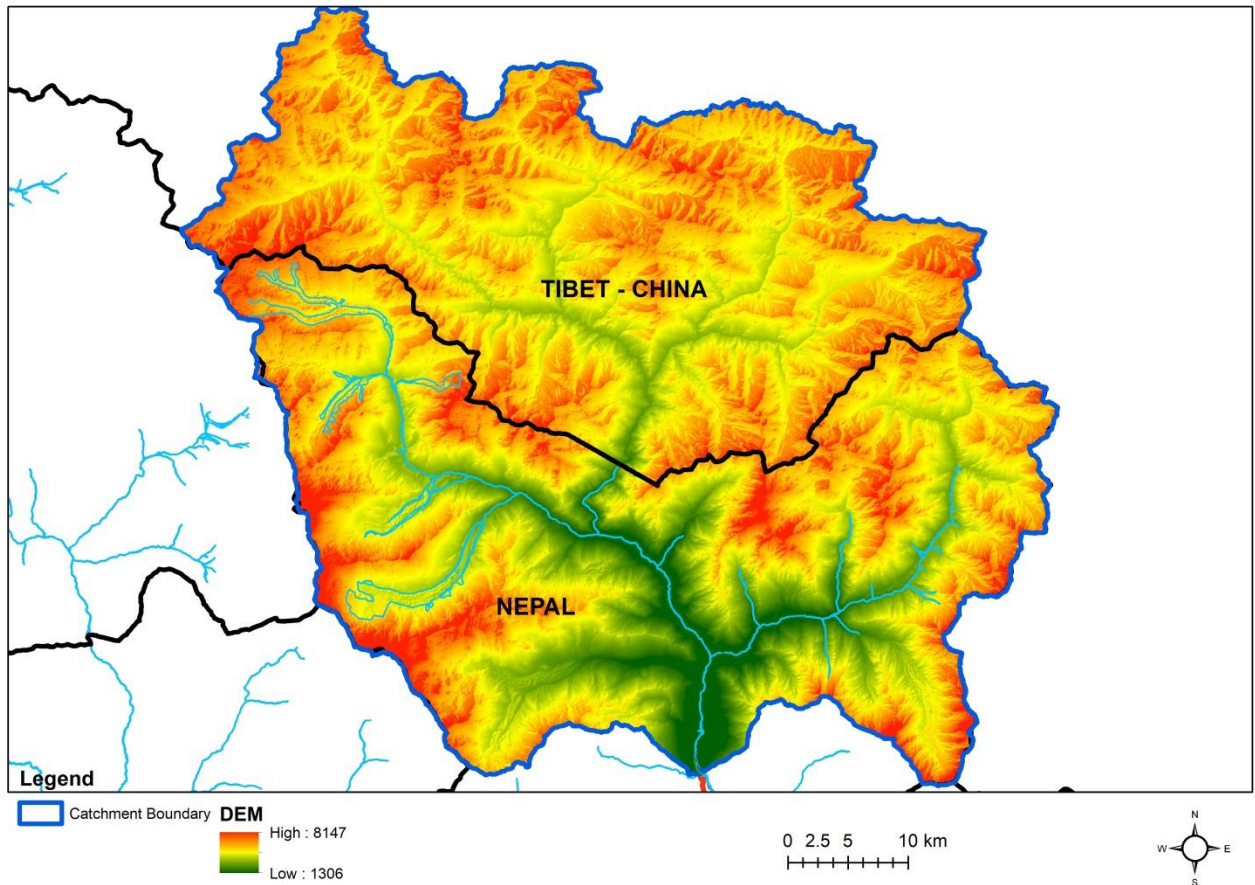


Figure 5-4: Catchment of the Budhi Gandaki at the intake

As in other rivers, discharge of the Budhi Gandaki River is also strongly influenced by the monsoon. The daily flow recorded between 1964 and 2010 was transposed to estimate discharge at intake site to estimate long term monthly discharge for the project. The water discharge is lowest in the month of February/March, and start to rise from April/May with the start of monsoon. After August the river flow starts to decrease and its hydrograph becomes flatter from December to February/March.

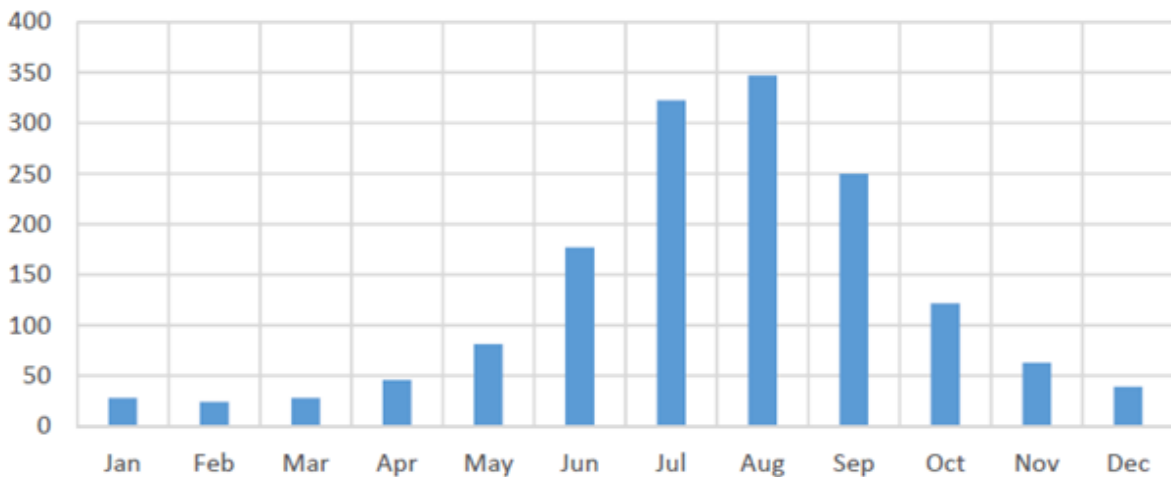


Figure 5-5: Long term monthly average at intake (m^3/sec)

The low discharge between October and February mainly consists of ground water and snow melt inputs. The lowest monthly flow was recorded to be 23.8 m³/sec for Feb, whereas highest monthly flow of about 346.52 m³/sec was recorded in August.

Table 5-3: Long term monthly average at intake

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.9	23.8	27.57	44.78	80.19	176.43	324.8	346.52	248.7	118.93	61.51	38.17

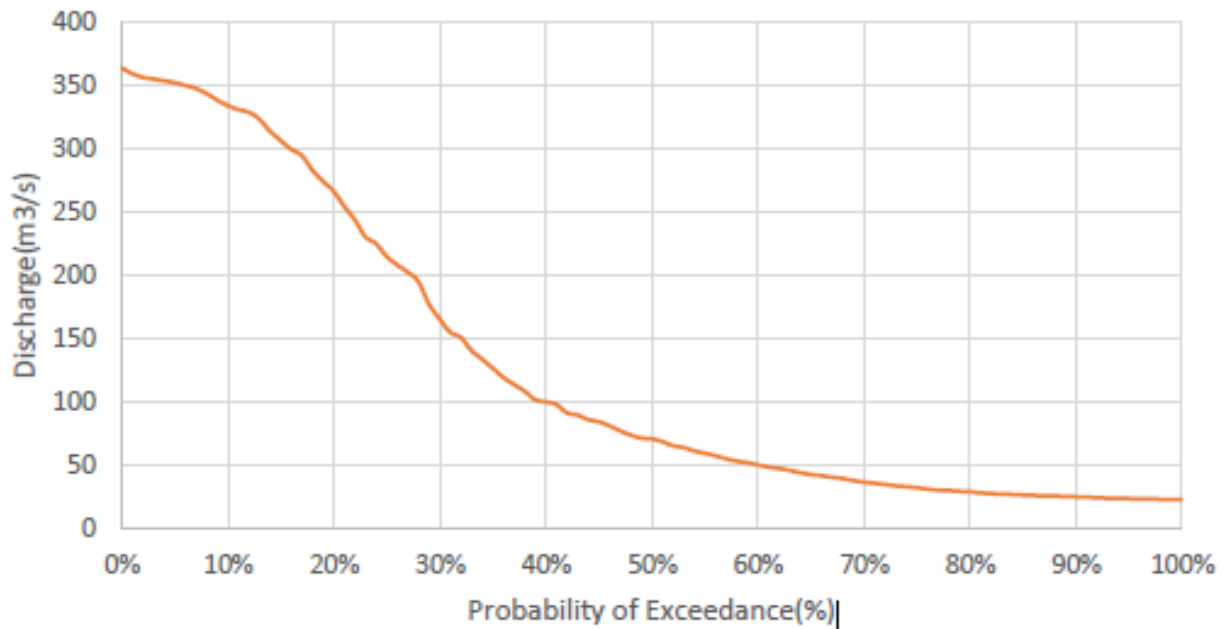


Figure 5-6: Flow duration curve

The flow duration curve revealed that probability of having the design discharge in the river 40%, whereas the average discharge of 128 m³/sec is available less than 40%.

5.1.3.2 Climate

The BGHEP catchment is spread within the altitude of about 600 m to 7990 m asl of the Gorkha district. The sharp variation in altitude is reflected in the climate condition of the area. According to the physical relief, the project has subtropical to temperate climatic zones. The warm-humid climate is experienced between May and September, whereas cold-dry climate between November and January. The region receives approximately 80% of the annual rainfall during monsoon period. Rainfall intensities vary throughout the basin with maximum intensity occurring on the south facing slopes of the mountains. During the monsoon period, relative humidity reaches the maximum. The temperatures during this period are lower as compared to the pre-monsoon period. The mean daily temperature varies from 7.0 °C in January to 20.5 °C in August and the relative humidity varies from 55 % to 90%. The extreme minimum temperature falls below -1.0 °C and the extreme maximum temperature reaches above 30 °C.

5.1.3.3 GLOF Risk Assessment

The Budhi Gandaki is part of the larger Gandaki basin in the central Nepal. A total of 116 glacial lakes were recorded in the Gandaki River basin, out of which 12 glacial lakes are within the Budhi Gandaki sub-basin, which is about 1.1 % of the total glacial lakes area of the country (ICIMOD, 2011). The glaciers within the Budhi Gandaki basin are estimated to cover around 306 km².

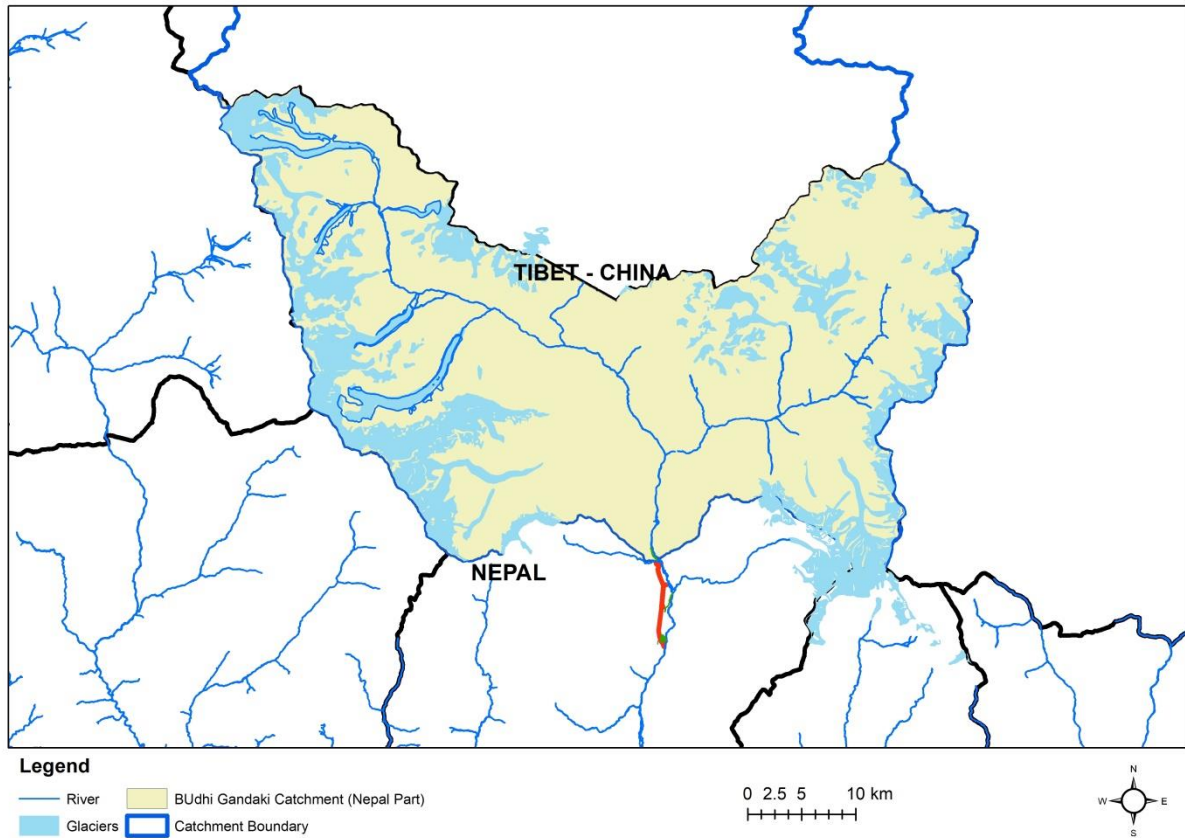


Figure 5-7: Distribution of Glacier within the Budhi Gandaki Catchment

Prior to designing any hydropower projects, consideration should be given to the possibility of occurrence of any GLOF event at the upstream of the project within the project life. In this regard, of the lakes identified the largest one gabud_gl_0009 also called locally as Birendra Tal has an estimated area of 0.25 km². On the physical consideration, gabud_gl_0009 of the Budhi Gandaki catchment was categorized as one of the potentially critical lakes by ICIMOD. However, in the latest Inventory of Glacial Lakes by ICIMOD (2018), Birendra Tal has been removed as the potential dangerous glacial lake as there is no damming, erosional land feature, compact debris at downstream, in contact with retreating glacier and in case of glacier topple, there is only the possibility of overflow of splash water. So, no GLOF is expected. In the Feasibility Study and Detailed Design of Budhi Gandaki HPP (Volume 1: Main Report), discharge from probable GLOF was estimated as 3000 m³/s.

Table 5-4: Glacier Lake of the Budhi Gandaki River

Basin	Sub-Basin	Glacial Lakes			
		Number	% of total	Area (sq.km)	% of total
Gandaki	Budhi Gandaki	12	0.82	0.709	1.09
	Basin Total	116	7.91	0.538	14.72

Source: ICIMOD, 2011

5.1.4 Water Quality

The water quality of the Budhi Gandaki was sampled to understand the water quality statuses of these rivers. To understand the surface water characteristics and verify the water quality changes in different seasons

(dry and rainy) along with predicted potential impacts of the project, two sampling campaigns were conducted: one was conducted in April 2019 and one in October 2019. Water samples from four points from Budhi Gandaki was sampled for pre-monsoon and post monsoon period.

Table 5-5: Sampling Stations in Project Area

Station No	Name of Sampling Station	Location of Sampling Stations		Remarks
		Latitude*	Longitude*	
1	Budhi Gandaki River, Upstream of Dam	28°22'3.15"N	84°53'14.09"E	Salleri Bazaar
2	Budhi Gandaki River, Downstream of Dam	28°21'0.57"N	84°53'49.98"E	Jagat Bazaar
3	Upstream of Powerhouse (PH) Area	28°18'13.80"N	84°54'24.79"E	Doban Area
4	Downstream of Powerhouse (PH) Area	28°16'58.96"N	84°54'0.04"E	Tatopani Area

Note: * Latitude and longitude are taken approximately at the midpoint of each sampling station.

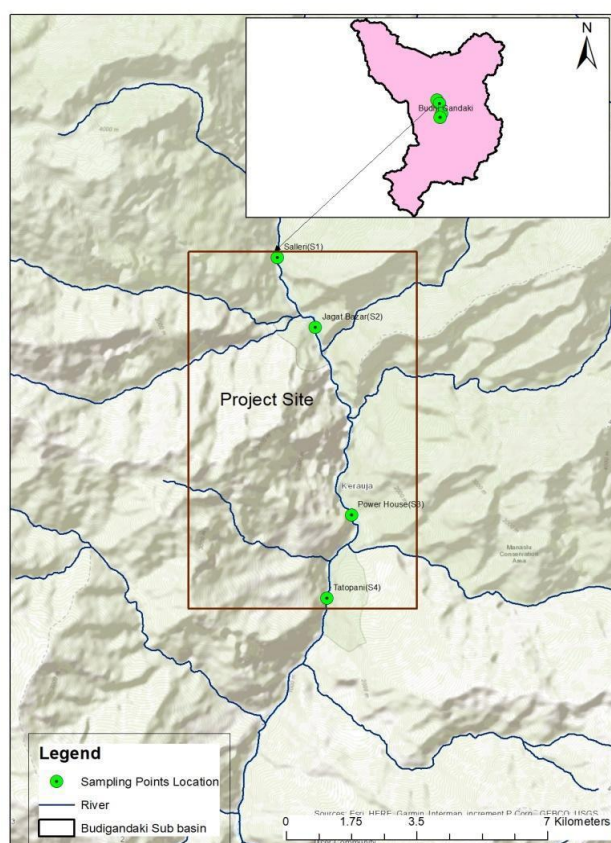


Figure 5-8: Sampling Stations in the Project Area

These samples were analyzed for parameters such as temperature (Temp); pH; Dissolved Oxygen (DO); Total Suspended Solids (TSS); Hardness (Hd); Chloride (Cl) and Ammonia (NH₄). The summarized results of the analysis are presented in Table for Budhi Gandaki.

Table 5-6: Water Quality Sampling at Project Sites

Parameters	April 2019				October 2019				Nepal Standard
	S1	S2	S3	S4	S1	S2	S3	S4	
Temp (in °C)	26	26	28	29	23	23	24	25	-
pH @ 27 °C	7.8	7.5	8.2	8.4	7.9	8.1	8.2	8.4	6.5 – 8.5*

DO (mg/l)	8.2	8.3	8.3	8.5	8.3	8.4	8.6	8.7	-
TSS (mg/l)	24	25	29	31	24	26	29	33	1000
Cl (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2
NH4 (mg/l)	<0.1	<0.1	0.13	0.15	0.11	0.11	0.15	0.2	1.5

*These values show lower and upper limits.

Note: S1= above the dam; S2= Jagat Bazaar; S3= Before the Power House; S4= after the tailrace

Slight differences in main parameters have been recorded in the two sampling campaigns and, therefore, there is no evidence of significant changes in water quality. The main parameters are here below analyzed.

pH: Natural water usually has pH values between 7.0 to 8.5. These values are typical with slight seasonal variations and sudden change which could indicate pollution. Many chemical reactions are controlled by pH and biological activity which is usually restricted to a fairly narrow pH range of 6.0 to 8.0. Highly acidic or highly alkaline water are undesirable as corrosion hazards and possible difficulties in treatment will be observed. All the samples that were analyzed are within the range.

DO (dissolved oxygen): Dissolved Oxygen refers to the level of free, non-compound oxygen present in water or other liquids. It is an important parameter in assessing water quality due to its influence on the organisms living within a water body. Dissolved oxygen levels in water drop below 5.0 mg/l puts stress to the aquatic life. The lower the concentration of oxygen, the greater the stress. Oxygen levels below 1-2 mg/l for a few hours can result in large fish kills. The samples have DO which varies from 8.2 to 8.7.

TSS (Total Suspended Solids): Total Suspended Solids are present due to particles which can be measured by filtering a sample through a fine paper surface. A runoff river generally increases the suspended solids in streams. With a high concentration of suspended solids lower will be the water quality by absorbing light. In most situations, a total suspended solids concentration below 20 mg/L appears clear, while levels over 40 mg/L may begin to appear cloudy. The samples show a TSS value between 24 mg/l and 33mg/L.

Total Hardness: Hardness reflects the geology of the catchment area and sometimes provides a measure of the influence of human activity in a watershed. Hardness is a measure of calcium and magnesium that enters the stream through the weathering of rock. Given the geology of the area, the hardness in the samples is low.

Chloride: Almost all natural waters contain chloride ions. Their concentrations vary considerably according to the mineral content of the earth in any given area. Drinkable water limit is generally below 250 mg/L. In the project area the chlorine concentration is very low due to geological reasons.

Ammonia: Ammonia occurs naturally in water bodies arising from break down of nitrogenous organic and inorganic matter in soil and water, excretion by biota, reduction of the nitrogen gas in water by microorganisms and from gas exchange with the atmosphere. Higher concentration could be an indication of organic pollution such as from domestic sewage, industrial waste and fertilizer run off. Unpolluted waters contain small amounts of ammonia and ammonia compounds, usually less than 0.10 mg/L. In the samples collected in the project area the values are all around 0.1 mg/L.

5.1.5 Air Quality

Implementation of the project requires activities such as drilling, blasting, quarrying, excavation works and movement of vehicles for the transportation of construction materials *etc.* which deteriorates the air quality of the area. Observation at the different project sites showed no serious sources of air quality deterioration such as factories, quarries, and stone crushing plants. However, construction of road and movements of vehicles in the earthen road along the project area are expected to cause pollution. Dust in the air in and around the project sites along the earthen road is observed to be major source of air quality deterioration. However, the project sites showed no serious issues as there are limited settlements. Some settlements are affected by the dust from the construction of roads that becomes airborne by the movement of vehicles. Currently, Tatopani Bazar, Doban gaun and Jagat Bazar are the settlements that are affected by the road construction network within the project area.

Table 5-7: Budhi Gandaki Air Pollution Monitoring at project area

Parameters	April 2019				October 2019			
	S1	S2	S3	S4	S1	S2	S3	S4
TSP ($\mu\text{g}/\text{m}^3$)	110.2	112.1	114.8	115.2	111.1	112.5	115.2	117.1
PM10 ($\mu\text{g}/\text{m}^3$)	56.8	58.2	60.1	62.2	57.2	58.7	60.4	62.6
PM2.5 ($\mu\text{g}/\text{m}^3$)	45.2	46.4	48.1	49.8	47.1	47.9	48.2	49.4

Note: S1= above the dam; S2= Jagat Bazaar; S3= Before the Power House; S4= after the tailrace

The total suspended particulate materials (TSPM) ranged from $110.2\mu\text{g}/\text{m}^3$ to $117.14\mu\text{g}/\text{m}^3$ in the project area while the PM_{10} varied between $56.81\mu\text{g}/\text{m}^3$ to $62.63\mu\text{g}/\text{m}^3$; whereas $\text{PM}_{2.5}$ varied from the range of $45.23\mu\text{g}/\text{m}^3$ to $49.71\mu\text{g}/\text{m}^3$. All the parameters' values are much less than the national ambient air quality standard for Nepal. The monitoring sites represent rural setting, the major contributor to the particulate matters is related to vehicle blown dust from rural earthen roads, blasting for the road construction activities and the windblown dusts from the agricultural fields apart from the vehicular emissions at the project site.

Noise Quality

Noise generating activities in the project area are blasting for the road construction activities. There is no vehicular movement throughout the project sites. The minimum noise level in the proposed project area was in the range of 37.4-44.2 dBA while the maximum was 56.9-68.4 dBA.

Table 5-8: Sound Pressure Levels recorded in the project area

Parameter	April 2019				October 2019			
	S1	S2	S3	S4	S1	S2	S3	S4
Lmin	37	39	41	44	38	41	42	45
Lmax	57	60	63	65	59	62	65	68

Note: S1= above the dam; S2= Jagat Bazaar; S3= Before the Power House; S4= after the tailrace

5.2 Biological Environment

5.2.1 Vegetation and Forest Resources

Forest Resources Assessment (FRA) project had updated the forestry sector information system. Some of the important findings of the project were (DFRS, 2015):

- The forest in Nepal occupies a total of 6.61 million ha which is 44.74% of the total area of the country,
- About 82.68% (4.93 million ha) of the forest lies outside the protected areas whereas 17.32% (1.03 million ha) lies inside the protected areas.
- About 47% of the forest lies in the middle mountains.
- The estimated total stem volume is 982.33 million m³ (164.76 m³/ha).
- The total above-ground air-dried biomass in the forest of Nepal is 1,159.65 million tons (194.51 t/ha).
- The total carbon stock in Nepal's forest has been estimated as 1,054.97 million tons (176.95 t/ha).
- A total of 443 tree species belonging to 239 genera and 99 families were identified in the sample plots.

Nepal is divided into three distinct botanical provinces i.e., eastern, central and western one. Eastern Nepal (E of 860 30') is dominated by east Himalayan floral elements that are more representative to the humid area and diversified than the drier west Himalayan flora (W of 830 E) whereas the central part is intermixed. The project construction area (within eastern province) is highly rich in local biodiversity owing to much wet climatic condition (Polunin and Stainton, 1984). According to Dobremez (1976) vegetation types of Nepal are distributed in six bio-climatic zones that cover from Tropical (below 1000 m) to Nival zone (above 5000) m and are further sub-

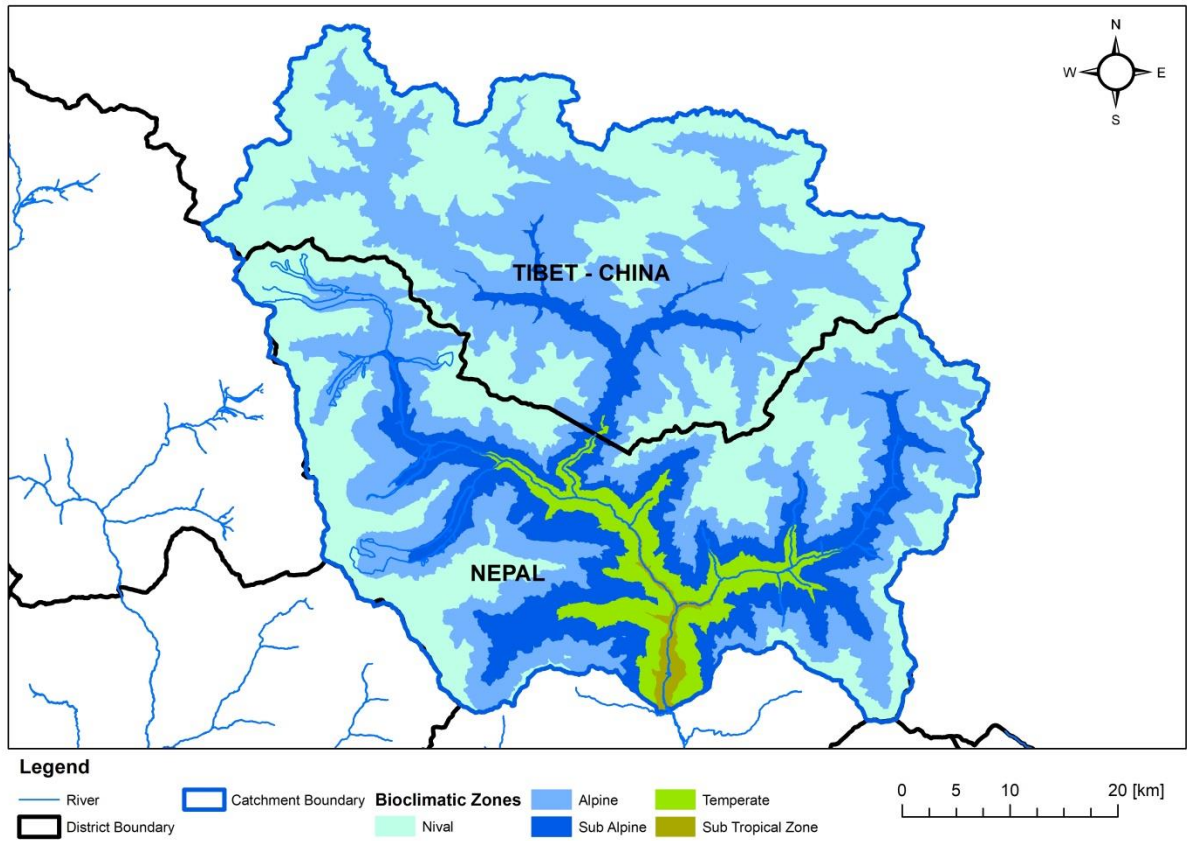


Figure 5-9: Bioclimatic Zones of the Budhi Gandaki Catchment

divided into eleven sub-zones. The project area is located in the Gorkha district, which covers an area of 3,614.70 km². The elevation range found within the district is from 228 to 8,163 masl.

The Budhi Gandaki Catchment from the intake site has four climatic zones. A small strip of subtropical zone was observed in the dam site in the river basin, which immediately followed by other strips of the temperate and alpine zones. Rest of the areas is above 5000 masl which is Nival zone. The hydrology significantly dominates landscape and climatic zones of the catchment.

Out of total land area of the district (about 3,614.70 Sq.km) the total forest area is 1, 32, 120 ha which is 36.55% of the total landmass. Within this forest area, the major forest covering is 82.72% (1, 09,300 ha), wooded and Shrubland together is 16.60% (21,933 ha) and bush land is 0.66% (877 ha).

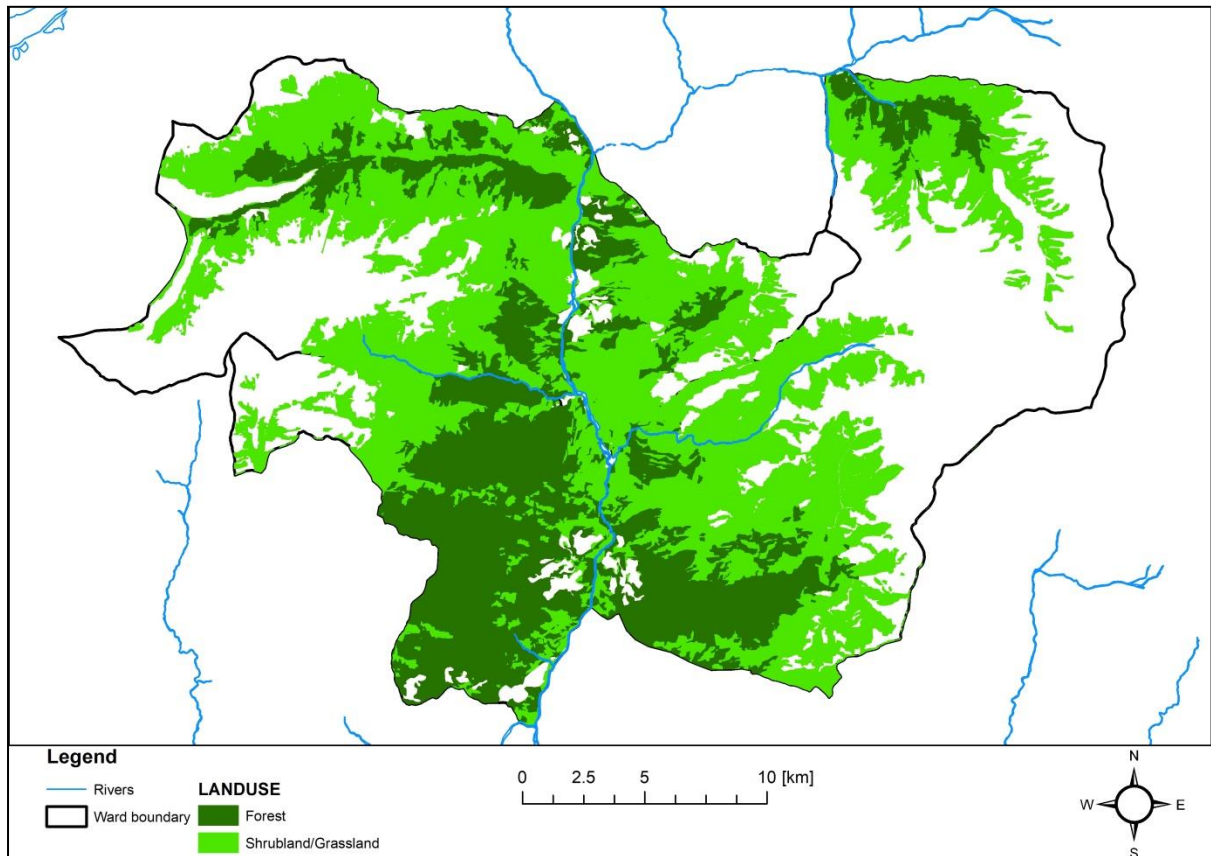


Figure 5-10: Distribution of forests in the project municipality wards

5.2.2 Manaslu Conservation Area

Manaslu Conservation Area (MCA), established in 1998, covers an area of 1663 km² embracing 9 climatic zones from lower Sub-tropical to Nival (out of 11 found in Nepal). Nineteen types of ecosystems and eleven types of vegetation types have been recorded in MCA, which are:

Table 5-9: Ecosystem and vegetation of the Manaslu Conservation Area

SN	Ecosystem Types	Vegetation Types
1	Glaciers, snow, rock	Upper Alpine Meadow
2	Alpine Meadow with Gramineae and Cyperaceae	Moist Alpine Scrub
3	Mesophytic mat patches and vegetation on rocks	Trans Himalayan Steppe
4	Alpine Meadow in the southern side of the Himalayas	Trans Himalayan High Alpine vegetation

5	Rhododendron mesohygrophytic scrublands	Birch-Rhododendron forest
6	Upper sub-alpine Rhododendron-Birch forest	Fir (<i>Abies spectabilis</i>) Forest
7	Upper sub-alpine Birch-Blue Pine open forest	Larch forest
8	Upper sub-alpine north Himalayan alpine vegetation	Upper temperate Blue Pine forest
9	Lower sub-alpine Fir (<i>Abies spectabilis</i>) Forest	Temperate Mountain Oak Forest
10	Open and dry montane Blue Pine Forest	Lower Temperate Oak Forest
11	Juniper forest	Chir Pine and broad-leaved forest
12	Rhododendron-Hemlock-Oak forests	
13	Mountain Oak (<i>Quercus semecarpifolia</i>) forest	
14	Blue Pine-spruce Forest	
15	Spruce mountain forest	
16	Hygrophytic <i>Quercus lamellosa</i> forest	
17	Upper sub-tropical Hygrophytic <i>Schima - Castanopsis-Englehardtia</i> forest	
18	Lower sub-tropical Hygrophytic <i>Schima - Castanopsis-Englehardtia</i> forest	
19	High altitude cushion plant formation	

Source: (Bhujū et al., 2007).

As the project area is located at the lower fringe of the conservation area, thus, two ecosystem types namely, lower sub-tropical zone with Hygrophytic *Schima-Castanopsis-Englehardtia* forest and upper sub-tropical zone Hygrophytic *Schima -Castanopsis-Englehardtia* forest were recorded. Likewise, Chir-pine and Broad-leaved forests are confined in some parts of the project area. An estimated 2,500 species of flora have been recorded from MCA, including 587 vascular plants, 10 gymnosperms, 491 dicots, and 86 monocots (Bhujū et al., 2007).

5.2.3 Non-timber forest product (NTFP)

The district is rich in biodiversity, which is also reflected in abundance of NTFPs. The major NTFPs found in the northern region of Gorkha are Yarsagumba (*Ophiocordyceps sinensis*), Panchaunle (*Dactylorhiza hatagirea*), Jatamansi (*Nardistachys grandiflora*), Chirayito (*Swertia chirayita*), Launth Salla (*Taxus wallichiana*), Satuwa (*Paris polyphylla*), Kutki (*Neopicrorhiza scrophulariflora*), Musli (*Chlorophytum arundinaceum*), Kaulo (*Machilus odoratissima*), Ban Lasun (*Allium wallichii*), Pashanbhed (*Berginia ciliate*), Sugandhwal (*Valeriana jatamansi*), Jiwanti (*Epimanchera macrei*), Sungabha (*Coelogyne* sp.), Chutro (*Berberis* spp.), Nagbeli (*Lycopodium clavatum*), Tejpaat (*Cinnamomum tamala*), Barro (*Terminalia bellirica*). Some of the well known NTFPs of commercial importance that are found in the project area are Sajiban (*Jatropha curcus*), Baans (*Dendrocalamus* spp.), Nigalo (*Drepanostachym* sp.), Lokta (*Daphne bholua*), Guchchi Chyaa (*Morchela* sp.), Asuro (*Justicia adhatoda*), Sindure (*Mallotus philippinensis*), Chiuri (*Diploknema butyracea*) (DFO 74/75).

5.2.4 Forests of the project site

5.2.4.1 Headworks Inundation area

The headworks and pondage areas have sparse forest vegetation due to the rocky environmental condition. The principal tree species found in the river banks were Rani Salla (*Pinus roxburghii*), and associated tree species were few individuals of Tooni (*Toona ciliata*), Kafal (*Myrica esculenta*), Khanayo (*Ficus cunia*), Jamun (*Syzygium cuminii*), Hade Bayar (*Zizyphus incurva*), Uttis (*Alnus nepalensis*), Bhalayo (*Rhus* sp.), Bakenu (*Melia azadiractah*), Kaulo (*Machilus* sp.) and tree size Tushare (*Debregesia* sp.). Other tree species found at the vicinity were Khirro (*Sapium insigne*), Bains (*Salix* sp.), Mayal (*Pyrus pashia*).

Common shrubs and herbs species found were Chutro (*Berberis asiatica*), Dhursul (*Colebrokia oppositifolia*), Bilaune (*Maesa chisia*), Bhogate (*M. macrophylla*), Jangali Gulab (*Rosa* sp.), Chakramard (*Cassia* sp.), Gueli (*Elaegnus* sp.), Khareto (*Phyllanthus parviflora*), Bhuletro (*Butea minor*), Titepati (*Artemisia dubia*), Sisno (*Urtica dioica*), *Bistorta capitata*, Pakhanved (*Berginia ciliata*), Nihuro (*Dryopteris cochleata*), Unyu (*Pteris vittata*), *Crassocephalum crepidioides*, *Dennstaedtia appendiculata*, Kuro (*Bidens pilosa*), *Cynoglossum* sp., *Conyza* sp.



Figure 5-11: Vegetation of the pondage area

5.2.4.2 Access road to power house and powerhouse Area

The power house site is located in the forested area just below the ridge. The structures associated with it are underground. However, the access road to the power house and camp sites passes through the relatively denser forested area. The project will also use some section of the road which is under-construction (high way) by the government and the access road will be diverted from a point close to Dobhan bazaar at the right side of the river. The forest at the power house and access road sites are under private ownership.



Figure 5-12: Forest distribution in the powerhouse area and access road

The principal tree species of this site were Chilaune (*Schima wallichii*), Angeri (*Lyonia ovalifolia*), Khirro (*Sapium insigne*), Amala (*Phyllanthus emblica*), Kalikath (*Myrsine semiserrata*), Sindure (*Mallotus philippinensis*), Salla (*Pinus roxburghii*), Kafal (*Myrica esculenta*), Guelo (*Callicarpa arborea*), kaulo (*Machilus* sp.), Hade Bayar (*Zizyphus incurva*), and saplings of Khanayo (*Ficus cunia*), etc. Frequently observed shrubs and herbs of the site are Bilaune (*Maesa chisia*), Dhursul (*Colebrokia oppositifolia*), Dhainyaro (*Woodfordia fruticosa*), Badkaulo (*Casearia graveolens*), Allo (*Girardia diversifolia*), Titepati (*Artemisia indica*), Unyu (*Pteris biaurita*), Pyauli (*Reinwardtia indica*), *Oplismenos* sp., etc.

5.2.4.3 Muck disposal site

Site 1

The tree species recorded in the muck disposal area – 1 are sparsely distributed. The tree species of this site are Kaulo (*Machilus odoratissima*), jamun (*Syzygium cumini*), Paheli (*Litsea* sp.), Kathe Kaulo (*Machilus* sp.), Bhalayo (*Rhus* sp.), and Hade Bayar (*Zizyphus incurva*). Ground flora is composed of Datiwan (*Achyranthes bidentata*), Kibbu (*Strobilanthus atropurpureus*), saplings of *Ficus* sp., Sisno (*Urtica dioica*), Unyu (*Pteris biaurita*), Nihuro (*Dryopteris cochleata*), *Conyza* sp., etc.

Site 2

The tree species recorded in the muck disposal area – 2 are also sparsely distributed. The tree species of this site are Malato (*Macaranga pustulata*), Lodo (*Ehretia* sp.), Hade Bayar (*Zizyphus incurva*). Siris (*Albizia* sp.) and Chilaune (*Schima wallichii*). Ground flora is composed of Dhursul (*Colebrokia oppositifolia*), Allo (*Girardiana diversifolia*), Bilaune (*Maesa chisia*),

Charchare Lahara (*Cissus* sp.), *Neuruda graminifolia*, Phusro Unyu (*Dennstaedtia appendiculata*), Banmara (*Ageratina adenophora*), Pani Amala (*Nephrolepis cordifolia*), etc.

5.2.4.4 Adit entrance tunnel

Very few trees are recorded in this site. The tree species include Lodo (*Ehretia* sp.), Sindure (*Mallotus philippinensis*), Arupate (*Prunus* sp.) and Jamun (*Syzygium cumini*).

Ground flora is composed of Dhursul (*Colebrokia oppositifolia*), Dhaiyaro (*Woodfordia fruticosa*), *Cythula spinulosa*, Sisno (*Urtica dioca*), Salimo grass (*Chrysopogon grylus*), etc.

5.2.4.5 Reduced water zone

Several plant species are recorded in this zone due to considerable stretch of the river segment. Tree species found in this area include Sindure (*Mallotus philippinensis*), Khanayo (*Ficus cunia*), salla (*Pinus roxburghii*), Khirro (*Sapium insigne*), Chyuri (*Diploknema butyracea*), Malato (*Macaranga pustulata*), Tooni (*Toona ciliata*), Guelo (*Callicarpa arborea*), Paheli (*Litsea* sp.), Daar (*Boehmeria rugulosa*), Bhalayo (*Rhus* sp.), Siris (*Albizzia chinensis*), Hade Bayar (*Zizyphus incurva*) Chilaune (*Schima wallichii*), Lodo (*Ehretia* sp.), Kafal (*Myrica esculenta*), Jamun (*Syzygium cumini*), Uttis (*Alnus nepalensis*), Bains (*Salix* sp.), Mayal (*Pyrus pashia*), Amala (*Phyllanthus emblica*), etc.

Likewise, shrub and herb species noted in this locality are Bilaune (*Maesa chisia*), Bhogate (*Maesa macrphylla*), Khareto (*Phyllanthus parviflora*), Bhuletro (*Butea minor*), Nigalo (*Drepanostachyum* sp.), Dhainyaro (*Woodfordia fruticosa*), Badkaulo (*Casearia graveolens*), Allo (*Girardia diversifolia*), *Cythula spinulosa*, *Sambucus adnata*, Chakramard (*Cassia occidentalis*), Sisno (*Urtica dioca*), Pyauli (*Reinwardtia indica*), Kibbu (*Strobilanthus atropurpureus*), Titepati (*Artemisia indica*), Unyu (*Pteris biaurita*), *Oplismenos* sp., Ganja (*Cannabis sativa*), *Tectaria coadnata*, Sarpako Makai (*Ariesaema* sp.), Titepati (*Artemisia dubia*), Nihuro (*Dryopteris cochleata*), Unyu (*Pteris vittata*), *Crassocephalum crepidioides*, Phusro Unyu (*Dennstaedtia appendiculata*), Kuro (*Bidens pilosa*), *Cynoglossum* sp., *Conyza* sp., Datiwan (*Achyranthes bidentata*), *Neuruda graminifolia*, Phusro Unyu (*Dennstaedtia appendiculata*), Banmara (*Ageratina adenophora*), Salimo grass (*Chrysopogon grylus*), etc.



Regenerating *Alnus nepalensis* forest patch at the river bank



Osbekia nepalensis (a flowering shrub), at the river bank

Figure 5-13: Some photos of vegetation in project area

Note: Individual tree data from the project structures are shown in the Annex 4 at the end of this report and Forest loss from all the project construction sites, species wise and volume are provided in impact chapter.

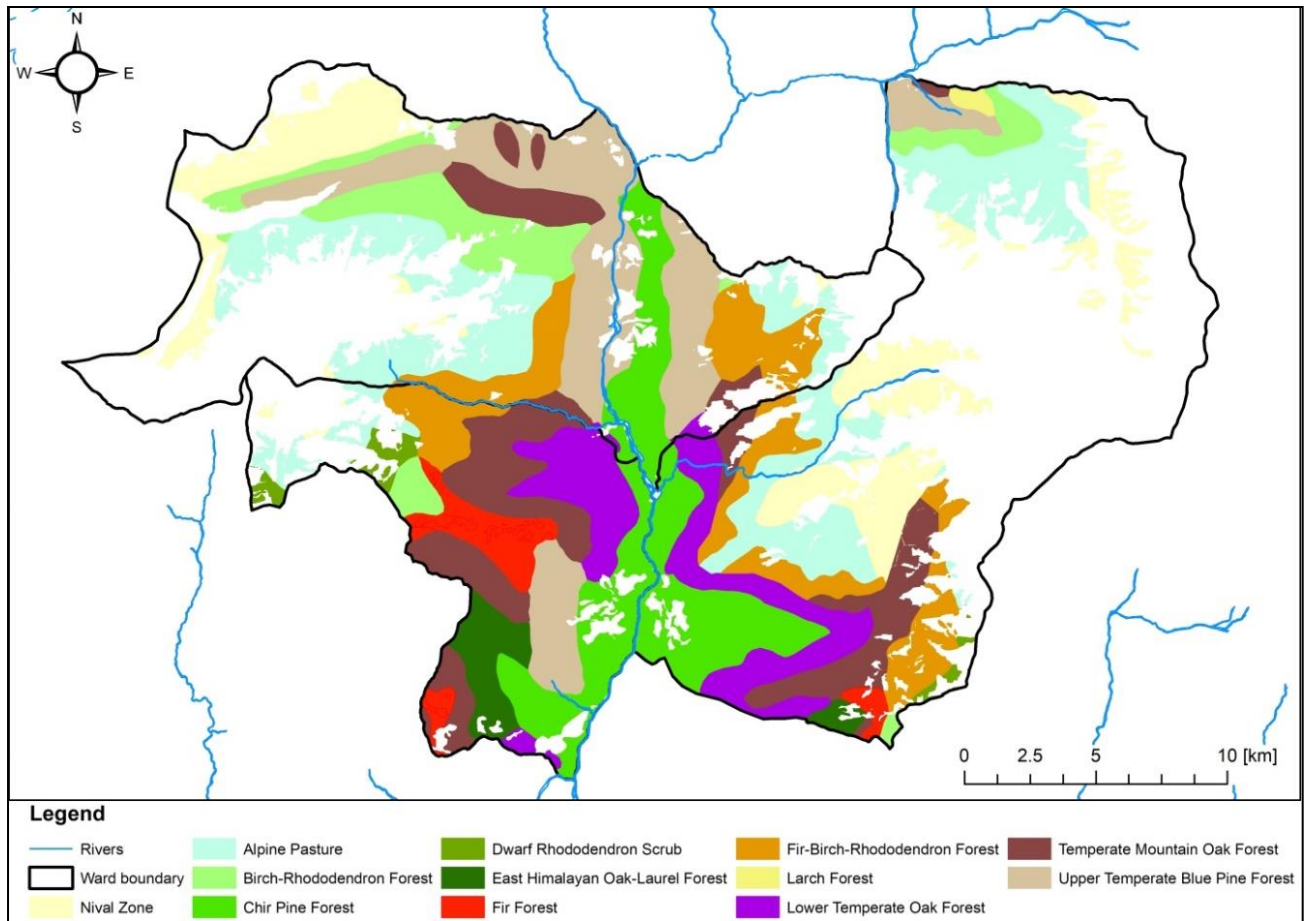


Figure 5-14: Forest type of the project R. Municipality – wards

source: Field verification of the google 2019 imagery

5.2.5 Bio-diversity (Budhi Gandaki)

Due to diverse habitat conditions and altitudinal difference, the area is found relatively rich in plant biodiversity. In relation to this project, they are recognized in three levels i.e. site specific (SS) - pertaining to the project construction sites, local (L) – in between the project sites and regional (R) - covering the project impact area and vicinity. They are enlisted below:

Table 5-10: Vegetation of the project area

SN	Botanical Name	Local Name	Family	Distribution range
1	<i>Ageratina adenophora</i>	Banmara	Compositae	SS, L, R
2	<i>Alnus nepalensis</i>	Uttis	Btulaceae	L, R, SS
3	<i>Albizia chinensis</i>	Siris	Leguminosae	L, R,
4	<i>Albizia</i> sp.	-	Leguminosae	SS, L, R,
5	<i>Alangium</i> sp.	Ankol	Alangiaceae	L, R
6	<i>Artemisia dubia</i>	Titepati	Compositae	SS, L, R
7	<i>Artemisia indica</i>	Titepati	Compositae	SS, L, R
8	<i>Adiantum</i> sp.	Unyu	Pteridaceae	L, R,
9	<i>Arundinaria</i> sp.	Nigalo	Gramineae	L, R,
10	<i>Prunus</i> sp.	Arupate	Rosaceae	SS, L, R
11	<i>Aeschynanthus parviflorus</i>	-	Gesneriaceae	L, R,
12	<i>Asparagus racemosus</i>	Kurilo	Liliaceae	SS, L, R,
13	<i>Bauhinia vahlii</i>	Bhorla	Leguminosae	L, R,

14	<i>Butea minor</i>	Bhuletro	Leguminosae	SS, L, R,
15	<i>Boehmeria rugulosa</i>	Daar	Urticaceae	L, R,
16	<i>Berberis asiatica</i>	Chutro	Berberidaceae	L, R,
17	<i>Berginia ciliata</i>	Pashanhed	Saxifragaceae	SS, L, R
18	<i>Bidens pilosa</i>	Kuro	Compositae	SS, L, R
19	<i>Bistorta capitata</i>	-	Polygonaceae	L, R,
20	<i>Bridelia retusa</i>	Gayo	Euphorbiaceae	L, R,
21	<i>Brassiopsis hainla</i>	Chuletro	Araliaceae	L, R
22	<i>Cannabis sativa</i>	Ganja	Cannabinaceae	L, R
23	<i>Caryopteris odorata</i>	Nilo Dhasure	Verbenaceae	L, R
24	<i>Casearia graveolens</i>	Badkaulo	Flacourtiaceae	SS, L, R
25	<i>Cinnamomum tamala</i>	Tejpaat	Lauraceae	L, R
26	<i>Conyza</i> sp.	-	Compositae	SS, L, R
27	<i>Cotoneaster</i> sp.	-	Rosaceae	L, R
28	<i>Cissampelos</i> sp.	Batulpaate	Menispermaceae	L, R
29	<i>Coelogyne</i> sp.	Sungabha	Orchidaceae	L, R
30	<i>Colebrokia oppositifolia</i>	Dhasure	Compositae	SS, L, R
31	<i>Crassocephalum crepidioides</i>	-	Compositae	SS, L, R
32	<i>Cheilanthes</i> sp.	Unyu	Pteridaceae	L, R
33	<i>Choenomorpha fragrans</i>	-	Apocynaceae	L, R
34	<i>Cissus</i> sp.	Charahare Lahara	Vitaceae	SS, L, R
35	<i>Callicarpa arborea</i>	Guelo	Verbenaceae	L, R
36	<i>Clerodendron</i> sp.	Chinde	Verbenaceae	L, R
37	<i>Cynoglossum zelanicum</i>	Kuro	Boraginaceae	L, R
38	<i>Cynodon dactylon</i>	Dubo	Compositae	L, R
39	<i>Cyathula tomentosa</i>	-	Amaranthaceae	L, R
40	<i>Datura suaveolens</i>	Dhaturo	Solanaceae	L, R
41	<i>Debregesia</i> sp.	Tushare	Urticaceae	SS, L, R
42	<i>Dennstaedtia appendiculata</i>	Phusre Unyu	Dennstaedtiaceae	SS, L, R
43	<i>Desmodium oojeinense</i>	Saandan	Leguminosae	L, R
44	<i>Desmodium</i> sp.	Bhattamase	Leguminosae	L, R
45	<i>Diploknema butyracea</i>	chiuri	Sapotaceae	L, R
46	<i>Dioscorea deltoidea</i>	Vyakur	Dioscoreaceae	L, R
47	<i>Dendrobium</i> sp.	Sungabha	Orchidaceae	L, R
48	<i>Dryopteris cochleata</i>	Niuro	Dryopteridaceae	SS, L, R
49	<i>Ehretia</i> sp.	Lodo	Boraginaceae	SS, L, R
50	<i>Euphorbia royleana</i>	Sinundi	Euphorbiaceae	L, R
51	<i>Ficus cunia</i>	Khanayo	Moraceae	L, R
52	<i>Ficus</i> sp. (climber)	Dudhe Lahara	Moraceae	L, R
53	<i>Galinsoga parviflora</i>	-	Compositae	SS, L, R
54	<i>Girardiana diversifolia</i>	Allo	Urticaceae	SS, L, R
55	<i>Hedychium</i> sp.	Pankha Phool	Zingiberaceae	L, R
56	<i>Homalium nepalensis</i>	Falame Kanda	Flacourtiaceae	SS, L, R
57	<i>Hypericum cordifolium</i>	-	Hyricaceae	L, R
58	<i>Jatropha curcus</i>	Sajiban	Euphorbiaceae	L, R
59	<i>Litsea</i> sp.	Paheli	Lauraceae	SS, L, R
60	<i>Lyonia ovalifolia</i>	Angeri	Ericaceae	SS, L, R
61	<i>Machilus odoratissima</i>	Kaulo	Lauraceae	SS, L, R
62	<i>Machilus</i> sp.	Kathe Kaulo	Lauraceae	SS, L, R
63	<i>Macaranga pustulata</i>	Malato	Euphorbiaceae	SS, L, R
64	<i>Maesa macrophylla</i>	Bhogate	Myrsinaceae	SS, L, R
65	<i>Maesa chisia</i>	Bilaune	Myrsinaceae	SS, L, R
66	<i>Melia azadiractah</i>	Bakaino	Meliaceae	L, R

67	<i>Mallotus philippinensis</i>	Sindure	Euphorbiaceae	SS, L, R
68	<i>Myrica esculenta</i>	Kafal	Myricaceae	SS,L, R
69	<i>Neyraudia arundinacea</i>	-	Gramineae	L, R
70	<i>Oplismenos</i> sp.	-	Gramineae	L, R
71	<i>Osbeckia nepalensis</i>	Rato Chulsi	Melastomaceae	L, R
72	<i>Onychium</i> sp.	Unyu	Pteridaceae	L, R
73	<i>Oxalis corniculata</i>	Chari amilo	Oxalidaceae	L, R
74	<i>Peperomia</i> sp.	-	Piperaceae	L, R
75	<i>Phyllanthus parviflora</i>	Khareto	Euphorbiaceae	L, R
76	<i>Phyllanthus emblica</i>	Amala	Euphorbiaceae	SS, L, R
77	<i>Pteris vittata</i>	Unyu	Pteridaceae	L, R
78	<i>Pteris biaurita</i>	Unyu	Pteridaceae	SS, L, R
79	<i>Pinus roxburghii</i>	Salla	Pinaceae	SS, L, R
80	<i>Pyracantha crenulata</i>	Ghangaru	Rosaceae	L, R
81	<i>Pyrus pashia</i>	Mayal	Rosaceae	SS, L, R,
82	<i>Reinwardtia indica</i>	Pyauli	Linaceae	L, R
83	<i>Rhus javanica</i>	Bhakyamlo	Euphorbiaceae	L, R
84	<i>Rhus</i> sp.	Rani Bhalayo	Euphorbiaceae	L, R
85	<i>Rosa</i> sp.	Gulaf	Rosaceae	SS, L, R
86	<i>Rubia manjith</i>	Majitho	Rubiaceae	L, R
87	<i>Rubus ellipticus</i>	Eiselu	Rosaceae	L, R
88	<i>Schima wallichii</i>	Chilaune	Theaceae	L, R
89	<i>Sambucus adnata</i>	-	Sambucaceae	L, R
90	<i>Salix</i> sp.	Bains	Salicaceae	L, R
91	<i>Chrysopogon grylus</i>	Salimo	Gramineae	L, R
92	<i>Solanum xanthocarpum</i>	Kantakari	Solanaceae	L, R
93	<i>Sonchus</i> sp.	-	Compositae	L, R
94	<i>Strobilanthes atropurpureus</i>		Acanthaceae	SS, L, R
95	<i>Syzygium cuminii</i>	Jamun	Myrtaceae	SS, L, R
96	<i>Sapium insigne</i>	Khirro	Euphorbiaceae	SS, L, R
97	<i>Thysanolaena maxima</i>	Amriso	Gramineae	L, R
98	<i>Toona ciliata</i>	Tuni	Meliaceae	SS,L, R
99	<i>Trichilia connaroides</i>	Ankhitare	Meliaceae	L, R
100	<i>Urtica dioica</i>	Sisno	Urticaceae	SS, L, R
101	<i>Wendlandia coriacea</i>	Tilke	Rubiaceae	L, R
102	<i>Woodfordia fruticosa</i>	Dhaiyaro	Lythraceae	SS, L, R
103	<i>Zizyphus incurva</i>	Hade Bayar	Rhamnaceae	SS, L, R

Note: R= Regional, L=Local, SS=Site specific

5.2.6 Vegetation of Ethnobotanical Importance

Among several plants consisting ethno-botanical importance, mainly the following plants have been recognized with the higher value.

Table 5-11: Vegetation with Ethno-botanical importance

SN	Local name	Botanical name	Use
1	Kurilo	<i>Asparagus racemosus</i>	Tonic
2	Chutro	<i>Berberis asiatica</i>	Edible fruit
3	Pashanbhed	<i>Berginia ciliata</i>	Medicinal use
4	Majitho	<i>Rubia manjith</i>	Dye, medicinal
5	Aiselu	<i>Rubus ellipticus</i>	Edible fruit
6	Dhaiyaro	<i>Woodfordia fruticosas</i>	Medicine for dysentery
7	Angeri	<i>Osbeckia nepalensis</i>	Edible fruit
8	Gueli	<i>Elaegnus</i> sp.	Wild edible fruit

9	Sisno	<i>Urtica dioca</i>	Medicinal, food for famine period
10	Amala	<i>Phyllanthus emblica</i>	Wild edible fruit, medicinal
11	Jamun	<i>Syzygium cumini</i>	Wild edible fruit, medicinal
12	Kafal	<i>Myrica esculenta</i>	Wild edible fruit
13	Nihuro	<i>Dryopteris cochleata</i>	Wild vegetable
14	Tejpaat	<i>Cinnamomum tamala</i>	Spices, medicinal
15	Gaanja	<i>Cannabis sativa</i>	Medicinal, narcotic
16	Daar	<i>Boehmeria rugulosa</i>	Wooden vessel
17	Chutro	<i>Berberis asiatica</i>	Medicinal
18	Titepati	<i>Artemisia dubia</i>	Medicinal
19	Titepati	<i>Artemisia indica</i>	Medicinal
20	Dubo	<i>Cynodon dactylon</i>	Medicinal, religious
21	Kum kum	<i>Didymocarpus sp.</i>	Incense
22	Allo	<i>Girardiana diversifolia</i>	Clothes
23	Angeri	<i>Lyonia ovalifolia</i>	For making charcoal
24	Sindure	<i>Mallotus philippinensis</i>	Medicinal
25	Salla	<i>Pinus roxburghii</i>	Resin
26	Khirro	<i>Sapium insigne</i>	Fish poison
27	Kantakari	<i>Solanum xanthocarpum</i>	Herbal soap, medicinal

5.2.7 Agro-diversity of the area

Among the agricultural production upland rice Maize (*Zea mays*), Kodo (*Elusine coracana*), barley (*Hordeum ulgare*), Buckwheat (*Fagopyrum esculentum*), etc are grown. Rice (*Oryza sativa*) is not cultivated in this area. However, and upland variety of rice, locally known as **Ghaiya**, is cultivated here which does not need irrigation facility. Almost all spices and vegetables such as ginger (*Zinziber officinale*), garlic (*Alium sativum*), onion (*Alium cepa*), chilly (*Capsicum frutescens*), potato (*Solanum tuberosum*), Cabbage (*Brassica oleracia var capitata*), bottle-gourd (*Lagenaria siceraria*), cucumber (*Cucumis sativum*), tomato (*Solanum tuberosum*), pumpkin (*Cucurbita pepo*), etc. are grown. Among the fruits lemon (*Citrus acida*), orange (*Citrus reticulata*), peach (*Prunus persica*), plum (*Prunus domestica*), guava (*Psidium guajava*), banana (*Musa paradisiaca*), pear (*Pyrus communis*), etc. are cultivated. Among the fodder plants **Khanayo** (*Ficus cunia*), **Nibharo** (*Ficus auriculata*), **Chyuri** (*Diploknema butyracea*) are more common.

5.2.8 Forest Management System

The project area has three types of forest managements, which are described below:

Community forests: The forests in the project impact area are managed by local Community Forest Users' Group. In Chumnubri Rural Municipality, Kamaladanda CFUG is managing the forest area. The total forest area is 22.6ha. There are 42 households and benefited population is 219. In reduced water zone and Power House area, Sallaghari CFUG and Dobhan CFUG, and Bengrang Saatkanya CF are managing the forests. The total forest area of Sallaghari CF is 253.11ha. There are 166 households and benefited population is 943. The total forest area of Dobhan CF is 111.21. There are 40 households and benefited population is 251. The total forest area of Betrang Saatkanya CF is 27ha. There are 155 households and benefited population is 870.

Conservation area community managed forest: Within MCA, especially the headworks area, it is managed by Manaslu Conservation Area Forest Management Committee in co-ordination with Manaslu Conservation Area Project.

Private forest: The private forest lies in the access road to power house. It is the dense forest to be affected by the project activity and lies in Dharche - 3 RM, whereas other project sites lie in the thinly populated forest patches.

5.2.9 Terrestrial wildlife

The Budi Gandaki Hydroelectric Project is a PROR type located in Gorkha District in Gandaki Province of Nepal. Some of the project structures lie within Manaslu Conservation Area as declared by the Department of National Parks and Wildlife Conservation of the GoN. According to recent data of DNPWC, Manaslu Conservation Area is inhabited by 33 species of mammals, 110 species of birds and 3 species of reptiles (www.dnpwc.gov.np, English version).

During the field survey, construction of road was in progress along the right bank of Budigandaki River. These activities disturb the wildlife habitat. Activities such as blasting, heavy vehicular movements, vibrations, noise, excavation of rock, deposition of rock and soil into the river disrupt the natural living of wildlife. Such situations can create obstacles in finding direct evidences of wildlife as they might have moved to nearby safer area during the study period. Baseline survey conducted on early May recorded a total of 99 species of terrestrial wild animals from the project and its peripheral areas which includes 16 species of mammalian fauna, 71 species of avifauna and 12 species of herpetofauna. Based on the baseline survey, the area has not been declared as a natural or critical habitat and it does not provide the migratory route for the recorded wildlife species of the area. No hunting and poaching activities were recorded. However, some inhabitants did face the problem of crops and live stocks being ruined by pests and nuisance animals.

5.2.9.1 Mammals

In the field survey, 16 species of mammals were reported from project and its peripheral areas. Field visits and consultations with the local people revealed that mammals such as Rat, Porcupine, Jungle cat, Jackal, Marten, and Assamese monkey are the pest animals as they destroy crops or domestic animals. During consultation at headwork and in between the area from the headwork to powerhouse area, the local people have reported Asiatic black bear (*Ursus thibetanus*) about 15 km far from the project foot print. Moreover, during consultation at the powerhouse area, people reported the appearance of bear being found some 5-7 years ago around the project area but away from the direct impact area. Further consultations revealed that Asiatic black bear does utilize the habitat of the impact area. However, the status of Asiatic Black Bear can be further examined during the preconstruction phase to ascertain its status. No mammals with aesthetic, cultural and medicinal values at local levels were reported from the project area. A list of mammalian diversity reported to be found in the project and its peripheral areas is presented the table below.

Table 5-12: Mammal Species Recorded in Project Construction Sites and its Peripheral Areas

SN	Nepali Name	English Name	Scientific Name	Status of occurrence			Major Habitat					Migratory Status/season		Reported Location	
				C	S	R	F	B	O	A	Wa	M/R	S		
1	Himali Banlokharke	Orange-bellied Himalayan Squirrel	<i>Dremomys lokriah</i>	√			√						R		¥, □
2	Rato Rajpankhi Lokharke	Red Giant Flying Squirrel	<i>Petaurista petaurista</i>		√		√						R		≠, ∞, ψ
3	Ghar Muso	House Rat	<i>Rattus rattus</i>	√						√			R		≠, ∞, ψ
4	Malaya Dumsi	Malayan Porcupine	<i>Hystrix brachyura</i>		√		√			√			R		≠, ∞, ψ
5	Ban Biralo	Jungle cat	<i>Felis chaus</i>		√		√						R		≠, ∞, ψ
6	Chituwa	Leopard	<i>Panthera pardus</i>			√	√						R		≠, ∞, ψ
7	Fusro Fyauro	Bengal Fox	<i>Vulpes bengalensis</i>			√	√						R		≠, ∞, ψ
8	Syal	Golden Jackal	<i>Canis aureus</i>	√			√		√				R		≠, ∞, ψ
9	Malsanpro	Yellow-throated Marten	<i>Martes flavigula</i>	√			√						R		≠, ∞, ψ
10	Ghar Chuchundro	Asian House Shrew	<i>Suncus murinus</i>	√						√			R		≠, ∞, ψ
11	Nepte Chamero	Greater Short-nosed Fruit Bat	<i>Cynopterus sphinx</i>	√			√						R		≠, ∞, ψ
12	Terai Langur	Terai Grey Langur	<i>Semnopithecus hector</i>	√			√						R		≠, ∞, ψ
13	Pahare Bandar	Assam Macaque	<i>Macaca assamensis</i>	√			√						R		≠, ∞, ψ
14	Rato Bandar	Rhesus Macaque	<i>Macaca mulatta</i>		√		√						R		≠, ∞, ψ
15	Ratuwa /Rate Mirga	Barking Deer	<i>Muntiacus muntjak</i>			√	√						R		≠, ∞, ψ
16	Ghoral	Common Goral	<i>Naemorhedus goral</i>			√	√						R		≠, ∞, ψ

Source: Field Visit and Participatory Information from Local People, EIA of Budhi Gandaki Hydroelectric Project, May, 2019

Note:

Status of occurrence: C- Common, S- Spars, R- Rare;

Habitat: F- forest, B – Bush, O- Open grass land, A – Agricultural land, Wa – Water;

Migratory status and season: M – Migratory, R - Resident, S – migration season, Su- Summer visitor, Wi – Winter visitor;

Reported from: ≠ – Headwork and its peripheral areas, ¥ – Between headwork and powerhouse areas.

□ – Powerhouse and its peripheral areas

5.2.9.2 Birds

Birds are attracted by fruit, flower, young leaf bearing trees, dense vegetation, etc. The project area lacks this very vegetation especially in the headwork area. Vegetation is scrubby and has been thinly distributed with some avifauna area from some favorable areas. Based on the baseline survey, the consultations, some secondary literature and direct observations, 71 species of birds from the project and its peripheral areas are recorded. Most of the reported birds are resident birds. Some migratory species include Indian cuckoo, Eurasian cuckoo, Eurasian sparrow-hawk, Blue-capped rock thrush, Verditer flycatcher and Greenish warbler.

Few aquatic birds were also reported within the impact area which includes White throated kingfisher, Crested kingfisher, Cattle egret, Indian pond heron, Blue whistling thrush, White-capped water redstart, Plumbeous water redstart and Grey Wagtail. The reduction of flow of water in the river and/or fish production may impact these aquatic birds. Birds with special aesthetic, cultural, food or medicinal values at local levels were not reported.

Table 5-13: Bird Species Recorded form Project Construction Sites and its Peripheral Areas

S. No.	Nepali Name	English Name	Scientific Name	Status of occurrence			Habitat					Migratory Status/season		Reported Location		
				C	S	R	F	B	O	A	Wa	M/R	S			
1	Kalij	Kalij Pheasant	<i>Lophura leucomelanos</i>	√			√	√						R		≠, ¥, ψ
2	Kasthakut	Fulvous-breasted Woodpecker	<i>Dendrocopos macei</i>		√		√							R		¥, ψ
3	Thople Sasiya	Speckled Piculet	<i>Picumnus innominatus</i>			√	√							R		≠, ¥
4	Nyauli	Great Barbet	<i>Megalaima virens</i>	√			√							R		≠, ¥, ψ
5	Kuthruke	Blue-throated Barbet	<i>Psilopogon asiaticus</i>		√		√							R		¥, ψ
6	Seto-kanthe Matikore	White throated Kingfisher	<i>Halcyon smyrnensis</i>			√					√	√		R		¥, ψ
7	Thulo Chirbire Matikore	Crested Kingfisher	<i>Megaceryle lugubris</i>		√							√		R		≠, ¥, ψ
8	Biu Kuhiyo	Common Hawk Cuckoo	<i>Hierococcyx varius</i>		√		√							R		¥, ψ
9	Kafal Pakyo	Indian Cuckoo	<i>Cuculus micropterus</i>		√		√							M	Su	≠, ¥, ψ
10	Kukku Koili	Eurasian Cuckoo	<i>Cuculus canorus</i>		√		√							M	Su	≠, ¥, ψ
11	Koili	Western Koel	<i>Eudynamis scolopaceus</i>		√		√				√			R		≠, ¥, ψ
12	Madana Suga	Slaty-headed Parakeet	<i>Psittacula himalayana</i>			√	√							R		≠, ¥, ψ
13	Firfire Ghargaunthali	House Swift	<i>Apus affinis</i>		√		√				√			R		≠, ¥, ψ
14	Batashi Gauthali	Alpine Swift	<i>Tachymarptis melba</i>			√	√							R		≠, ¥, ψ
15	Thulo Dundul	Asian Barred Owllet	<i>Glaucidium cuculoides</i>		√		√							R		≠, ¥, ψ
16	Malewa	Rock Pigeon	<i>Columba livia</i>	√						√	√			R		≠, ¥, ψ
17	Tame Dhukur	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	√							√			R		≠, ¥, ψ

18	Kurle Dhukur	Western Spotted Dove	<i>Spilopelia suratensis</i>	√						√		R		≠, ¥, ψ
19	Pahadi Haleso	Wedge-tail Green Pigeon	<i>Treron sphenura</i>		√		√					R		≠
20	Kalo Chil	Black Kite	<i>Milvus migrans</i>		√		√			√		R		≠, ¥, ψ
21	Hadfor	Lammergeier	<i>Gypaetus barbatus</i>			√				√		R		≠, ¥, ψ
22	Himali Gidda	Himalayan Griffon	<i>Gyps himalayensis</i>		√					√		R		≠, ¥, ψ
23	Banbaz	Eurasian Sparrowhawk	<i>Accipiter nisus</i>			√	√			√		M	W i	≠, ¥, ψ
24	Baudai	Common Kestrel	<i>Falco tinnunculus</i>		√					√		R		≠, ¥, ψ
25	Bastu Bakulla	Cattle Egret	<i>Bubulcus ibis</i>	√						√	√	R		≠, ¥, ψ
26	Aaskote Bakulla	Indian Pond Heron	<i>Ardeola grayii</i>		√						√	R		≠, ¥, ψ
27	Bhadrai	Lang-tailed Shrike	<i>Lanius schach</i>	√					√		√	R		≠, ¥, ψ
28	Himali Bhadrai	Grey-backed Shrike	<i>Lanius tephronotus</i>	√					√		√	R		≠, ¥, ψ
29	Syal-pothari Lampuchre	Red-billed Blue Magpie	<i>Urocissa erythroryncha</i>		√		√					R		≠, ¥, ψ
30	Pahadi Kokale	Grey Treepie	<i>Dendrocitta formosae</i>		√		√					R		≠, ¥
31	Ghar Kag	House Crow	<i>Corvus splendens</i>			√				√	√	R		≠, ¥, ψ
32	Kalo Kag	Large-billed Crow	<i>Corvus macrorhynchos</i>	√			√			√	√	R		≠, ¥, ψ
33	Lampuchre ranichari	Long-tailed Minivet	<i>Pericrocotus ethologus</i>		√		√					R		≠, ¥, ψ
34	Ranichari	Scarlet Minivet	<i>Pericrocotus flammeus</i>			√	√					R		≠, ¥, ψ
35	Pahelo Marunichari	Yellow-bellied Fantail	<i>Rhipidura hypoxantha</i>		√		√	√				R		≠, ¥, ψ
36	Kalo Chibe	Black Drongo	<i>Dicrurus macrocercus</i>		√		√			√		R		≠, ¥, ψ
37	Sano Hajara Chanchar	Blue-capped Rock Thrush	<i>Monticola cinclorhynchus</i>			√	√					M	S u	≠, ¥
38	Kalchaude	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	√							√	R		≠, ¥, ψ
39	Tiktike Arjunak	Slaty-blue Flycatcher	<i>Ficedula tricolor</i>		√		√	√				R		≠, ¥, ψ
40	Nilothutho Arjunak	Verditer Flycatcher	<i>Eumyias thalassina</i>	√			√	√				M	W i	≠, ¥
41	Chanchale Arjunak	Grey-headed Canary Flycatcher	<i>Culicicapa ceylonensis</i>	√			√					R		≠, ¥, ψ
42	Sundar Niltava	Rufous-bellied Niltava	<i>Niltava sundara</i>			√	√					R		≠, ¥, ψ
43	Dhobini Chari	Oriental Magpie Robin	<i>Copsychus saularis</i>		√			√		√		R		¥, ψ
44	Niltauke Khanjari	Blue-fronted Redstart	<i>Phoenicurus frontalis</i>	√			√	√				R		≠, ¥, ψ
45	Setotauke Jalkhanjari	White-capped	<i>Chaimarrornis leucocephalus</i>	√							√	R		≠, ¥, ψ

		Water Redstart															
46	Nilambar Jalkhanjari	Plumbeous Water Redstart	<i>Rhyacornis fuliginosus</i>	√						√		R					≠, ¥, ψ
47	Jhek Jhek Jhapsi	Common Stonechat	<i>Saxicola torquata</i>		√			√		√		R					≠, ¥, ψ
48	Dangre Rupi	Common Myna	<i>Acridotheres tristis</i>	√						√		R					≠, ¥, ψ
49	Chichilkote	Great Tit	<i>Parus major</i>	√			√					R					≠, ¥, ψ
50	Hariyo Chichilkote	Green-backed Tit	<i>Parus monticolus</i>		√		√					R					≠, ¥,
51	Pandu Chichilkote	Black-lored Tit	<i>Parus xanthogenys</i>	√			√					R					≠, ¥, ψ
52	Julfe Jureli	Himalayan Bulbul	<i>Pycnonotus leucogenys</i>	√				√				R					≠, ¥, ψ
53	Jureli	Red-vented Bulbul	<i>Pycnonotus cafer</i>		√		√	√				R					≠, ¥, ψ
54	Bakhre Jureli	Black Bulbul	<i>Hypsipetes leucocephalus</i>	√			√					R					≠, ¥, ψ
55	Suya Ghanse Fisto	Striated Prinia	<i>Prinia criniger</i>	√				√		√		R					≠, ¥, ψ
56	Kankir	Oriental White-eye	<i>Zosterops palpebrosus</i>		√		√					R					≠, ¥, ψ
57	Jiwal Fisto	Greenish Warbler	<i>Phylloscopus trochiloides</i>		√		√	√				M	W i				≠, ¥, ψ
58	Sunchasme Fisto	Golden-spectacled Warbler	<i>Seicercus burkii</i>				√	√	√			R					≠, ¥, ψ
59	Tumulkari Fisto	Grey-hooded Warbler	<i>Seicercus xanthoschistos</i>	√				√	√			R					≠, ¥, ψ
60	Chirke Torignada	Streaked Laughingthrush	<i>Garrulax lineatus</i>				√	√				R					≠, ¥, ψ
61	Kalochiunde Banbhyakur	Black-chinned Babbler	<i>Stachyris pyrrhops</i>				√	√	√			R					≠, ¥, ψ
62	Junge Jurechara	Whiskered Yuhina	<i>Yuhina flavicollis</i>		√			√				R					≠, ¥, ψ
63	Sibia	Rufous Sibia	<i>Heterophasia capistrata</i>		√			√				R					≠, ¥
64	Aagnibakshya Puspakokil	Fire-breasted Flowerpecker	<i>Dicaeum ignipectus</i>	√				√				R					≠, ¥, ψ
65	Nepal Bungechara	Green-tailed Sunbird	<i>Aethopyga nipalensis</i>		√			√				R					≠, ¥, ψ
66	Kalikanthe Bungechara	Black-throated Sunbird	<i>Aethopyga saturata</i>		√			√				R					≠, ¥, ψ
67	Ghar Bhangera	House sparrow	<i>Passer domesticus</i>				√			√		R					≠, ¥, ψ
68	Rukh bhangera	Eurasian Tree sparrow	<i>Passer montanus</i>	√						√		R					≠, ¥, ψ
69	Fusro Tiktike	Grey Wagtail	<i>Motacilla cinerea</i>		√					√		R					≠, ¥, ψ
70	Gulafikanthe Chuina	Rosy Pipit	<i>Anthus roseatus</i>		√			√				R					≠, ¥, ψ
71	Amonga Titu	Common Rosefinch	<i>Carpodacus erythrinus</i>				√	√	√			R					≠, ¥, ψ

Note:

Status of occurrence: C- Common, S- Spars, R- Rare;

Habitat: F- forest, B – Bush, O- Open grass land, A – Agricultural land, Wa – Water;

Migratory status and season: M – Migratory, R - Resident, S – migration season, Su- Summer visitor, Wi – Winter visitor;

Reported from: ≠ – Headwork and its peripheral areas, ¥ – Between headwork and powerhouse areas, □ – Powerhouse and its peripheral areas

5.2.9.3 Amphibians and Reptiles

Herpetofauna (reptiles and amphibians) plays an important role in controlling the population of various prey species such as reptiles and birds, and some small mammals such as squirrels, rats, and mice. Forested wetlands, swamps, water body, bushes are the areas favored by herpetofauna. They have small home range are more sensitive to changes in their environment and undergo the resting period during hibernation and aestivation. As most of the herpetofauna live in the proximity of water, reduction of downstream flow may impact them. Based on the field survey, consultations and literature reviews, a total 12 species of herpetofauna were recorded from project and its peripheral area which includes 5 species of amphibians and 7 species of reptiles. Reported herpetofauna includes frog, toad, snakes, skink and lizards. The list of herpetofauna reported in the project and its peripheral areas is presented in the table below.

Table 5-14: Amphibians and Reptiles Recorded from Project Construction Sites and its Peripheral Areas

S. No.	Nepali Name	English Name	Scientific Name	Status of occurrence			Habitat					Migratory Status/season		Reported Location	
				C	S	R	F	B	O	A	Wa	M/R	S		
1	Khasre Bhaguto	Himalayan Toad	<i>duttaphrynus himalayanus</i>		√		√				√		R		¥, □
3	Khasre Bhaguto	Marbled Toad	<i>duttaphrynus stomaticus</i>		√						√		R		≠, ¥, □
4	Hariyo Paha	Beautiful Stream Frog	<i>Amolops formosus</i>		√							√	R		≠, ¥, □
5	Rato Paha	Sikkimese Frog	<i>Ombrana sikimensis</i>			√	√					√	R		□
6	Cheparo	Common Garden Lizard	<i>Calotes versicolor</i>	√				√	√				R		≠, ¥, □
7	Patharchatuwa	Himalayan Rock Lizard	<i>Laudakia tuberculata</i>	√				√	√				R		≠, ¥, □
8	Bhanumungre	Sikkim Skink	<i>Asymblepharus sikimensis</i>		√		√				√		R		≠, ¥, □
9	Bhanumungre	Brahminy Skink	<i>Mabuya carinata</i>	√			√				√		R		≠, ¥, □
10	Chankhe Sarpa	Mountain Keelback	<i>Amphiesma platyceps</i>			√	√				√	√	R		¥, □
11	Bayana	Himalayan Trinket Snake	<i>Elaphe hodgsoni</i>			√	√				√		R		¥, □
12	Haryau Sarpa	White-lipped Pit Viper	<i>Trimeresurus albolabris</i>		√		√			√	√		R		≠, ¥

5.2.9.4 Conservation Status of Terrestrial Wild Animals

A total of 99 species of terrestrial wild animals were recorded from the project and its peripheral areas. Of which, 17 species are listed on CITES Appendixes and 7 on IUCN red-data list as Threatened species. GoN has given legal protection to 39 species of animals under NPWC Act-1973, of which, *Macaca assamensis* was recorded from the project area. No endemic species was recorded.

Table 5-15: Conservation status of wildlife

S. No.	Nepali Name	English Name	Scientific Name	CITES Appendix	IUCN Red List		Protected Under NPWC Act, 1973
					National	Global	
Mammals							
1	Malaya Dumsi	Malayan Porcupine	<i>Hystrix brachyura</i>	-	DD	-	-

2	Ban Biralo	Jungle cat	<i>Felis chaus</i>	II	-	-	-
3	Chituwa	Common leopard	<i>Panthera pardus</i>	I	VU	VU	-
4	Fusro Fyauro	Bengal Fox	<i>Vulpes bengalensis</i>	III	VU	-	-
5	Syal	Golden Jackal	<i>Canis aureus</i>	III	-	-	-
6	Malsapro	Yellow-throated Marten	<i>Martes flavigula</i>	III	-	-	-
7	Terai Langur	Terai Grey Langur	<i>Semnopithecus hector</i>	I	-	NT	-
8	Pahare Bandar	Assam Macaque	<i>Macaca assamensis</i>	II	VU	NT	Protected
9	Rato Bandar	Rhesus Macaque	<i>Macaca mulatta</i>	II	-	-	-
10	Ratuwa /Rate Mirga	Barking Deer	<i>Muntiacus muntjak</i>	-	VU	-	-
11	Ghoral	Common Goral	<i>Naemorhedus goral</i>	I	NT	NT	-
Birds							
1	Kalij	Kalij Pheasant	<i>Lophura leucomelanos</i>	III	-	-	-
2	Madana Suga	Slaty-headed Parakeet	<i>Psittacula himalayana</i>	II	-	-	-
3	Thulo Dundul	Asian Barred Owl	<i>Glaucidium cuculoides</i>	II	-	-	-
4	Kalo Chil	Black Kite	<i>Milvus migrans</i>	II	-	-	-
5	Hadfor	Lammergeier	<i>Gypaetus barbatus</i>	II	VU	NT	-
6	Himali Gidda	Himalayan Griffon	<i>Gyps himalayensis</i>	II	VU	NT	-
7	Banbaz	Eurasian Sparrowhawk	<i>Accipiter nisus</i>	II	-	-	-
9	Baudai	Common Kestrel	<i>Falco tinnunculus</i>	II	-	-	-

Sources

Birds of Nepal: An Official Checklist (2018).

The Status of Nepal's Mammals: The National Red List Series (2011)

Nepal Biodiversity Strategy and Action Plan 2014-2020.

<http://www.iucnredlist.org/> (August, 2019).

Key to the IUCN Codes: CR = Critically Endangered, EN= Endangered, VU= Vulnerable, NT = Near Threatened, DD= Data Deficient

5.2.9.5 Aquatic Animals

Fish Location and Habitat Condition of Fish Sampling Stations

As mentioned in the methodology, to unravel the baseline status of fish fauna, four sampling stations were selected along the Budhi Gandaki River. The criteria for selecting sampling stations were based on river gradient, river habitat, confluence of tributaries, habitat likely to be impacted by project in future and accessibility of sampling stations. Out of four fish sampling stations, station I and II lie inside the Manaslu conservation area.

Table 5-16: Location and Habitat Condition of Sampling Stations

S. No	Name of Sampling Station	Location of Sampling Stations		Habitat Characterization (visual estimate)		River Width (visual estimate)	Water Temp.	Habitat Condition	Spawning ground
		Latitude*	Longitude*						
I	Budigandaki River, Upstream of Dam	28°22'3.15"N	84°53'14.09"E	Rapid 50% Run 30% Riffle 10% Pool 10%	Boulder 45% Cobble 30% Pebble 20% Sand 5%	30 – 40 m	13°C	Disturbed	-
II	Budigandaki River, Downstream of Dam Station IIA (1000 m)	28°21'0.57"N	84°53'49.98"E	Rapid 40% Run 40% Riffle 10% Pool 10%	Boulder 25% Cobble 35% Pebble 30% Sand 10%	30 – 50 m	14°C	Disturbed	Observed at Yaru Khola
	Budigandaki River, Downstream of Dam Station II B (1000 m)	28°19'48.87"N	84°54'21.38"E						
III	Budigandaki River, Upstream of Powerhouse (PH) Area	28°18'13.80"N	84°54'24.79"E	Rapid 45% Run 25% Riffle 15% Pool 5%	Boulder 45% Cobble 30% Pebble 20% Sand 5%	30 – 40 m	14.5°C	Highly Disturbed	-
IV	Budigandaki River, Downstream of Powerhouse (PH) Area	28°16'58.96"N	84°54'0.04"E	Rapid 50% Run 30% Riffle 10% Pool 10%	Boulder 45% Cobble 35% Pebble 15% Sand 5%	30 – 40 m	16°C	Highly Disturbed	-

Source: Field Visit of Budigandaki Hydroelectric Project, May, 2019

Note: * Latitude and longitude are taken approximately at the midpoint of each sampling station.

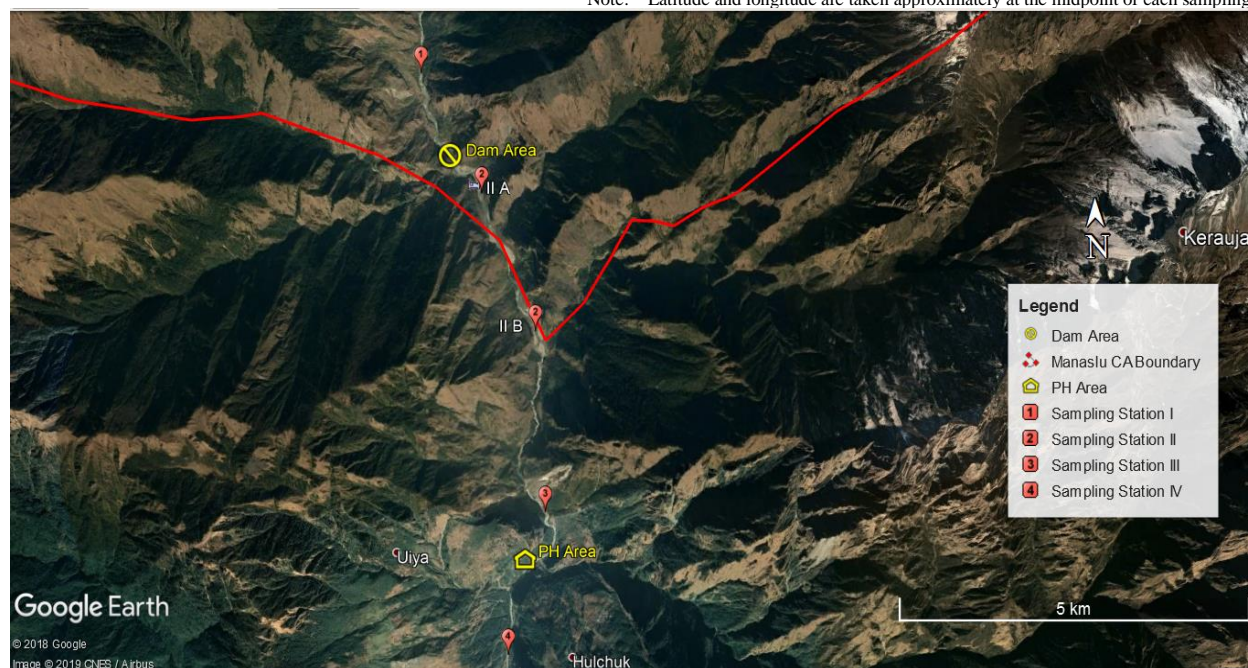


Figure 5-15: Map of Location of Sampling Station

The Budhi Gandaki River is fast flowing natural river. Boulders are comparatively higher on upper reaches and pebbles and cobbles on the lower reaches and where the river becomes flat. River substratum is not visible; only the large boulders in the river substratum are visible at certain section. Growth of green algae on the rock, presence of diverse aquatic invertebrates, aquatic birds and their droppings at rock and fishing activities indicate

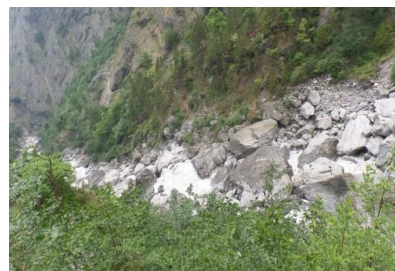
the productive ecological habitat. Above the maximum flood line, bushy vegetation interspersed with the pebbles, cobbles and boulders of the river bank. The water temperature during the survey period was between 13- 16 0C. Jagat Khola and Yaru Khola are the perennial streams present at dewater-zone of Budhi Gandaki River. Discharge of these streams will be an important contributor for e-flow during the project operation.



Jagat Khola on right and Budigandaki on left



Confluence of Yaru Khola with Budigandaki



Steep River Gradient at Yarutar

Figure 5-16: River Profile of the Project Sites

Jagat Khola: The river joins with the right bank of Budigandaki at fish sampling station II A (below dam) and lies within the Manaslu conservation area. During the survey period, water was clear and boulders at bottom substratum were clearly visible. Its width was about 4-7 m. Spawning ground and fishing activities were not recorded.

Yaru Khola: The river joins with the left bank of Budhi Gandaki River at fish sampling station II B and lies outside the Manaslu conservation area. During the survey period, water was clear bottom substratum was clearly visible in all the sections. Its width was about 4-7 m. Spawning ground of fishes was recorded.

At Yarutar, just downstream of the station IIB (about 3.5 km downstream from dam), a steep river gradient (called Yaru Chhanga) exists within the Budigandaki River. It might act as natural barrier for the migration of fishes.

During the survey period, road was under construction at powerhouse area along the right bank of the Budhi Gandaki river. Demolition wastes produced during the construction were found to be deposited directly into the river. There was excessive noise and vibration in the area generated during blasting of explosive and deposition of waste into the river. Moreover, due to deposition of soil, turbidity of river was quite high. So, aquatic habitat was highly disturbed during the survey period. It was further exacerbated by extraction of construction materials such as sand, rock from the river bed.



Figure 5-17: Deposition of demolition wastes produced during road construction, into the Budigandaki river



Figure 5-18: Extraction of sand from the riverbed

5.2.9.6 Fish Diversity

In the baseline survey, three fish species were recorded (including reported species) within the impact area of Budigandaki River. Out of three species, *Schizothorax richardsonii* was observed during the survey and other two namely *Schizothoraichthys progastus* and *Pseudecheneis sulcata* were reported by local fishermen during the survey. *Schizothorax richardsonii* and *Pseudecheneis sulcata* were reported from all the sampling stations and *Schizothoraichthys progastus* from station IV (below powerhouse area) only. According to local fishermen, *Schizothoraichthys progastus* is normally seen during summer season, *Pseudecheneis sulcata* during post monsoon season and *Schizothorax richardsonii* in all seasons. Table below presents the recorded fish species at different sampling stations.

Table 5-17: Fish species recorded in the sampling stations

S. No.	English Name	Nepali Name	Scientific Name	Station I		Station II (A+B)		Station III		Station IV	
				O	R	O	R	O	R	O	R
1	Sulcatus Catfish	Kavre	<i>Pseudecheneis sulcata</i>	-	+	-	+	-	+	-	+
2	Point-nosed Snowtrout	Chuchhe Asala	<i>Schizothoraichthys progastus</i>	-	-	-	-	-	-	-	+
3	Blunt-nosed Snowtrout	Buchche Asala	<i>Schizothorax richardsonii</i>	+	+	+	+	+	+	+	+
Total				1	2	1	2	1	2	1	3

Source: Field Survey and Participatory Information from Local People and Fishermen, field study of Budhi Gandaki Hydroelectric Project, May, 2019.

Note: + = Present; - = Absent; O= Observed species; R= Reported species.

Figure below presents the fish diversity at different sampling stations. Sampling station IV recorded 3 species and stations I, II and III recorded 2 species. So, fish diversity was found higher at lower stretch of the river.

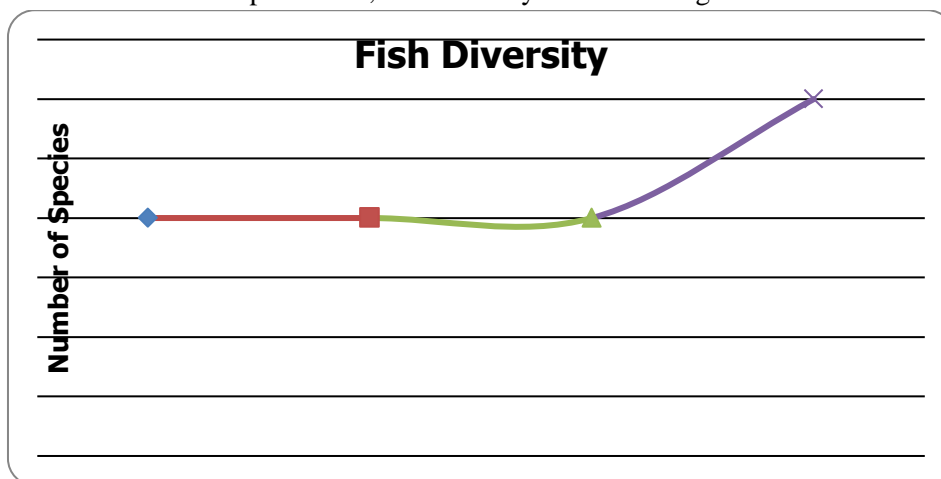


Figure 5-19: Fish diversity at different sampling stations

A total of 36 fishes of *Schizothorax richardsonii* were sampled from the sampling stations. Out of 36 species, station I represents 38.89 %, station II represents 27.78%, station III represents 22.22% and station IV represents 11.11 % by number. Figure below presents the percentage of fish catch at different sampling stations.

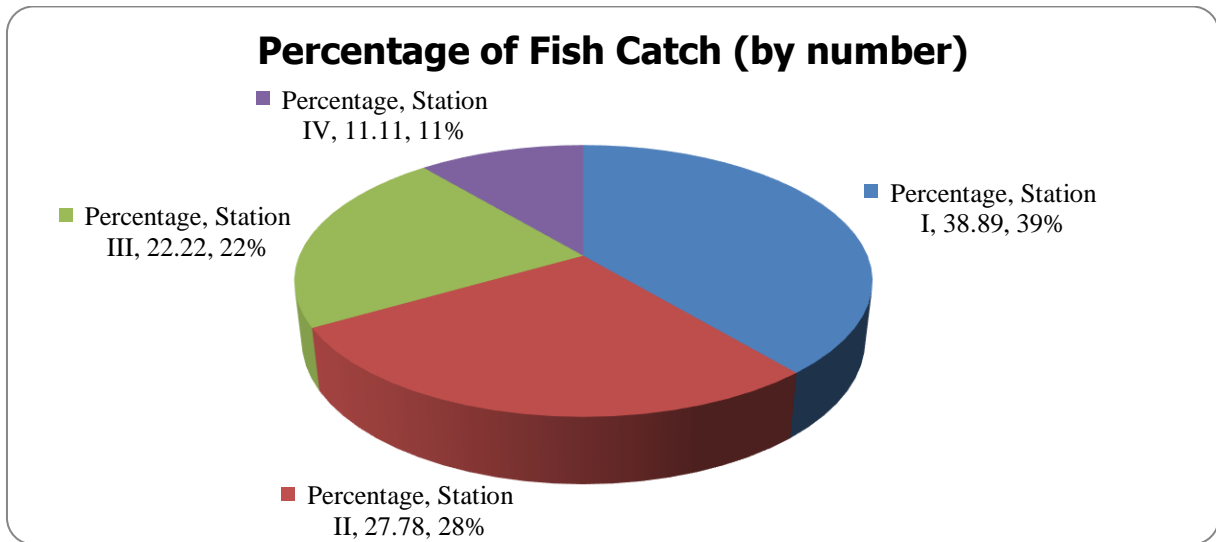


Figure 5-20: Fish diversity at sampling stations

Average Fish Length and Weight in the Study Area

In general, longer the length higher is the weight of the fish. Figure below presents the average length and weight of the fish in different sampling station of the project area. Average length and weight of fishes are higher at upper reaches of the project area.

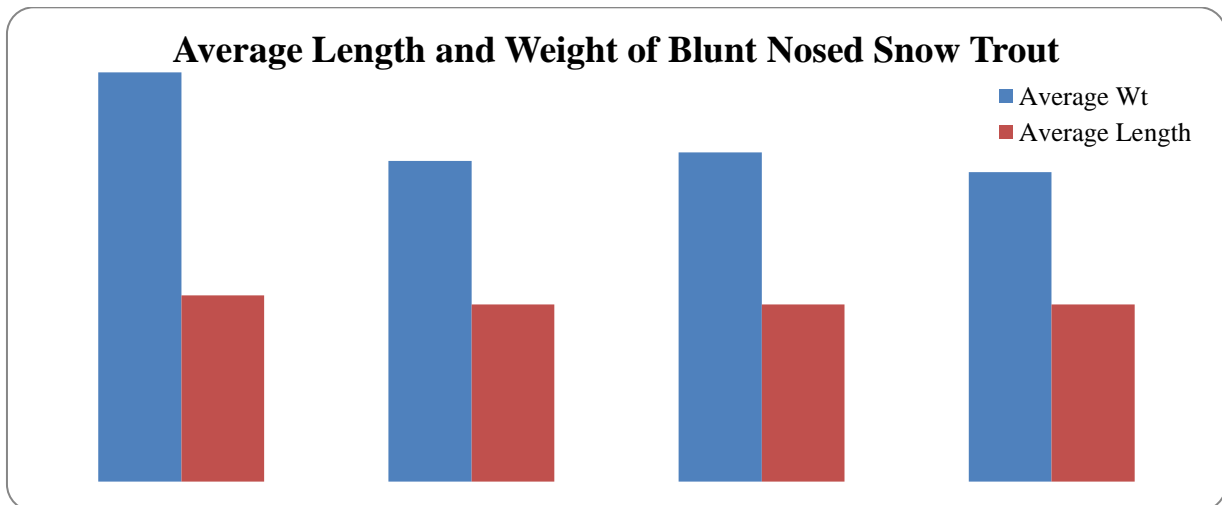


Figure 5-21: Average length and weight of Blunt Nosed Snow Trout at sampling stations

Table 5-18: Length and weight of sample fishes at sampling stations

Station No.	Scientific Name	Nepali Name	Grand No. of fish caught	Weight			Length		No. of fish caught %
				Total (gm)	Wt.	AV wt gm	Range cm	AV Length cm	
I	<i>Schizothorax richardsonii</i>	Buchchhe Asala	14	450.7	32.19		11.5-23.3	14.66	38.89
II	<i>Schizothorax richardsonii</i>	Buchchhe Asala	10	252.3	25.23		11.0- 22.1	13.94	27.78
III	<i>Schizothorax richardsonii</i>	Buchchhe Asala	8	207.2	25.9		11.6-18.5	13.94	22.22
IV	<i>Schizothorax richardsonii</i>	Buchchhe Asala	4	97.4	24.35		12.8-15.5	13.95	11.11
Total			36	1007.6					100

Source: Field Survey and Participatory Information from Local People and Fishermen, Field Study of Budhi Gandaki Hydroelectric Project, May, 2019.

Catch per Unit Effort (CPUE)

Fish abundance is measured based on the catch per unit effort. Figure and Table below represents the findings of the catch per unit effort for each sampling station. The catch per unit effort is higher at upper reaches of the Budhi Gandaki River. It correlates with the less disturbed and diverse habitat created by feeder streams at upper reaches. Lower reaches of river are highly disturbed due to undergoing road construction. Blasting of explosive for road has added excessive vibration into the river affecting the fishes and their habitats might be the cause for the lower CPUE.

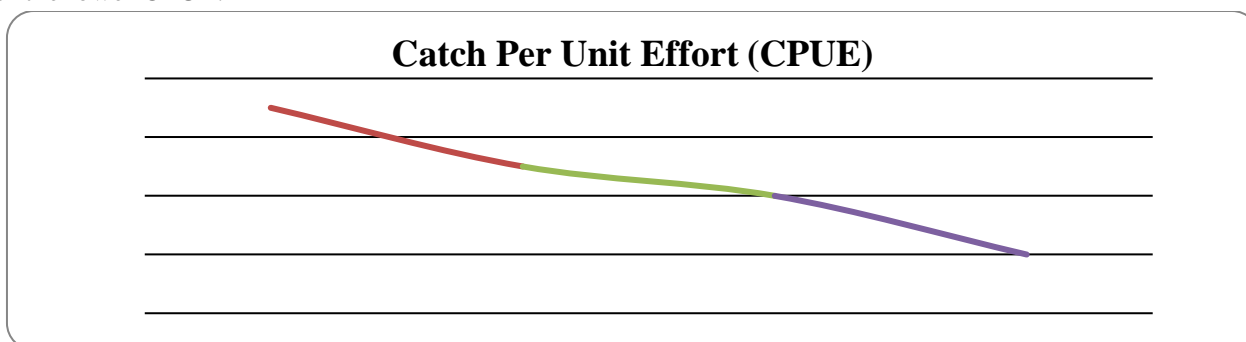


Figure 5-22: Catch per unit effort (CPUE) at sampling stations

Table 5-19: Catch per unit effort (CPUE) at sampling stations

Station No.	Level of Effort	No. of Fish caught	Catch per unit effort (CPUE)
I	200	14	0.07
II	200	10	0.05
III	200	8	0.04
IV	200	4	0.02
Total	800	36	0.045

Source: field visit of Budigandaki Hydroelectric Project, May, 2019.

Migratory Fish, Migratory Pattern and Migratory Season

Fishes undertake to the upstream and downstream migration for spawning, feeding and for searching suitable habitat. Two fish species namely *Schizothorachthys progastus* and *Schizothorax richardsonii* of medium distance migratory nature were recorded on the basis of interactions with the local fishermen, direct observation and relevant literatures. Reported *Pseudecheneis sulcata* is resident (R) species. Table below presents the migratory pattern of recorded migratory fish species.

Table 5-20: Migration patten of fish species

S. No	Nepali Name	English Name	Scientific Name	Migratory Pattern
1	Chuchhe Asala	Pointd-nosed Snowtrout	<i>Schizothorachthys progastus</i>	MM
2	Buchche Asala	Blunt-nosed Snowtrout	<i>Schizothorax richardsonii</i>	MM

Sources: Survey of Fish Hotspots and their Conservation and Management (Singh, 2009) and consultation with local fishermen. Field Visit of Budigandaki Hydroelectric Project, May, 2019.

Note: MM - Medium Distance Migratory Species, R - Resident Species

Table 5-21: Migration season of the fishes

Nepali Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chuchhe Asala	<i>Schizothorachthys progastus</i>		↑	↑	↑							↓	↓
Buchche Asala	<i>Schizothorax richardsonii</i>		↑	↑	↑							↓	↓

Sources: Survey of Fish Hotspots and Their Conservation and Management (Singh, 2009), Ichthyology of Nepal (Shrestha, 2008) and consultation with local fishermen.

Note: ↑ upstream migration, ↓ downstream migration,

Table 5-22: Fish Habitat Preference, Feeding, Spawning Season, Spawning Location

Scientific Name	Fish Feed Preferences	Fish Habitat Preference	Spawning Season	Spawning Substrate	Major Spawning Ground
<i>Schizothorax richardsonii</i>	Any aquatic algae and mud	Rapids pools and riffle	Sep.-Oct. Mar.- April (Rai et.al., 2002)	Pebbles and gravel bed	Bank of feeder streams Jagat Khola, Yaru Khola and Dovan Khola
<i>Schizothoraichthys progastus</i>	Any aquatic algae and mud	Rapids pools and riffle	Sep.-Oct. Mar.- April (Rai et.al., 2002)	Pebbles and gravel bed	-

Sources: Interaction with local people and fishermen and Cold-water Fisheries in Trans Himalayan Countries, 2002. Field Visit of Budigandaki Hydroelectric Project, May, 2019

Status of Fish

Out of 3 recorded species, *Schizothorax richardsonii* is the Vulnerable (VU) species observed during the survey.

Table 5-23: Conservation Status of the Fish Species of Project Area

Nepali Name	English Name	Scientific Name	CITES Appendix	IUCN Red List (Global)	Protected Under NPWC Act, 1973	Endemic Species
Buchche Asala	Blunt-nosed Snowtrout	<i>Schizothorax richardsonii</i>	-	VU	-	-

Sources: साईटस अनुसूचीमा सूचीकृत नेपालमा पाईने संझकटापन्न वन्यजन्तु तथा वनस्पतिहरु (२०७१), Nepal Biodiversity Strategy and Action Plan 2014-2020. <http://www.iucnredlist.org/> (August, 2019). Ichthyology of Nepal (Shrestha, 2019). Key to the IUCN Code: VU = Vulnerable

Fishing Activity, Fishing Gear, Fishing Season and Economic Importance

Since the station I and II lie inside the Manaslu conservation area, people refuse to give information about fishing practice from the area. However, it is reported that, few people living close to the river in the project area practice part time fishing and no one has taken fishing as livelihood option. On average, people catch about 10-30 kg of fishes in a year. Household practice of river-fishing in the Project Area is given in the tables below.

Table 5-24: Household practice of river fishing Part A

Name of Fishermen	Address	Family members			Occupation		Engage in fishing activities (yr.)	Fishing from Sampling Station	Fish price/kg
		Male	Female	Total	Major	Other			
Nar Bd. Ghale	Darche-1, Kerauja, Yarubagar	2	4	6	Business, carpenter, mason	Part time fisherman	4-5	II	RS. 800
Gaman Ghale	Darche-1, Kerauja, Yarubagar	2	5	7	Business, carpenter, mason	Part time fisherman	12	II	Rs. 800

Table 5-25: Household practice of river fishing (B)

Name of Fishermen	Amount of harvest (kg)	Consumption (kg)	Sold (kg)	Population Trend	Fishing Season	Nearby market	Fish	Use & Value of fish
Nar Bd. Ghale	20 kg	20	-	↓	Feb.-Apr. Sept.- Nov.	No		Food
Gaman Ghale	20 kg	20	-	↓	Feb.-Apr. Sept.- Nov.	No		Food

Source: Field Survey, EIA of Budhi Gandaki Hydroelectric Project, May, 2019.

Note: Population trend: ↓= Decreasing, ↑ = increasing, 0= constant

Fishing Implements

Normally used fishing implements is cast net (Hate Jaal), Loop (Paso), Rod & line and D-net (Ghorlang). Destructive method of fishing such as electro fishing, blasting and poisoning were not reported from the area.

Fishing Season

The best period of fishing in the river as reported by the fishermen is February to April and September to November. In this period, the number fish catch and weight is reported be higher than in the other seasons.

Fish price/Fish Market

Average catch per day per fisherman during fishing season (about 6-7 months) is reported to be 1/2 kg. Proper fish market is absent in the project area. The fishes caught are mostly consumed by the inhabitants. Excess fishes are preserved by smoking or sun drying for future use. The price of fish at local level depends on fish species and fish size. Normally, higher the size of fish, higher is the price. On average fish price is about NPR 700-800/kg. Smoked fish are sold at higher price.

Fish population trend and value-

During consultation, it has been reported that the population of fishes are decreasing since last 5-10 years but they have no idea about its cause.

All the fish species reported during the survey are edible and have considerable food value. These fishes can be grouped under three categories, High food value (H) which are large or moderate size fish with good taste. Medium food value (M) fishes are of medium size with inferior taste in comparison to high food value fish. Low food value (L) fish are generally small sized with inferior taste. The price of the fish varies according to the food value, i.e. higher the food value higher is the price. In the project area, fishes are used mainly for food by local fishermen. No cultural, aesthetic and medicinal values of fishes were reported.

Table 5-26: Food Value of the Fishes of the Project Area

S. No.	Scientific Name of Fish	Local Name of Fish	Food Value of Fish
1	<i>Pseudecheneis sulcatus</i>	Kabre	M
2	<i>Schizothoraichthys progastus</i>	Chuchhe Asala	H
3	<i>Schizothorax richardsonii</i>	Buchchhe Asala	H

Source: Field Survey and Participatory Information from Local People and Fishermen, EIA of Budhi Gandaki Hydroelectric Project, May, 2019.

5.3 Socio-economic condition

The proposed Budhi Gandhi Hydroelectric Project is in the Gorkha District of the Gandaki Province. The district has total of 11 municipalities (9 Rural and 2 Urban Municipalities). The Gorkha Urban Municipality is headquarter of the Gorkha District; and the project is located in the Chum Numbri Rural Municipality and Dharche Rural Municipality. The project's headworks are located in the Chum Numbri Rural Municipality, whereas the most part of the tunnel and powerhouse are located in the Dharche Rural Municipality.

5.3.1 Demographic Profile

Gorkha District, located in Nepal, boasts a total population of 2,916,457 people. The sex ratio in this district is 95.59 males per 100 females, indicating a slight male majority. The population density is 198 persons per square kilometer, reflecting a relatively moderate population distribution across the region. There are 666,937 total households in Gorkha District, with an average household size of 4.37 individuals, indicating larger families and possibly a mix of urban and rural settlements.

Breaking down the district further into its constituent palikas (rural municipalities and municipalities), we observe varying sizes of households and populations. For instance, Palungtar Municipality stands out with 11,072 households and a population of 37,409. In contrast, smaller Rural Municipalities like Chumanubri and Dharche have fewer households and populations. Lastly, the dataset includes institutional households, numbering 97, with a total population of 2,740, comprising 1,924 males and

816 females. While this category is relatively small in comparison, it may represent organizations or institutions contributing to the local population.

Dharche Rural Municipality is a is one of the project-affected local administration area, with a population of 14,263 residents. The sex ratio in this area is 91.94 males per 100 females, indicating a slight female majority. The population density is relatively low at 22 persons per square kilometer, suggesting a less densely populated and possibly rural area. Dharche Rural Municipality comprises 3,808 households, and the average household size is 3.75 persons, indicating smaller families compared to the district average.

Chumanubri Rural Municipality is another subregion within Gorkha District, with a population of 5,932 people. The sex ratio here is 92.16 males per 100 females, indicating a slight female majority as well. The population density in this area is notably lower, at only 4 persons per square kilometer, suggesting a sparsely populated or remote region. Chumanubri Rural Municipality consists of 2,068 households, with an average household size of 2.87 persons, indicating relatively smaller families compared to both the district and Dharche Rural Municipality.

Table 5-27: Demographic Profile of Gorkha District and project associated local administrative bodies

Area/Region	Total Population	Sex Ratio (male per 100 female)	Population Density (person per square km)	Total Household	Average Household size
Gorkha District	2,91,64,578	95.59	198	66,66,937	4.37
Dharche Rural Municipality	14,263	91.94	22	3,808	3.75
Chumanubri Rural Municipality	5,932	92.16	4	2,068	2.87

Source: Field Visit 2019

5.3.2 Demographic Characteristics of Project area

The project is located within ward no 3 of Chum Numbri Rural Municipality and ward no 1 and 3 of Dharche Rural Municipality. The key settlement or “bazaar”, where most of the population are concentrated in the project area are Tatopani, Yarubagar, Salleri and Jagat, all of which are located along banks of the Budhi Gandaki River.

Table 5-28: Key settlements in the project area

Rural Municipalities	Key Settlements
Chum Numbri- 3	Jagat, Salleri
Dharche-1	Yaruphant, Dobhan
Dharche – 3	Tatopani

Source: National statistics office, National Population and Housing Census 2021

5.3.3 Demographic Profile by age/sex of the affected Wards

Ward 3 of Chumanumbri Rural Municipality is the proposed inundation area of the project. Ward 1 and 3 of Dharche Rural Municipality is the proposed low flow area of the project.

Chumanubri Rural Municipality has a total of 2,068 households and a population of 5,932, with a slightly higher female population (3,087) than male (2,845). The average household size is 2.87, and the sex ratio stands at 92.16 females per 1000 males. In Chumanubri Ward 3, within the same Rural

Municipality, there are 709 households with a population of 2,321. The average household size is 3.27, and the sex ratio is 90.87.

Shifting to Dharche Rural Municipality, it encompasses 3,808 households and a total population of 14,263, with 7,431 females and 6,832 males. The average household size in this Rural Municipality is 3.75, and the sex ratio is 91.94. Additionally, the dataset provides specific data for two wards within Dharche Rural Municipality. Ward 1 has 234 households with a population of 851, an average household size of 3.64, and a sex ratio of 93.41. In contrast, Ward 3 has 527 households, a population of 1,886, an average household size of 3.58, and a sex ratio of 85.08.

Table 5-29: Demographic Profile by age/sex of the affected Wards

Municipalities	Number of Households	Total Population	Male Population	Female Population	Average Household size	Sex Ratio
Chunambri	2068	5932	2845	3087	2.87	92.16
Chunambri Ward 3	709	2321	1105	1216	3.27	90.87
Dharche	3808	14263	6832	7431	3.75	91.94
Dharche Ward 1	234	851	411	440	3.64	93.41
Dharche Ward 3	527	1886	867	1019	3.58	85.08

Source: National statistics office, National Population and Housing Census 2021

5.3.4 Caste/Ethnicity Profile

With a total population of 5,932 in Chumanumbri Rural Municipality, it reflects the diverse makeup of the community. The largest ethnic group in this area is Chumba/Nubri, accounting for 3,465 individuals, followed by the Gurung community with 2,269 members. Other ethnic groups, including Tamang, Bishwokarma, and Ghale, also contribute to the rich cultural fabric of the region.

Table 5-30: Caste/Ethnicity Profile of Chumanubri Rural Municipality

Caste/Ethnicity Profile of Chumanubri Rural Municipality			
Caste/Ethnicity	Total	Male	Female
All Caste	5932	2845	3087
Kshetri	23	15	8
Tamang	30	17	13
Bishwokarma	25	14	11
Gurung	2269	1074	1195
Ghale	99	44	55
Chumba/Nubri	3465	1672	1793
Others	21	9	12

Source: National statistics office, National Population and Housing Census 2021

Dharche Rural Municipality has a total population of 14,263 people, with 6,832 males and 7,431 females. The Gurung community is the most populous ethnic group in Dharche Rural Municipality, with 11,808 individuals, making up a significant portion of the total population. The Bishwokarma community is also noteworthy, with 598 members, almost evenly split between males (298) and females (300). The Ghale community has 1,751 members, with 827 males and 924 females, indicating a slightly higher female population within this ethnic group.

Table 5-31: Caste/Ethnicity Profile of Dharche Rural Municipality

Caste/Ethnicity Profile of Dharche Rural Municipality			
Caste/Ethnicity	Total	Male	Female
All Caste	14263	6832	7431

Kshetri	26	16	10
Brahman - Hill	25	16	9
Magar	13	8	5
Tamang	11	7	4
Bishwokarma	598	298	300
Gurung	11808	5641	6167
Ghale	1751	827	924
Others	31	19	12

Source: National statistics office, National Population and Housing Census 2021

5.3.5 Religion

The summary of the religious demographics data for Chumanubri Rural Municipality, and Dharche Rural Municipality in Nepal is as follows:

Hinduism is the predominant religion in all three regions, with the highest number of followers in Gorkha, where it constitutes a significant majority of the population. In Chumanubri Rural Municipality and Dharche Rural Municipality, the Hindu population is relatively smaller but still substantial. It's evident that Hinduism has a strong presence throughout these regions.

Buddhism is the second-largest religious group in these areas, with a notable presence in Gorkha and Dharche Rural Municipality. Chumanubri Rural Municipality, in particular, stands out as having a significant Buddhist population. This reflects the influence of Buddhism in these regions and its coexistence with Hinduism. Christianity has a modest but notable following in all three regions, with Gorkha having the highest number of Christian adherents. Other religious groups such as Islam, Kirat, and Sikha are present as well but in much smaller numbers. The Bon tradition also has a presence, primarily in Gorkha and Dharche Rural Municipality.

These statistics highlight the religious diversity and pluralism in Nepal, with a range of faiths coexisting within these regions. It's indicative of the country's rich cultural and religious tapestry, where followers of various religions live side by side. The data also underscores the importance of understanding and respecting the religious diversity that shapes these communities, contributing to the vibrant tapestry of Nepal's cultural and social landscape.

Table 5-32: Religion of Project Affected Local Levels

Religion	Chumanubri Rural Municipality	Dharche Rural Municipality
Hindu	105	1380
Bouddha	5153	6037
Islam	1	0
Kirat	1	1
Christian	672	2180
Prakriti	0	0
Bon	0	4665
Jain	0	0
Bahai	0	0
Sikha	0	0

Source: National statistics office, National Population and Housing Census 2021

5.3.6 Tourism

Gorkha district is one of the important touristic destinations of Nepal. It is popular for its natural beauty, historically land religiously important sites, cultural and biological diversity. Some of the popular tourist attractions of in the Gorkha District are:

Manaslu Conservation Area was established in 1998. It covers 1,663 km² in the Mansiri Himalayan Range in the Gorkha District, borders Annapurna Conservation Area in west and the Tibetan Plateau in north and east. The Manaslu Conservation Area is the habitat of about 33 species of mammals including the elusive snow leopard, musk deer, and the Himalayan Thar, 110 species of birds, 11 species of butterflies and 3 species of reptiles. There are also 2000 species of plants, 11 types of forests and over 50 species of useful plants in the conservation area. Dharche Danda is the highest point of the lower Manaslu trekking route. It offers 180 degree panoramic view of more than 20 Himalayan peaks. Dharche danda (hill) also holds a religious significance for the Gurung community. Laprak Gurung Village is another wonderful, heavenly and exciting remote village of the Gorkha. It is situated in the hills at an altitude of 2,300 m above the sea level. Narad Pokhari is one of the important pilgrimage sites of Hindus. Visitors can go to Narad Pokhari from Barpak. It is believed that if one worships after taking bath here at Shrawan Shrangti, one's wish would come true. Sirandanda is situated at the hill top from where its name has been derived. One can reach Sirandada with a short hike of one hour from Bhachek. Major attractions of Sirandanda are: Nagepokhari, Dudhpokhari, Bhoteodar, Chima and tea garden. It also offers a magnificent view of sunrise and a stunning Manaslu range. Tsum Valley is a sacred Himalayan pilgrimage valley situated in northern Gorkha. Tsum comes from the Tibetan word "Tsombo" which means vivid. The trail heads up the valley of the Budi Gandaki River through wild and unexplored country inhabited mainly by members of the Gurung ethnic groups. Gorkha Palace was the birthplace of the king Prithvi Narayan Shah, who was born in the central palace named DhuniPari. Gorkha palace is built on top of a hill at an altitude of 3281 feet (about 1000 meter). Tallo Durbar: It is a large building built in mid-18th century in the administrative heart of the Gorkha. It occupies site where the old Gorkha palace stood before the arrival of the Shahs which is earmarked for a museum, Rani Pokhari (Pond), old market etc. are important sites near Tallodarbar in Gorkha bazaar. Manakamana temple is one of the important pilgrimage sites of Hindus in Nepal. It is located in beautiful ridge south-east of the township of Gorkha. Dashain Fulpati Procession is one of the important cultural events during Nepal's popular festival Dashain in Gorkha. On Fulpati (7th day of Dashain) – special kind of flowers are brought from the Gorkha palace to the capital city Kathmandu. Mountains and water bodies: Gorkha is famous for the attractive mountain's peaks and numerous rivers, lakes and ponds formed the water coming down from the Himalayas. Some of the major mountains and rivers are listed in the tables below:

Table 5-33: Mountain Peaks and rivers of Gorkha District

Mountain Peaks	Height [m]
Manaslu (Killer Mountain)	8163
Himal Chuli-East	7893
Myadi Chuli-	7881
Himal Chuli-West	7540
Manaslu-North	7157
Shringi Himal	7177
Bouddha	6672
Himal Chuli-North	7371

Ganesh Himal		7429
Rivers	Ponds	Lakes
Budhi Gandaki	Thulo Dudh pokhari	Birendra Taal
Daraudi	Sano Dudhpokhari	Kalchhu Maan Taal
Chepe	NimchePokhari	ChhosongTaal
Marsyangdi	Rani Pokhari	
Syarkhola	BhulBhulekhar	
ManePaani		

Source: District profile of Gorkha 2074

5.3.7 Trade and Industry

Gorkha is an agrarian society with about 81.96 % of the population depending on the agriculture, whereas as a small portion of the population; 2.99%, however are working in the industries. The industry in the district is mainly small-scale and/or handicraft industries such as mill, computer institutes, wool craft, bamboo, poultry, beekeeping, handmade paper, silk production, tailoring, animal firms, spices industries etc.

Table 5-34: Trade and Industry

S.N.	Types of industry	Counts	Remarks
1	Productive Industry	236	
2	Energy based Industry	10	Hydro-Electricity
3	Agriculture and Forestry Industry	500	
4	Tourism Industry	328	Hotel
5	Service	566	
6	Construction	167	Rent/Lease
	Total	1807	

Source: District profile of Gorkha 2074

5.3.8 Small-Scale Enterprises

Chumanubri Rural Municipality

Chumanubri Rural Municipality, with a total of 2,068 households, showcases a smaller but still significant presence of small-scale enterprises. A considerable portion of households (1,628) does not report any registered enterprises. The prominent sectors are cottage industry and trade/business, with 66 male entrepreneurs and 23 female entrepreneurs in the former and 30 male entrepreneurs and 35 female entrepreneurs in the latter. There is also limited activity in transportation, service, and other sectors, along with a "Not stated" category comprising 202 households, which could benefit from further clarification regarding the nature of their enterprises.

Dharche Rural Municipality

Dharche Rural Municipality, with a total of 3,808 households, demonstrates the presence of small-scale enterprises across various sectors. However, a significant number of households (3,369) do not have registered enterprises. The most prominent sectors are cottage industry and trade/business, with 63 male entrepreneurs and 43 female entrepreneurs in the former, and 52 male entrepreneurs and 116

female entrepreneurs in the latter. Transportation, service, and other sectors also contribute to the local economy, albeit with fewer entrepreneurs. Interestingly, the "Not stated" category is relatively small, suggesting a more comprehensive recording of enterprise types in this region compared to the other two areas.

In summary, these data provide insights into the distribution of small-scale enterprises within these regions of Nepal. While cottage industries and trade/business activities are common themes, the specifics of enterprise types and gender participation vary among these areas. The "Not stated" category highlights the importance of further research and data collection to gain a comprehensive understanding of the local economies and opportunities for development in these regions.

Table 5-35: Small scale enterprise other than agriculture

Area	Total Household	Households Without enterprise	Type of small-scale enterprises										Not stated
			Cottage industry		Trade/ business		Transportation		Service		Other		
			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
Chumanubri Rural Municipality	2068	1628	66	23	30	35	3	3	20	13	25	20	202
Dharche Rural Municipality	3808	3369	63	43	52	116	32	21	25	23	14	30	20

Source: National statistics office, National Population and Housing Census 2021

5.3.9 School and Education

In Gorkha, a total population of 234,195 individuals aged 5 years and above was assessed for their literacy status. Among them, 169,477 can read and write, while 2,803 can only read without writing abilities. However, a substantial portion, 61,598 people, can't read or write, and 317 did not state their literacy status. When considering gender, there is a significant disparity, with more males (109,347) reported as literate compared to females (124,848). This difference extends to those who can only read or can't read and write as well.

In Chumanubri Rural Municipality, out of a total population of 5,279 individuals aged 5 years and above, 2,067 are reported as literate, while 85 can only read without writing, and 3,097 can neither read nor write. Additionally, 30 individuals did not specify their literacy status. Among males (2,507), a larger percentage are reported as literate compared to females (2,772). The gender gap is also evident in those who can only read or can't read and write.

Dharche Rural Municipality has a total population of 12,941 individuals aged 5 years and above. Of this population, 8,094 are literate, 107 can read only, and 4,710 can't read or write. Similar to the other areas, there were 30 individuals who did not state their literacy status. When considering gender, the data reveals that more males (6,144) are reported as literate compared to females (6,797), reflecting a gender disparity in literacy rates.

In Chumanubri-03, there is a total population of 2057 individuals, with a nearly balanced gender distribution, with 974 males and 1083 females. This suggests a relatively even representation of both genders. In Dharche-01, the population is smaller, with a total of 754 people. The gender distribution is also reasonably balanced, with 359 males and 395 females. Interestingly, there is a slight numerical advantage for females in this location. Dharche-03 has a larger population of 1704 individuals, with a more pronounced gender imbalance. There are 773 males and 931 females. This location has a higher proportion of females compared to males.

In summary, the data highlights varying literacy rates among these regions, with notable differences between genders. Efforts to promote literacy and education, especially among females and those who can't read or write, could be essential in improving overall literacy levels in these areas. Additionally, further investigation may be needed to understand the reasons behind these disparities and to develop targeted interventions for literacy improvement.

Table 5-36: Population aged 5 years and above by Literacy status

Population aged 5 years and above by Literacy status					
Area and Sex	Total	Can read and write	Can read only	Can't read and write	Not Stated
Chumanubri Rural Municipality					
Total	5279	2067	85	3097	30
Male	2507	1228	45	1221	13
Female	2772	839	40	1876	17
Dharche Rural Municipality					
Total	12941	8094	107	4710	30
Male	6144	4364	46	1720	14
Female	6797	3730	61	2990	16
Chumanubri-03					
Total	2057	1084	6	967	0
Male	974	604	1	369	0
Female	1083	480	5	598	0
Dharche-01					
Total	754	413	11	328	2
Male	359	228	6	124	1
Female	395	185	5	204	1
Dharche-03					
Total	1704	963	8	726	7
Male	773	525	2	242	4
Female	931	438	6	484	3

Source: National statistics office, National Population and Housing Census 2021

In Chumanubri Rural Municipality, the total population in age group 5-25 years is 1541. This region has a roughly balanced gender distribution, with 738 males and 803 females for this age group. Educational participation varies significantly. Among the population, 782 individuals are currently attending school, indicating a relatively high attendance rate. On the other hand, 387 individuals have never attended school, which is a cause for concern. There are 345 individuals who have ever attended school but are not currently attending, suggesting that while many have access to education, there may be dropout rates or interruptions in schooling. The data does not provide specific reasons for non-attendance or dropout, so further investigation would be needed to address these issues and improve educational outcomes. Chumanubri-03 has a smaller population in this age group, with 739 individuals. Like Chumanubri Rural Municipality, the gender distribution is roughly balanced, with 350 males and 389 females. Educational participation is relatively high, with 480 individuals currently attending school. However, 95 individuals have never attended school, and 161 have attended in the past but are not currently attending. The gender balance is maintained in educational participation, with slightly more females attending school, but the differences are not drastic.

Dharche Rural Municipality has a substantial population in this age group, with 4822 individuals. There is a slightly higher representation of females (2458) compared to males (2364). Educational participation is relatively strong, with 3733 individuals currently attending school. However, 932 individuals have attended in the past but are not currently attending, and 134 have never attended school. The data shows a gender balance in attendance, with slightly more females currently attending school. This is a positive sign for gender equality in education. Dharche Rural Municipality appears to have a higher overall participation rate compared to the Chumanubri area, suggesting relatively better access to education. Dharche-01 has a smaller population in this age group, with 288 individuals. The gender balance here is maintained, with slightly more females (146) than males (142). The majority, 231 individuals, are currently attending school, while 44 have attended in the past but are not currently attending, and 11 have never attended school. The data suggests a reasonably high participation rate, and the gender balance in educational attendance is maintained. Given the smaller population size, it might be beneficial to assess the quality of education and the specific needs of this community to

ensure continued access to schooling. Dharche-03 has 641 individuals aged 5 to 25 years, with a fairly balanced gender distribution (302 males and 339 females). The majority, 494 individuals, are currently attending school, while 114 have attended in the past but are not currently attending, and 26 have never attended school. Similar to other areas, the data suggests that access to education is relatively good, and there is a gender balance in attendance. To further improve educational outcomes, it may be essential to understand the factors contributing to non-attendance and address any barriers to education.

Table 5-37: Population aged 5 to 25 years who have completed educational level below S.L.C./S.E.E.

Area	Sex	Total	Currently attending		Ever attended	Never attended	Attendance not stated
Chumanubri Rural Municipality	Total	1541	782	345	387	27	1541
	Male	738	387	184	156	11	738
	Female	803	395	161	231	16	803
Chumanubri-03	Total	739	480	161	95	3	739
	Male	350	241	73	35	1	350
	Female	389	239	88	60	2	389
Dharche Rural Municipality	Total	4822	3733	932	134	23	4822
	Male	2364	1847	464	43	10	2364
	Female	2458	1886	468	91	13	2458
Dharche-01	Total	288	231	44	11	2	288
	Male	142	121	17	3	1	142
	Female	146	110	27	8	1	146
Dharche-03	Total	641	494	114	26	7	641
	Male	302	241	49	8	4	302
	Female	339	253	65	18	3	339

Source: National statistics office, National Population and Housing Census 2021

5.3.10 Public Health

The district has 2 government run hospitals, 3 primary health posts, 66 health posts, 240 village clinics and more than 621-woman health workers. Besides, there are also district herbal centers, herbal pharmacy, and private herbal company in the district. The details of the health institutions are shown in the following table:

Table 5-38: Health institutions of the Gorkha District

Type of Health Institution	Counts	Type of Health Institution	Counts
Government Hospital	2	NGOs-Working in Health area	9
Primary Health Center	3	Woman Health Workers	621
Health Post	66	Urban Health Service	7
Village Clinic	240	H.I.V test and Treatment Center	4
Immune Clinic	258	ART Service	1
DOTs Microscopy Center	6	Village Community Service	5
DOTs Treatment Center	71	Health Institution	5
Leprosy Treatment Center	71	Private Hospital	4

Source: District profile of Gorkha 2074

5.3.11 Sanitation and Hygiene

Chumanubri Rural Municipality has a total of 2068 households. The dominant type of toilet facility used here is pit toilets, with 786 households using them. Flush toilets with septic tanks come next at 665 households. Flush toilets connected to public sewerage are used by 214 households, and 122 households rely on public toilets. However, a significant concern arises from the fact that 281 households, approximately 13.6% of the total, do not have any toilet facilities. This indicates a substantial sanitation gap in this area. Chumanubri-03, with 709

households, also primarily uses pit toilets, with 285 households opting for this type of sanitation. Flush toilets with septic tanks are used by 151 households, followed by flush toilets connected to public sewerage used by 156 households. Public toilets serve 93 households. In this area, 24 households (approximately 3.4% of the total) lack any toilet facilities, which is a relatively small but still concerning proportion.

Dharche Rural Municipality stands out with a larger number of households, totaling 3808. Here, the dominant choice is flush toilets with septic tanks, used by a substantial 2482 households. Flush toilets connected to public sewerage are preferred by 354 households, while 783 households have pit toilets. Public toilets are used by 85 households. A notable issue is that 104 households (approximately 2.7% of the total) in Dharche Rural Municipality are without any toilet facilities. This underscores the importance of addressing this sanitation gap. Dharche-01, with 234 households, has a higher proportion of households using pit toilets (140 households). Flush toilets connected to public sewerage are used by 55 households, and flush toilets with septic tanks serve 19 households. Only one household relies on public toilets. A notable concern is that 19 households (approximately 8.1% of the total) in Dharche-01 lack any toilet facilities, indicating a significant sanitation challenge in this area. Dharche-03, with 527 households, shows variations in toilet facilities. Pit toilets are the most common choice, with 378 households using them. Flush toilets with septic tanks are used by 89 households, while flush toilets connected to public sewerage serve 44 households. There are no households using public toilets. Similar to other areas, the presence of 16 households (approximately 3% of the total) without any toilet facilities highlights the need for sanitation infrastructure improvements.

In summary, the sanitation data based on the National Population and Housing Census (NPHC) of 2021 highlights significant differences in toilet facility types across these areas. Pit toilets are a common choice, particularly in Chumanubri Rural Municipality and Dharche Rural Municipality. Flush toilets with septic tanks are prevalent in Dharche Rural Municipality. However, a concerning aspect is the presence of households without any toilet facilities in each area, emphasizing the need for sanitation initiatives to address these gaps and improve public health and hygiene conditions. The proportion of households without toilet facilities varies, with Dharche-01 having a relatively higher percentage.

Table 5-39: Number of households by type of toilet facility

Area	Total	Type of toilet used				Without toilet facility
		Flush toilet (public sewerage)	Flush toilet (septic tank)	Pit toilet	Public toilet	
Chumanubri Rural Municipality	2068	214	665	786	122	281
Chumanubri-03	709	156	151	285	93	24
Dharche Rural Municipality	3808	354	2482	783	85	104
Dharche-01	234	55	19	140	1	19
Dharche-03	527	44	89	378	0	16

Source: National statistics office, National Population and Housing Census 2021

5.3.12 Drinking Water Facilities

The main source of drinking water for most households in Chumanubri Rural Municipality is tap/piped water within premises, with 1,400 households relying on this source. Additionally, 457 households use tap/piped water located outside their premises. However, it's notable that none of the households in this area use tubewells/handpumps for drinking water, and only a small number (13) use covered wells/kuwas. The presence of spout water, river/stream, and jar/bottle sources indicates a diverse range of water sources in this region. Chumanubri-03 has 709 households, and the majority (576) have access to tap/piped water within their premises. Another 112 households use tap/piped water outside their premises, which is the second most common source. Interestingly, there are no households here relying on tubewells/handpumps, covered wells/kuwas, or uncovered

wells/kuwas for drinking water. The presence of spout water, river/stream, and jar/bottle sources suggests some reliance on alternative sources.

In Dharche Rural Municipality, tap/piped water within premises is the most common source for drinking water, with 1,539 households using it, closely followed by tap/piped water outside premises (1,824 households). Unlike Chumanubri, Dharche has a significant number of households (13) relying on uncovered wells/kuwas, and there is a substantial usage of spout water (423 households). This area also exhibits a more diverse range of water sources. Dharche-01 and Dharche-03 are subdivisions within Dharche Rural Municipality, with 234 and 527 households, respectively. In Dharche-01, tap/piped water within premises and tap/piped water outside premises are the primary sources, while in Dharche-03, the majority of households rely on tap/piped water within premises, with fewer using tap/piped water outside premises. Notably, none of the households in Dharche-01 or Dharche-03 use tubewells/handpumps, covered wells/kuwas, or other sources like spout water or river/stream for drinking water.

The availability of tap/piped water within premises and outside premises varies across the areas, with Chumanubri-03 and Dharche having higher proportions of households with this convenience compared to Chumanubri Rural Municipality. Tubewell and handpump usage for drinking water is virtually nonexistent in Chumanubri and Dharche Rural Municipality. In contrast, Dharche Rural Municipality has a larger proportion of households relying on tap water but also has some households using uncovered wells/kuwas.

In summary, while tap water is the primary source of drinking water across these areas, the data highlights variations in access and the presence of alternative water sources, with Chumanubri Rural Municipality and Dharche Rural Municipality exhibiting more diverse water supply options compared to their respective subdivisions, Chumanubri-03, Dharche-01, and Dharche-03.

Table 5-40: Number of households by main source of drinking water

Area	Total	Main source of drinking water								
		Tap/piped water (within premises)	Tap/piped water (outside premises)	Tubewell / handpump	Covered well/kuwa	Uncovered well/kuwa	Spout water	River /stream	Jar bottle	Others
Chumanubri Rural Municipality	2068	1400	457	0	13	46	113	32	2	5
Chumanubri -03	709	576	112	0	0	1	19	0	0	1
Dharche Rural Municipality	3808	1539	1824	0	2	13	423	1	0	6
Dharche-01	234	50	120	0	0	0	64	0	0	0
Dharche-03	527	308	219	0	0	0	0	0	0	0

Source: National statistics office, National Population and Housing Census 2021

5.3.13 Type of Foundation of Housing Units

Majority of households in Chumanubri Rural Municipality (1,858) have foundations made of mud-bonded bricks/stone, which is a traditional construction method. A smaller number of households (138) use cement-bonded bricks/stone, reflecting a transition toward more modern construction materials. Additionally, 30 households have foundations of reinforced cement concrete with pillars, indicating further modernization in construction techniques. There are also 39 households with wooden pillars as foundations, possibly indicating a mix of traditional and modern construction practices. Three households fall into the "Other" category, representing unique or less common foundation types. Ward 03 within Chumanubri Rural Municipality has 709 households, and the foundation types reflect a similar pattern as the overall Rural Municipality. Most households (526) have mud-bonded bricks/stone foundations, indicating a traditional construction style. There are 126 households with cement-bonded bricks/stone foundations, suggesting some transition toward more modern construction methods. The presence of 23 households with reinforced cement concrete foundations and 31 with wooden pillars demonstrates a mix of traditional and modern construction practices within this specific ward. Three households are categorized as "Other," indicating unique foundation types.

Dharche Rural Municipality is characterized by a larger population of 3,808 households, and the data shows a similar trend in foundation types. The majority of households (2,838) use mud-bonded bricks/stone for their foundations, indicating a reliance on traditional construction materials and methods. However, a significant number (822) have adopted cement-bonded bricks/stone foundations, signaling a shift toward modern construction techniques. Additionally, 88 households have foundations of reinforced cement concrete with pillars, further highlighting the modernization of housing construction. There are 57 households with wooden pillars as foundations, possibly reflecting a blend of traditional and modern practices. Three households are classified as Other. Ward 01 primarily consists of mud-bonded bricks/stone foundations, with 230 out of 234 households using this traditional construction method. In contrast, Ward 03 shows a more diverse foundation landscape, with 432 households using mud-bonded bricks/stone, 92 using cement-bonded bricks/stone, and 1 with a reinforced cement concrete foundation.

Table 5-41: Number of households by type of foundation of housing unit

Area	Total	Type of foundation				
		Mud bonded bricks/ stone	Cement bonded bricks/ stone	Reinforced Cement Concrete with pillars	Wooden pillars	Other
Chumanubri Rural Municipality	2068	1858	138	30	39	3
Chumanubri-Ward 03	709	526	126	23	31	3
Dharche Rural Municipality	3808	2838	822	88	57	3
Dharche- Ward 01	234	230	4	0	0	0
Dharche- Ward 03	527	432	92	1	2	0

Source: National statistics office, National Population and Housing Census 2021

5.3.14 Cooking Practices

In Chumanubri Rural Municipality, the data illustrates the diverse range of cooking fuels used. Traditional methods are predominant, with 1,866 households relying on wood/firewood for cooking. However, there is also a notable presence of modern cooking practices, with 185 households using liquefied petroleum gas (LPG). Other fuel sources like electricity, cow dung, bio gas, kerosene, and others are used by a relatively small number of households. This data indicates a mix of traditional and modern cooking methods within the Rural Municipality. Ward 03 within Chumanubri Rural Municipality exhibits a similar pattern in cooking fuel usage. Most households (562) still use wood/firewood for cooking, reflecting traditional practices. However, 145 households have adopted LPG, indicating a shift towards modern cooking methods. The presence of other fuel sources, including kerosene and other fuels, is limited in this ward.

Dharche Rural Municipality reflects a comparable trend in cooking fuel choices. The majority of households (3,548) rely on wood/firewood for cooking, signifying the continued prevalence of traditional cooking practices. LPG is used by 252 households, suggesting a transition towards modern cooking methods. While other fuel sources like electricity, kerosene, and others are available, their usage is relatively limited. Ward 01 predominantly uses wood/firewood (226 out of 234 households) for cooking, with only a few households using LPG. In contrast, Ward 03 within Dharche Rural Municipality exhibits a more diverse cooking fuel landscape, with 479 households using wood/firewood and 48 using LPG. These variations between wards highlight localized preferences and circumstances that influence cooking fuel choices.

In summary, the data portrays a dual reality in Chumanubri Rural Municipality and Dharche Rural Municipality, where traditional cooking methods, such as wood/firewood, coexist with modern practices like LPG usage. The presence of other fuel sources is relatively limited, indicating the dominance of these two fuel types. Ward-level variations suggest that local factors and preferences play a significant role in determining cooking fuel choices within specific areas. Understanding these patterns is essential for energy planning and sustainability efforts in these regions, taking into account the transition towards cleaner and more efficient cooking methods.

Table 5-42: Number of households by type of fuel usually used for cooking

Area	Total	Type of fuel usually used for cooking purposes in the project area
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		Wood/ firewood	Liquefied Petroleum gas	Electricity	Cow dung	Bio gas	Kerosene	Others
Chumanubri Rural Municipality	2068	1866	185	2	1	2	11	1
Chumanubri-Ward 03	709	562	145	0	0	1	0	1
Dharche Rural Municipality	3808	3548	252	1	0	0	5	2
Dharche-Ward 01	234	226	7	0	0	0	1	0
Dharche-Ward 03	527	479	48	0	0	0	0	0

Source: National statistics office, National Population and Housing Census 2021

5.3.15 Source of Lighting Energy

Chumanubri Rural Municipality, with a total of 2,068 households, demonstrates a variety of lighting sources. Electricity is the most common source of lighting, with 1,744 households relying on it. This indicates a significant level of electrification and access to modern energy sources in the region. Solar lighting is adopted by 306 households, showcasing a growing interest in sustainable and renewable energy solutions, which aligns with global efforts to reduce environmental impact. A small number of households use kerosene or bio gas (1 each), possibly reflecting less common or backup lighting options. Additionally, 16 households use other lighting sources, which could encompass a range of alternatives. Ward 03 within Chumanubri Rural Municipality, with 709 households, follows a similar pattern in lighting sources. The majority (640 households) rely on electricity, highlighting a strong presence of modern energy infrastructure. Solar lighting is used by 66 households, indicating a growing awareness of sustainable energy solutions within this ward. The use of kerosene or bio gas is negligible, with only 1 household using each of these sources. A small number (2) opt for other lighting sources, which could be due to specific needs or preferences.

Dharche Rural Municipality, with a larger population of 3,808 households, showcases a comparable trend in lighting sources. Electricity is the primary source, with 3,483 households using it for lighting. This indicates widespread access to electricity and reliance on modern lighting solutions. Solar lighting is adopted by 314 households, demonstrating a growing interest in renewable energy for lighting purposes. A very small number of households (1) use kerosene, while 10 households opt for other lighting sources, possibly reflecting unique requirements or circumstances. Comparing the wards within Dharche Rural Municipality, Ward 01 predominantly uses electricity (229 out of 234 households) for lighting, indicating a high level of electrification. Solar lighting is less common in this ward, with only 4 households using it. In contrast, Ward 03 within Dharche Rural Municipality displays a more diverse lighting landscape, with 450 households using electricity and 73 using solar lighting. A small number of households use kerosene or other sources, indicating varying lighting preferences and circumstances within specific areas.

In summary, the data suggests a transition towards modern and sustainable lighting sources, particularly electricity and solar lighting, in both Chumanubri Rural Municipality and Dharche Rural Municipality. The widespread usage of electricity highlights increased access to power infrastructure, while the adoption of solar lighting indicates a move towards cleaner and renewable energy solutions. Ward-level variations reflect localized preferences and circumstances that influence lighting choices.

Table 5-43: Number of households by usual source of lighting

Area	Total	Usual source of lighting by households in project affected area				
		Electricity	Solar	Kerosene	Bio gas	Others
Chumanubri Rural Municipality	2068	1744	306	1	1	16
Chumanubri-Ward 03	709	640	66	0	1	2

Dharche Rural Municipality	3808	3483	314	1	0	10
Dharche- Ward 01	234	229	4	0	0	1
Dharche- Ward 03	527	450	73	1	0	3

Source: National statistics office, National Population and Housing Census 2021

5.3.16 Religious and Cultural Sites

There are major 14 temples and 5 Gumba in Gorkha District. Among them Manakamana, Raniban, Bhimsen Mandir are the famous religious sites.

5.4 Project Affected Families

The pondage formed by the dam is expected to inundate some parts of the Salleri Village. Furthermore, the feasibility study has indicated necessity of relocating of the village as the pondage water can gradually erode the colluvial deposit on which the Salleri Village is settled, washing away the entire village in the long term. The relocation of Salleri Village can result in:

- A total of 24 HHs are present in Salleri Village, whose houses will have to be acquired permanently by the projects. Among these houses 21 HHs have concrete structures (Pakki) and the remaining 3 HHs have mud (kacchi) houses.
- Most of the Paki houses have toilets facilities whereas Kacchi houses do not have toilet facilities.
- Among these concrete houses 17 houses are of 1 storey, 6 houses of 2 storeys and 1 household is of 3 storeys.
- Among Pakki houses 5 are hotels with sophisticated infrastructures.
- Other infrastructures in the area are 5 sheds and 1 community building which is still under construction.

The land use analysis of revealed that a total of 6.26 ha of land consisting of 5.87 ha of cultivated land and 0.42 ha of built-up area will be inundated by the pondage in the Salleri Village. This is the minimum land area that has to be acquired. However, in order to determin actual land to be acquired, cadastral data has to be analysed. It has revealed that 14.64 ha of land have to be acquired that fall within 80 parcels. This difference occurred because of two reasons (a) the boundary of parcels of spread beyond the pandage boundary, and (b) the forest areas at the tip of the reservoir also are registered as parcel.

The proposed permanent camp near the Uiya Village is another structure over the ground that would require acquisition of private land. The land use analysis has shown that a total of 1.89 ha of land is required for the camp, out of which 1.18 ha is cultivated land, and 0.71 ha is forest. Furthermore, the cadastral analysis revealed that 15 parcels in the cultivated land and a portion of a parcel in private forest fall in the camp site. The proposed access road from the tailrace outlet to the permanent camp near the Uiya Village requires 3.83 ha of land, which falls in the 2 parcels of the private forest.

Table 5-44: Sampled households in project area by indigenous and caste group

Project area	Indigenous groups					Total
	Brahmin	Chhetri	Janajati			
			Tamang	Gurung	Ghale	
Inundation Area (Salleri- Chum nubri 3 Rural Municipality)	-	-	-	24	-	24
Direct impact areas (Jagat and Yaru bagar)	-	7	-	36	12	55

Source: Field Study, 2019

The Details about Project affected families, detailed land description of 24 project affected household at chum numbri rural municipality ward no. 3 and affected parcel details is kept in Annex.

CHAPTER 6. ALTERNATIVE ANALYSIS

In this chapter a brief comparison of the possible alternatives to the Project, and rationale for choices in Project design is described. The alternatives were evaluated to choose the best design and operational modes considering also the possible environmental and social impacts.

6.1 No-Project Alternative

Exclusively from environmental point of view, the no project alternative could be considered positive when compared to project implementation, since it would avoid creation of any of the adverse impacts associated with the project development. Under the “without project” scenario there will be no contribution to the national energy requirements. However, the potential social and socio-economic benefits to the nation would be foregone and the life quality would remain at a low level in the project area. The long term development plans for the country may be slowed down with this option. Reliable power supply and improved services are associated with it the project which are the fundamentals to achieve full benefits.

Nepal is rich in hydro resources, with the development potential of 83,000 megawatts (MW) and commercially exploitable hydropower generating potential of about 42,000 MW. Nepal suffers from a severe shortage of power. Most of the existing hydropower plants are of the run-of-the-river type where the electricity generation fluctuates and is highly seasonal.

The government recognizes that it must accelerate the development of its abundant hydropower potential as an important step forward in its efforts to reduce poverty and stimulate economic growth. Hydropower development provides clean energy to enhance economic and social development in the rural and urban areas, it enables Nepal to generate revenue from exports of excess energy to neighboring countries.

Electricity demand peaks during the dry season or the winter months, when generation from hydropower plants is at its lowest. On the other hand, generation is at its highest during the rainy season, when there is less demand. The project's target is basically to produce as much energy as possible during the dry season.

In fact, in Nepal, mainly run of river projects are developing, which tend to feed for power and energy, but during the wet season. During the dry season, however, the availability of energy and power remains well below the demand and limits the agricultural and industrial development, as well as the welfare of the population.

From an environmental point of view, the “without forest” scenario will not allow for the implementation of this project. The reservoir area, and some of areas proposed for construction and activity sites have a varying quantity of forests. The project proposes to create a ‘green belt’ of forest which will substantially increase the forest cover, habitats for wildlife, community/lease forest use areas, and catchment slope maintenance. Moreover, in this regard it is appropriate to consider:

A large capacity for hydroelectric production, particularly during the dry season, allows a considerable saving in the present deforestation trend and for the air pollution in urban areas, and allows improving the level of welfare, education and health in the country by ensuring the supply of energy and supporting industrialization and agriculture.

This again leads to the opportunity, in planning at country level, to have large accumulation reservoirs, especially by making the most of the sites where physical conditions exist to achieve them and where investments have already been made.

Accumulating potential energy in concentrated and favorable sites for reservoirs is an advantage, always in terms of general planning and environmental protection. Many reservoirs scattered throughout the territory constitute a multiplicity of points of impact and a difficulty in management and increase of overall installation cost.

The BGHEP has apparently been positioned as a favorable morphological and environmental condition, comparatively, to maximize the reservoir.

6.2 Without Forest Loss Alternative

The “without forest” scenario will not allow for the implementation of this project. The reservoir area, and some of areas proposed for construction and activity sites have a range of forest types with varying quality. The project proposes to create a ‘green belt’ of forest in the safeguard buffer zone which will substantially increase forest cover, habitats for wildlife, community/lease forest use areas, and catchment slope maintenance. These efforts are meant to enhance watershed integrity.

6.3 Construction Method Alternatives

Construction methodology will be based on intensive technologies of construction equipment and maximum utilization of local resources to the extent possible. This is to ensure lowest possible cost for project development and ensure quality in the works undertaken. Due priority will be given for the recruitment of local people which will minimize the requirement of temporary camp, reduce fuel wood and timber requirement, enhance local skill and economy and develop better relationship between the project and local people. The surface construction work will be scheduled in daylight and night construction will be limited to underground work. Controlled blasting will be practiced at all times while excavating the underground area to have a minimum vibration impact on the house structures located close to the tunnel alignment. This will minimize the impact on local topography, structural damages in nearby settlement. Drilling work site will be selected away from the settlement whereas movement of vehicle in suspicious areas will be controlled to minimize the likely damage. The implementation of the project will require sand and aggregate which will be used from the proposed quarry sites and crushing the excavated materials from tunnel.

6.4 Construction Material Alternatives

Physical resources are consumed for the construction of proposed project. The materials to be used are boulders (stones) for gabion and walls, gabion wires, masonry wall, brick or concrete block, aggregates for concreting. Other local resources will be quarry and burrow used from the area. Reinforcement bars and cement will also need to be transported from other places of the country or outside of country. Electro mechanical equipment’s need to be imported from overseas manufacturers. There are no other cost-effective alternatives for the above materials in construction works of the project. The construction is intended to be carried out by conventional method, whereas earthwork, construction of simple structure such as drains, gabion walls, bio-engineering works etc. will be carried out manually.

6.5 Construction schedule alternatives

The estimated project construction period is 4 years from the date of commencement of the work. The construction works are mainly of two types - surface construction works and underground construction works. The surface construction works is to be carried out only in dry season. But the underground structures such as desander, tunnel, surge tank, powerhouse and other structures can be constructed throughout the year irrespective of weather and climatic conditions. All the surface work will be scheduled in day light.

6.6 Technology and Operation Procedures

The power plant will be designed and built with the latest state-of-the-art technology. The construction will be based on highly mechanized construction methods, i.e. with the least possible work force. The plant will be operated as a Peak Run of the River (PROR) plant.

6.7 Non-Implementation of the Project

Evaluation of the Project’s technical, financial and environmental feasibility will be evaluated before final decision is taken to proceed to the construction phase. If the project is found not feasible, the alternative is to not implement the project.

CHAPTER 7. PREDICTION AND ASSESSMENT OF ENVIRONMENTAL IMPACT

This chapter identifies and assesses environmental impacts of the project. The impact matrix has been presented in this section in a schematic form elaborates the environmental impacts corresponding to the project actions of the construction and operation phases.

7.1 Physical Environmental Impacts

Land Use Change

Land use of the project area will be affected both by the construction as well as operation of the project. The project will require temporarily putting up some facilities, such as quarry site, borrowing pit, spoiling disposal sites, coffering dam etc., which will temporarily change the land use.

The intake structure is proposed in the Chum numbri RM – 3. Three main structures, namely (a) 2 coffer dams, (b) main dam, and (c) temporary camp site are proposed to be constructed.

Both of the coffer dams will be constructed in the river, which covers about 1 ha, about 0.4 ha will be go into sparsely vegetated forest land.

The temporary camp is proposed close to the Salleri Village on the cultivated land covering about 0.25 ha. This land is expected to be inundated by the pondage. Thus, this part of cultivated land will be lost permanently.

The main dam structure is proposed on the river, however, its flanks will occur rocky slope of the forest on both banks of the budhi Gandaki River. A total of 0.4 ha of forest is expected to be lost.

The pondage formed by the reservoir has an area of about 28 ha. Most of the pondage will occupy the river's sand and water portion, which is about 12.5 ha, about 9.5 ha of sparsely vegetated forests on both sides of the bank will be inundated by the pondage. Furthermore, about 5.5 ha of cultivated land, and 0.5 ha of built-up area will also be inundated.

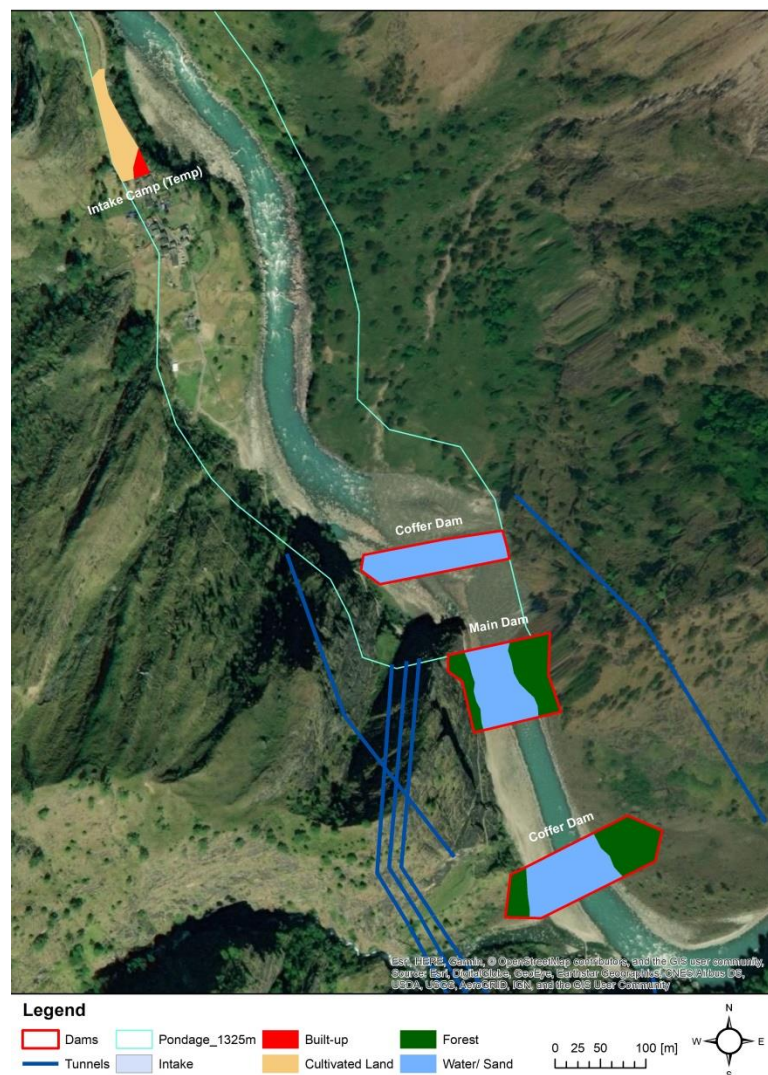


Figure 7-1: Landuse change in the intake

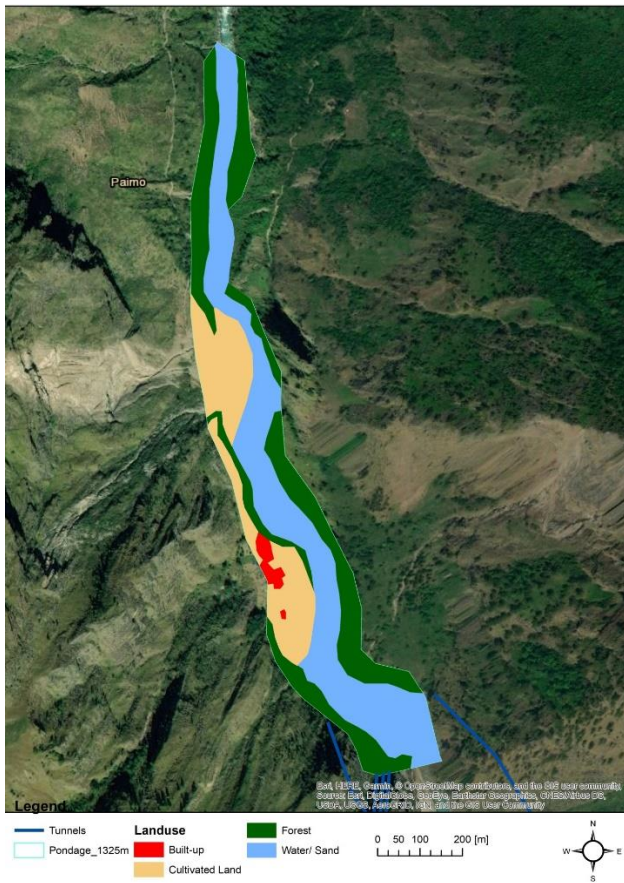


Figure 7-3: Land use impact of the pondage

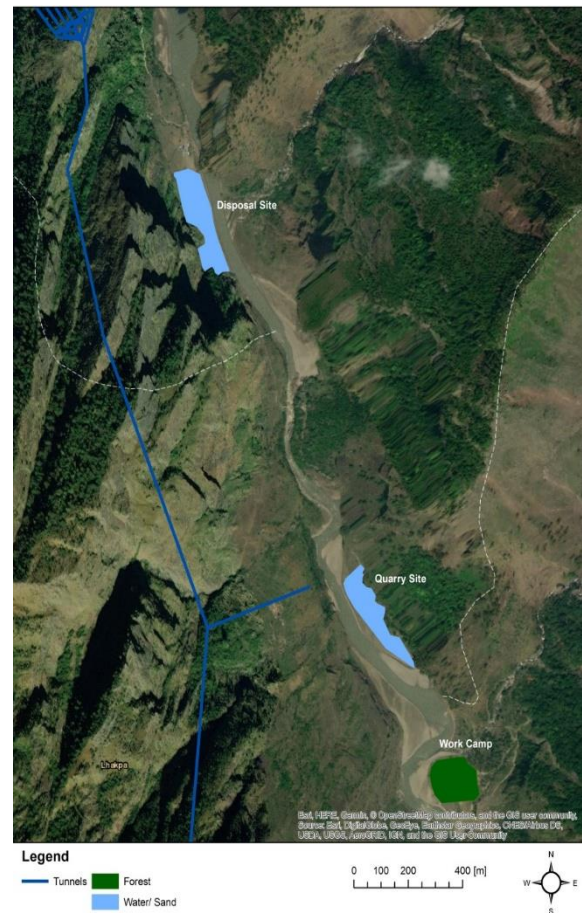


Figure 7-2: Land use impact at the Yaru Phat

The disposal site to dispose construction waste has been proposed on the left bank of the Budhi Gandaki River downstream to the Jagat Bagar, which covers about 2.8 ha of the sands/ water. It is located right outside of the Manaslu Conservation Area. A natural dam is located about 4 km downstream of the proposed dam as a result of a landslide. As a result of the damming, a large amount of sediment is accumulated in about 15 ha area of the wide valley of the Budhi Gandaki in the Yaru Phat of Dharche RM – 1. This sediment has been proposed to be used for construction, thus, a quarry has been proposed covering about 2.3 ha on the left bank of the Budhi Gandaki River. Furthermore, about a temporary work camp has been proposed on the terrace located on the right bank of the river in the Yaru Phat. About 2.2 ha of sparsely vegetated forest area has been proposed.

The tailrace area has three components that affect the land use of the area.

The work camp is located about a kilometer from east of Uiya village, Dharche RM – 1, on the right bank of the Budhi Gandaki River. It covers about 1.9 ha of area; out of 1.2 ha is in the cultivated land, and the remaining 0.8 is in the forest. An access road is proposed from the lower parts of the tailrace to access the structure located in the upper ridges. The proposed alignment is about 5 km in length. All of the road passes through forest land. Considering the formation width of 7 m, a total of 3.83 ha of forest land will be required for this road. A disposal site is proposed on the left bank of the river, which is located in Dharche RM -3. It is proposed on the forest land covering an approximate area of 2.3 ha.

Table 7-1: Summary of the Premenant land use change impact [ha]

A. Permanent Land

Project Component	Location	Municipality	Acquisition	Landuse Type (ha)						Total (ha)
				Forest (Ministry of Forests and Environment)	Water/Sand/Gravel/Boulders (Ministry of Forests and Environment)	Agriculture-Level Terrace Private	Shrubland/Grassland (Ministry of Forests and Environment)	Built up Pvt	Manaslu Conservation	
Headwork										
Pondage	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent	9.68	12.49	5.87		0.42		28.46
Main dam	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent	0.43	0.46					0.89
Headwork Camp	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent – inundated by pondage			0.25		0.03		0.28
Access Road										
Adit Site	Tatopani	Dharche-3 (Uiya)	Permanent	0.34	0.25		2.19			2.78
Intake	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent	0.61	0.13		1.24			1.98
Power House	Tatopani	Dharche-3 (Uiya)	Permanent						7.64	7.64
Disposal Area										
Disposal Area 1	Tatopani	Dharche-3 (Uiya)	Permanent		0.16		0.06			0.22
Disposal Area 2	Jagat	Chum Numbri - 3 (Sirdibas)	Permanent	0.11	1.44		1.16			2.71
Disposal Area 3	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent						2.08	2.08
Camp Site										

Camp Site 1	Tatopani	Dharche-3 (Uiya)	Permanent					0.29			0.29
Camp Site 3	Salleri	Chum Numbri - 3 (Sirdibas)	Permanent							2.29	2.29
Total				11.17	14.93	6.12	4.94	0.45	12.01	49.62	
B. Temporary Land											
Project Component	Location	Municipality	Acquisition	Landuse Type (ha)						Remarks (ha)	
				Forest (Ministry of Forests and Environment)	Water/Sand/Gravel/Boulders (Ministry of Forests and Environment)	Agriculture-Level Terrace Private	Shrubland/Grassland (Ministry of Forests and Environment)	Built up Pvt	Manaslu Conservation		
Headwork											
Coffer dam(s)	Salleri	Chum Numbri - 3 (Sirdibas)	Temporary	0.43	1.1						1.53
Quarry Site											
De-water Zone	Yaruphant	Dharche-1 (Kerauja)	Temporary		3.39						3.39
Camp Site											
Camp Site 2	Yaruphant	Dharche-1 (Kerauja)	Temporary							1.68	1.68
Total				0.43	4.49	0	0	0	1.68	6.6	

A total of 56.22 ha of land use change is expected from this project, out of which 49.62 ha will be of permanent nature, whereas 6.6 ha is temporary, which can be restored after completion of the construction phase. Considering the size of the project, *we have concluded that the impact to the land use is: Magnitude: Moderate, Extent – Local, Duration - Long term to Short term, and thus the significance is low.*

Hydrological and Sedimentation Impacts

Construction and Operation of the project will affect the hydrology and morphology of the Budhi Gandaki River. The construction of dam is proposed to be carried out by building 2 cofferdams; one upstream and second downstream of the main dam. The water blocked by the cofferdam will be diverted by two tunnels on the right bank. The material required for these construction works is proposed to be supplied by quarrying the sediments on the right bank, about 3 km downstream from the main dam. These activities are expected to change morphology of the river, however, these changes are expected to be localized because of the natural dam located about 1 km downstream from the quarry site. The natural dam is expected to buffer morphological changes in the river.

The constructions of the headworks, along with the operation of disposal sites, which are proposed on the banks of the river, are expected to increase sediment loads in the river. The river carries high load of sediments already, which will further cumulated, thus, significantly degrading the water quality.

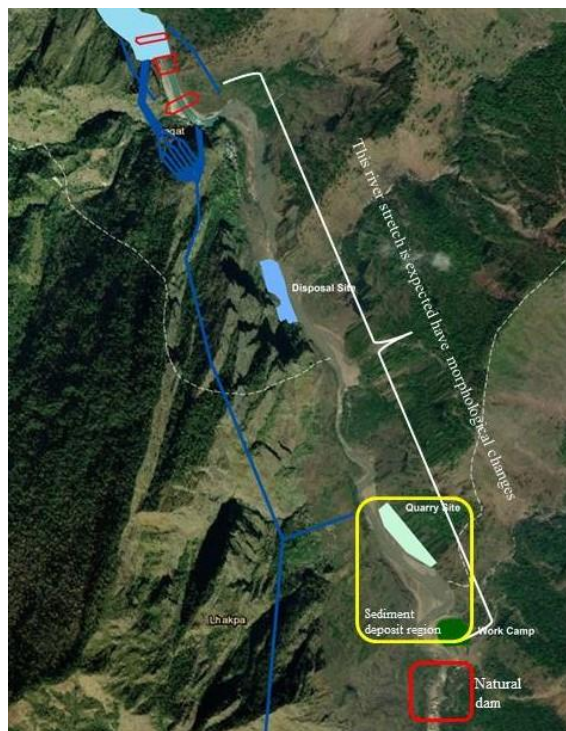


Figure 7-4: River stretch with morphological change

The operation of the dam is expected to change sediment transport and movements in the river. In the pondage area, sediments will start settling down, whereas, below the tailrace, sediment deposition is expected to be reduced significantly. In the low flow stretch of the river, because of the flow reduction, growth of vegetation along riverbanks may increase; as a result, from this the river course will be more stable, which can lead to a reduction of lateral erosion.

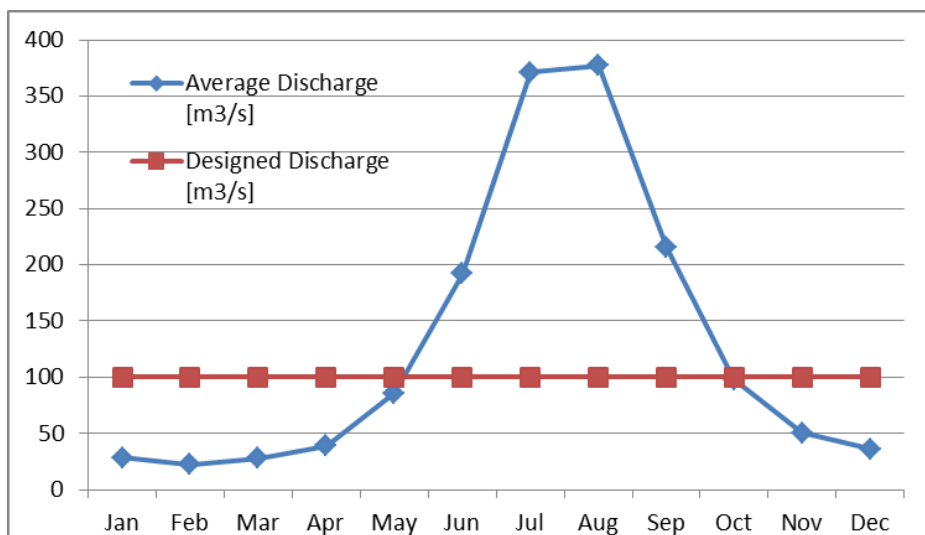


Figure 7-5: Comparison of average discharge of the Budhi Gandaki River at the intake against designed discharge [m³/s]

The most significant impact of the dam operation is due to diversion of water to the tunnel before it is released back to river from the tailrace. Firstly, a 2 km long pondage upstream from the dam will be formed changing the river hydrology into lake. Secondly, the river stretch between the dam and tailrace is about 9.5 km, which will have lower flow of water. Comparison of the average discharge of the river at the intake against design discharge reveals that the river has sufficient discharge only for four months between Jun and Sept. Thus, the peaking run-off model has been proposed for this project. The water is stored in the pondage for the months 8 months.

Considering minimum environmental discharge of 10% of minimum mean monthly discharge as suggested by the Hydropower Development Policy (2001), the Budhi Gandaki has lowest mean monthly discharge of 22.49 m³/s in the month of Feb; thus, 2.2m³/s has to be released from the dam. Furthermore, the Infrastructure Construction and Operation Working Procedure 2008 prepared by Department of National Parks and Wildlife Conservation (DNPWC) also suggests 10% discharge of minimum mean month discharge for the projects constructed on the border of the conservation area, and which has majority of the infrastructure outside of the conservation area. The project layout of BGHEP follows this condition, thus, 10% environmental flow has been proposed.

The 10% of the minimum discharge might not be sufficient to maintain surface water along the stretch of 9.5 km of reduced water zone (which falls outside of the Manaslu Conservation Area). However, there are five significant perennial snow-fed rivers which confluences with the Budhi Gandaki River in the reduced water zone. These rivers have significant discharge. We have estimated their discharge in the month of Feb, which is in average 3 – 5 m³/s. Thus we estimate, a total of 15 – 20 m³/s flowing in the stretch considering 2.2 contributions for the Budhi Gandaki River as environmental flow. *Thus, we expect the impact of reduced water flow to be of low magnitude; local is extent, however, long term in duration. This is of moderate in significance.*

Change in the Geomorphology of the Project

The project area is located within the tectonic domain of the Greater Crystalline Himalaya. The southern boundary of this domain, the Main Central thrust (MCT), lies at about 2 km south of the Powerhouse site.

The main lithological units represent are the following;

- The fine grain gneiss in the dam site area,
- The zone of HRT alignment where the augen gneiss shows a more abundant presence of augite (ferromagnesian pyroxene), and
- The garnet-kyanite schistose paragneiss with abundant mica content at the powerhouse site.

As a result of various surface processes of erosion and sediments' transport of the following quaternary deposit are represented at site:

Fluvial deposit represents the sediments found in the river bed, deposited and continuously transported and rearranged by the water following energy of the river. They are constituted of predominant rounded, medium to high sphericity, mainly gneiss clasts with a sandy soil matrix.

Alluvial deposit. These materials outcrop at the bottom of the valley floor to constitute morphological terraces slightly raised above the riverbed. They fill the entire Marsyangdi valley floor mainly forming

the plain formed upstream the natural dam. They are constituted well rounded, medium to high sphericity, heterometric clasts embedded on a silty sandy matrix.

Lacustrine Deposit. The fine sediment deposition in the lake upstream of Yaru Phat natural rock slide dam has found these deposits which are found mixed up with the alluvial ones. Their deposition occurred mainly due to low energy depositional environment created by the lake and they are constituted by fine particles as clay and, mostly, silt.

Colluvial deposit. These materials originate from the down slope movement by erosion and/or force of gravity. They are collected at the base of mountain or foothills, with little or no sorting. Over the project area, colluvial deposit have been observed along the right and left flanks of the Budhi Gandaki River valley.

A large amount of incoming sediments will be collected in the reservoir. Furthermore, the floods will carry the fine sediments all the way to the dam, which will be concentrated towards the bottom of the reservoir. Once the pondage is filled by the sediment, the project turns into Run-Of-River, losing its capacity to generate peaking electricity. The sediment accumulated in the pondage needs to be flushed out. These activities are expected to change the morphology of the pondage as well as the river downstream of the dam.

Furthermore, the river morphology is also expected to be affected by removal of cofferdams, which is necessary for commissioning of the project. Two cofferdams were proposed; one upstream and another downstream of the main dam. These cofferdams required to divert the river through the diversion tunnels to create a dry work area for the headwork construction. The removal of the cofferdams is expected to deposit sediment in the pondage area as well as in the Budhi Gandaki River, immediate downstream of the dam. Most of the materials used to construct the cofferdams will be extracted to be disposed off in the disposal sites, however, some amount will remain in the pondage and the river.

This impact is expected to be moderate of the magnitude, site specific in extent as it will occur around the pondage and dam site, and long term in duration. The significance of this impact is low.

Geological Risks

A brief geo-risk assessment has been made during detail feasibility study of the project. The present geological assessment of the project is indicating the probability of following geological risk; Dam foundation; possibility of liquefaction due to presence of thick fine layers below the dam in case of dam structure founded on alluvium deposit.

Stability of Yaru landslide dam body /rock slide debris deposit, natural spillway downstream of dam location

There is certain geological uncertainties/variation on the rock mass quality of headrace tunnel and powerhouse cavern area despite of good and favorable geological condition.

The unstable thick colluvial debris deposit at the toe of left hillside opposite to the powerhouse are might be problematic during construction, if further slide down; there is possibility of temporary blockade of the river. *These geological risks are considered to be high interms of magnitude, site specific in extent and long term in duration. The significance of these impacts is evaluated to be moderate.*

Erosion and slope instability

Erosion is expected to occur mainly from construction, mainly due to removal of protective ground cover and vegetation during land clearing. The project will involve construction of facilities and the potential for adverse impacts from erosion can be significant. Until the grounds are stabilized through natural or artificial means, increase in sedimentation yields is expected. However, if suitable mitigation measures are implemented, such erosion impacts due to construction could be significantly reduced and controlled.

In this section a brief description of the potential impacts caused by the main construction activities:

Earth Moving is a major activity associated with the dam and is required for building internal and external access roads, preparing sites for construction camps, dam foundation, opening quarries and for landscaping after completion of the dam site. Risks and potential impacts include increased sediment loads in drainage lines and release of chemical contaminants into water, and emissions of dust and noise.

Movement of Materials and Equipment to Site: Considerable movement of materials, such as cement, fuel, construction materials, construction waste, equipment and machinery, along roads to the dam site and within the construction area. Residents living alongside access roads may experience impacts from noise, vibration and dust pollution with reduced safety.

Quarry sites will be needed to provide rock fill for the dam, and as a source of aggregate for concrete and road surface materials. This involves removing of overburden, including topsoil which should be stockpiled for later use, blasting, rock crushing and sorting. Potential impacts on people and wildlife arise from the noise and vibration from hammers, blasting and dust.

Materials Storage will be required as some construction materials can be dangerous e.g. inflammable, toxic or explosive. Hazardous materials will need to be properly identified, stored and handled to minimize risks of accidents and environmental pollution.

Decommissioning of Construction Facilities on the completion of construction work is required. The construction facilities, quarries, stores, equipment and machinery, and worker camps will need to be safely and securely removed. Moreover the areas need to be stabilized to minimize risks of release of toxic or polluting materials to the environment. All disturbed sites which are no longer being used will need to be rehabilitated and re-vegetated.

Slope erosion due to pondage – The operation dam will form a pondage in the Budhi Gandaki River, which extends for about 2 km upstream from the dam site. The formation of pondage will elevate the water level up to 33 m from the river bed at the dam site, which means that the water will start eroding the slopes around the pondage. This process is serious particularly for the Salleri village. The feasibility study of this hydropower has indicated necessity of relocating of the village as the pondage water can gradually erode the colluvial deposit on which the Salleri Village is settled, washing away the entire village in the long term. *The erosion impact is expected to be of high magnitude, site specific in extent and long term in duration. The impact is expected to be of high significance.*

Air Quality

Impacts on air quality may be provoked by particles and fugitive dust from the construction activities, the emissions from on-road vehicles associated with the construction site and on-site machinery (off-road emissions). These activities can lead to potential impacts on the air quality at the project site, which can be limited through good construction management practices. There are many dust and emission sources in the construction sites that can release a range of particles, including dust (diameter up to 75 µm) and PM₁₀ (diameter of 10 microns or less) and PM_{2.5} (<2.5 µm in diameter). The dust particles can cause eye, nose and throat irritation, and lead to deposition on object surfaces, while the

PM₁₀ can have greater effect to human health, such as causing breathing and respiratory problems. PM₁₀ can be carried by wind to humans who live and work in the area surrounding and near the site. Emissions of particles and dust from construction activities can also affect indoor air quality in the neighboring areas and flora and fauna.

The expected settlements that are expected to be affected by the construction work are:

- headwork construction work is expected to have most significant degradation of air quality caused by the project, which is expected to affect Salleri Village, Jagat Village, and the settlement in the Jagat Bagar.
- operation of disposal site and quarry, downstream of the headworks, is expected to degrade air quality of Jagat Bagar and Yaru Phat.
- The construction of access to road to the powerhouse structures, permanent camp, and operation of disposal site is expected to affect Dobhan, Tatopani Village and Uiya Village. However, considering the terrain and distance, these will not have significant degradation of air quality.

The impact of the air pollution is expected to be of low magnitude, site specific in extent and short term in duration. The impact is expected to be of low significance.

Water Quality

During the construction phase, water quality and aquatic life are expected to be affected negatively. The construction activities in the road, dam area, disposal sites, quarry, etc. is going to release sediments into the river. Reduced primary production due to siltation of periphyton producing substrates, as well as due to reduced light penetration of the water column from increased turbidity might alter the quality of water. Moreover, the run off from crushed and ground rock material from the drilling, blasting and stone crushing plant as well as sanitary effluents from the construction worker's camps and housing areas can impact health of the people residing in the project area. Water quality of the project areas is also affected by oil and chemical spills along with the leaching of ammonia and nitrogen from the tunnel blasting and spoils rock deposits.

The workforce camp is proposed in the Yaru Phat, which is going to accommodate large number of workers. Disposal of human waste from the camp without treatment to the river will result in biological contamination of the river. Furthermore, the construction camps, quarry, and disposal sites will deploy heavy machinery and vehicles. The oil and petroleum material spillage might also end up in the rivers, degrading the water quality.

The impact of the air pollution is expected to be of low magnitude, local in extent and short term in duration. The impact is expected to be of low significance.

Water Right Issue

The use of river water in the project area was studied by walking along the bank of river. Also according to the survey, the existing water use age was also noted. The river water of Budhi Gandaki River is of minimal use to the inhabitants living downstream of the dam i.e. in the reduced water zone. People residing in areas such as Yarutar, Doban and Tatopani use water from other sources such as the tributaries of other rivers and water from other villages and are not dependent on the river water. The issue of water diversion for power generation and its implication on local water uses has been discussed during the consultation. This water in the Budhi Gandaki River is not used even for the purpose of fishing or for irrigation.

Noise and Vibration

Impacts due to noise and vibration are assessed for the project construction phase as the impacts during normal operation of the dam are expected to be negligible. These impacts are dependent on the sources of noise and vibration, distance, exposure time and differences between day/night times.

Impacts may occur throughout the construction phase. The Project will involve the use of many different types of equipment and activities that may cause noise impacts to the surrounding area include cutting and land excavation, and movement of equipment and materials for construction. Noise levels will be negligible for most of the community, located further than 10,000 feet (3,048 m) from the nearest construction site. The population living in the Jagat, Salleri, Yaruphat, Tatopani, Dobhan and Uiya will have to tolerate the noises and vibration coming from the project construction.

The impact of the air pollution is expected to be of low magnitude, site specific in extent and short term in duration. The impact is expected to be of low significance.

Impact of GLOF

The lakes identified at the upstream of the project are no longer addressed as threats by ICIMOD (2018), i.e. Birendra Tal has been removed as the potential dangerous glacial lake as there is no damming, erosional land feature, compact debris at downstream, in contact with retreating glacier and in case of glacier topple, there is only the possibility of overflow of splash water. So, no threat of GLOF is expected.

GHG emission

The energy generated from the hydropower project is considered to be relatively cleaner. In Nepali context, the other energy source to hydroelectric energy is fuelwood or petroleum, both of which are significant contributors of GHG. Thus, first of foremost, we have to recognize that hydroelectric energy will be largely beneficial in terms of GHG reduction. However, recently studies have indicated that hydropowers are not completely devoid of GHG emission. The primary source of GHG in hydropower is anaerobic decomposition of the biomass inundated under the reservoir. The commissioning of the hydropower means damming of the Budhi Gandaki River to create the pondage. The vegetative biomass inundated by the pondage will generate GHG gases. On the other hand, the pondage area will also act as a sink of the carbon to certain extent.

The proposed pondage area for the project is relatively small, thus, we have expected low magnitude of impact, transboundary extent and long term in duration. The impact is expected to be of low significance.

Table 7-2: Summary impact matrix on the physical environment at Construction and Operation Phase

Project Activity	Project Location	Potential Impact	Impact Qualifier			
			Magnitude	Extent	Duration	Importance
Topography and Land Use						
Permanent Acquisition of Project Structure, Activity areas and adit sites :	Inundation Area including Dam Structures – Gorkha district	Total land permanently acquired – 56.22 ha (49.62ha will be of permanent acquisition)	L (10)	L (20)	LT (20)	L
Dam and spillway: Ward 3, Chumnubri Rural Municipality						
Surge tank, Powerhouse – Dharche 3, 1 km upstream from Tatopani Settlement						
Temporary Use of land	Dam activities areas	Temporary land to be leased is 6.6 ha for temporary camps and activities areas	L (10)	L (20)	ST (20)	L
Erosion. Landslides and Slope stability						
Dam foundation and the Inundation and construction areas	Reservoir and Immediate catchment area	Likelihood of landslides	H (60)	SS (10)	LT (20)	M
		Erosion from agricultural and open forest land on the slopes				
		New roads (final alignment not complete)				
Hydrology and Sediment						
Change in Geomorphology of Water flow, operation of dam, general project activity.	Reservoir	Changes in water quality in reservoir and river	L (10)	L (20)	LT (20)	M
	Budhi Gandaki	Increase sediments due to erosion and landslides				
	River sections downstream the dam site	Water level fluctuations in Budhi Gandaki.				
		(Note for specific water quality and aquatic impacts in river and reservoir see section on biological environment)				
GLOF and Floods						
During all Phase of Project	Project area and immediate catchment in particular	Loss of life, settlements and agricultural and forest land	L (10)	R (60)	ST (5)	L
		Damage to dam and its machinery				
		Loss of infrastructure				
Noise and Air Quality						
Construction and operation activities	Dam site, activity areas with machinery, roads, tunnel and power station	Occupation hazards that cause damage to ears, eyes and accidents	M (20)	SS (10)	ST (5)	M
		(see section on Socio-economic and cultural Environment for specific site impacts)				

7.2 Biological Environment

The main impacts expected from the project on forest and vegetation are:

- loss of forest vegetation and forest fragmentation due to the site clearance for the project structures and facilities
- loss of plant diversity and forest products;
- loss of rare, endangered, vulnerable and protected species and relevant habitats
- increased access to forests of the project's surrounding area;
- increased demand for firewood and timber for the construction workers;
- loss of grazing land;
- loss of agro-diversity;
- forest fire hazards.

Loss of Forest Vegetation to Site Clearance

The project proposed to install majority of its structures underground, thus, relatively limited quantity of forest and vegetation are expected to be affected. Nonetheless for establishment of some of the project structures – intake and pondage, access road, camp sites, disposal sites, and portals for the tunnel adits are removal of vegetation will be necessary. In total about 49.65 ha of forest land (forest and shrubland/grassland together/ water bodies/ manaslu conservation area) will be cleared. About 1317 numbers of trees (tree and pole size) together will be felled from the forest and shrubland. The forest lands that needs to be removed falls under the following management system:

- community forestry (Please provide name of the community forest and user group details),
- conservation area community managed forest (also name of the CACM), and
- private forest.

A total of 275 trees are expected to be felled for construction of the project structures, of which 44 trees are in the Manaslu Conservation Area, and 231 are outside of the conservation area. Therefore, the total number of saplings required for the compensatory plantation is 3410, out of which 1100 saplings will be planted inside the MCA, and rest 2310 will be planted outside of the MCA. The impacts from the site clearance are seen both in environmental losses and also in associated changes affecting the ecosystem services and visual appearance. The detail losses are given in the Annex.

The impact of the forest loss is expected to be of low magnitude, site specific in extent and long term in duration. The impact is expected to be of moderate significance.

Forest Fragmentation

Due to the change in land use system from forest to man-made environmental changes such as built up structures, road construction, *etc.* some changes in the forest dynamics is expected including reduction in ecosystem services than to have a single forest block at various project construction sites. However, considering distribution and extent of forests in the project area, establishment of the project structures require only relatively smaller portion of it, and do not cause fragmentation. This scenario is depicted in the map presented below.

Thus, forest fragmentation expected from the project implementation is considered to be low in magnitude, local in extent but long term in duration. Since the project intake is located in the Manaslu Conservation Area; this impact is still considered as of high significance.

Loss of Non-Timber Forest Products

As discussed in the baseline chapter, the project impact area is rich in non-timber forest products (NTFPs), particularly, in medicinal and aromatic plants. These plants have high demand in the market with significant economic values. Furthermore, the field visit recorded their usage by the local

population. The removal of vegetation will also result in loss of these valuable plants, and also depriving the local community from the traditional use. *Thus, loss of NTFPs is considered to be moderate in magnitude, local in extent but long term in duration. Since the project intake is located in the Manaslu Conservation Area; this impact is still considered as of high significance.*

Loss of Biodiversity

The project area is distributed over the diverse habitat conditions which harbor considerable numbers of plant species. These species, however, are also distributed in other parts of the project districts. These species play important role in maintaining the local ecosystem. They are manifested as varieties of plants, popularly known as biodiversity at a given condition. Furthermore, the site also is rich in valuable plant species of medicinal, aromatic, ornamental, fiber bearing, religious, ethno-botanical, and ecological importances. The project activities, particularly, site clearance, are expected will result in removal of these valuable species. Most severe loss of biodiversity is expected to occur in the pondage area, access road, and disposal site. Two species of orchids (*Sunakhari*) and *Dioscorea deltoidea* (*Vyakur*) were recorded from these sites, which fall under CITES II. *The impact will be direct in nature, high in magnitude, site specific in extent and long term in duration.*

Impact on Protected Floral Diversity

project construction sites, especially the quarry site, access road, camp site, and its vicinity become more fragile due to construction activity. The reservoir area and the surroundings of power house, are partly fragile and landslide prone localities and the inundation activity adversely affects the habitat of the floral and faunal species including rare, endangered, vulnerable and protected plants. Only two species of orchids (*Sunakhari*) and *Dioscorea deltoidea* (*Vyakur*) have been recorded under CITES II in the project influence area.

Increased Demand for Firewood and Timber

A large number of work forces are expected to accumulate in the project area during the construction period, which will require consistent supply of energy for cooking and other domestic purposes. Though petroleum products including LPG gas are available, but in the higher cost and also consistently and/or reliably available. It is because the project area still not connected by motorable road. Thus, the obvious choice for energy might become the firewood increasing pressure on the local forests. Furthermore, the work forces might also harvest timber, which they also may need for construction of temporary huts and shade houses. Such requirements may also be applicable to local residents who live in the vicinity of the project sites. These activities lead to the pressure on the surrounding forest areas. This impact is expected to be indirect in nature, high in magnitude, local in extent but short term in duration.

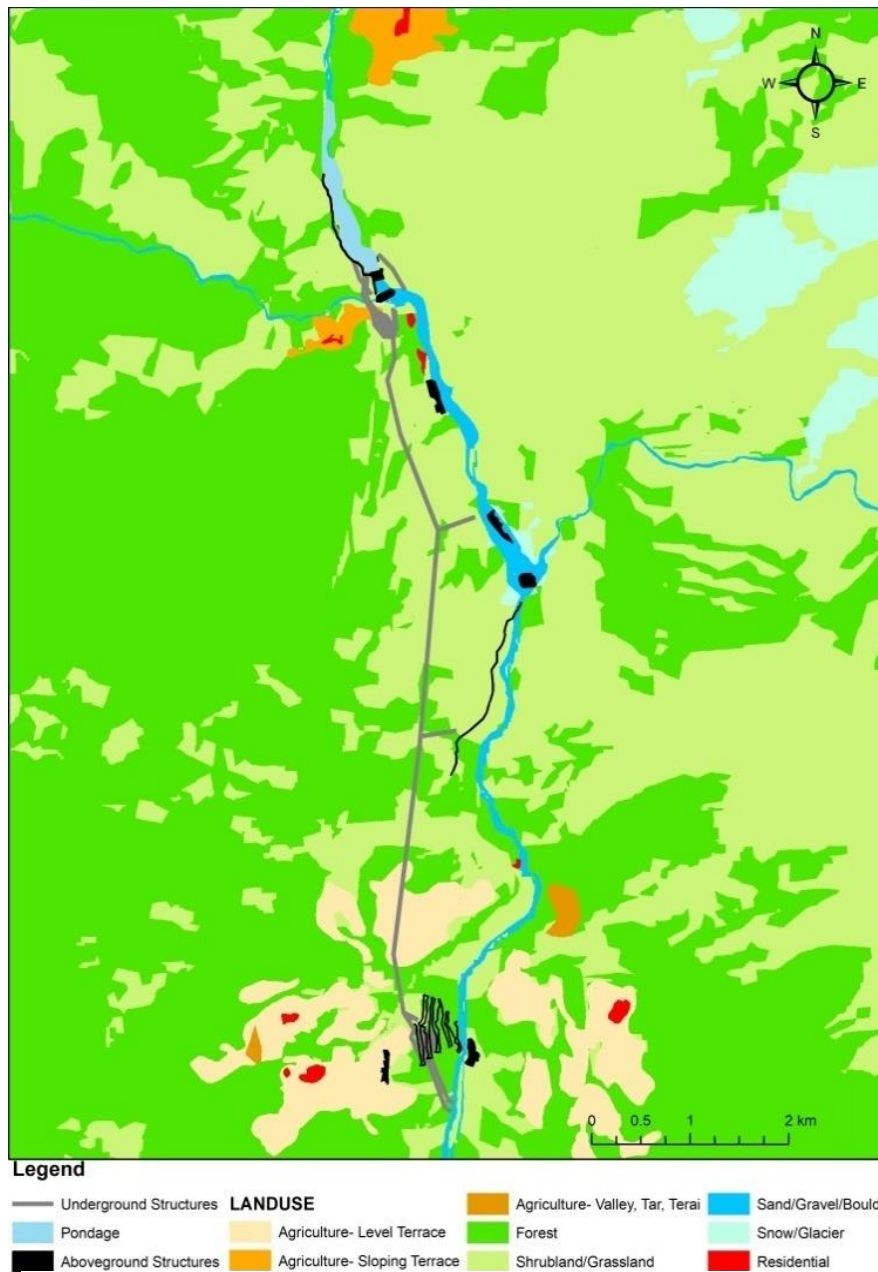


Figure 7-6: : Forest area affected by the project structures

Changes in Traditional Agro-Diversity Practices

The possible sites for the loss of agro-diversity are agri-fields (*Khet* and *Bari*) that need to be acquired by the project for the installation of project structures and facilities. However, we have to consider that only small portion of cultivated land will be affected directly by the project. Furthermore, similar type of cultivated land and practices are also carried out exists in the vicinity. The project activity triggers the loss of agro-diversity of and agricultural products that include varieties cereals, pulses, vegetables, fruit trees, fodder plants and other plant species cultivated under agro-farming practices. Furthermore, due to increasing development activities, there might be diminishing trend of cultivation of traditionally grown and resistant varieties and thus social paradigm can be shifted to grow new and improved varieties which adversely impact upon the availability of traditionally conserved genetic resource.

This impact is expected to be indirect in nature, low in magnitude, site specific in extent but short term in duration.

Forest Fire Hazard

The forest fire is frequent in Nepali forest, particularly, in the dry season. The project area has forest with dense undergrowth, which we expect to be prone to forest fire. During the construction period, the project area is expected to receive a large number of work force increasing human activities close to the forest, thus increasing the risk of accidental and sometimes deliberate forest fire. Furthermore, the project area is relatively remote with poor accessibility, emergency response to control forest fire is challenging. Therefore, we have concluded that forest fire is a potential impact that may be caused by the project implementation.

This impact is expected to be indirect in nature, low in magnitude, site specific in extent but short term in duration. This impact is considered of high significance.

Impact on Manaslu Conservation Area

Understanding the interaction of the project with the Manaslu Conservation Area (MCA) is an important part of this study. MCA was established in 1998 which is managed by Nepal Trust for Nature Conservation (NTNC). The intake and pondage area of the project falls within the territory of MCA, however, tunnel, powerhouse, and ancillary components fall outside of it. MCA is managed through Integrated Conservation and Development Programme (ICDP) approach that focuses on sustainable natural resources management. It prioritizes conservation without compromising socio-economic development. The project will design its activities by prioritize biodiversity conservation and accessibility to the natural resources for locals while implementing the project. However, the construction activities might result in disturbance such as - (a) clearance of vegetation in the intake sites for construction and (b) inundation of MCA forest area including a grazing land of Ghoral by pondage in operation phase. The project has to design a collaborative approach with MCA to minimize these impacts.

This impact is expected to be direct in nature, high in magnitude, site specific in extent but long term in duration. This impact is considered of high significance.

Increased Access to Forest

The project will construct access roads in the project area, which will ease accessibility to forested parts, which were inaccessible and/or were inconveniently accessible currently. This might have been protecting forests resources, which might not be the case post project implementation. However, we have to consider that currently road is being constructed in the project area by the government, which will create such scenario before the project implementation will start. This study is thus considering that the project can result in further acceleration in this process.

Thus, we are considering impact is expected to be of indirect nature, however of high in magnitude, site specific in extent but long term in duration. This impact is considered of high significance.

Table 7-3: Impact Matrix on Forest and Vegetation

Project Activities	Project Location	Project Impacts	Impact Qualifier			
			Magnitude	Extent	Duration	Significance
Construction Phase						
Felling of trees and clearing of vegetation for construction.	Dam, reservoir, access roads and construction sites, power house, surge tank, camp site, switch yard, tailrace	Loss of forest and riparian habitat	M (20)	L (20)	LT (20)	M
		Loss of plants of different protection categories	L (10)	L (20)	LT (20)	L
		Loss of ground vegetation with ecological importance	H (60)	L (20)	LT (20)	H
		Loss of NTFPs including plants with ethno-botanical and medicinal importance	H (60)	L (20)	LT (20)	H
		Possible invasion on alien species in the cleared areas	L (10)	L (20)	LT (20)	L
Construction activities - (presence of workers, operation of construction equipment and vehicles)	Dam, reservoir, access roads and construction sites, power house, surge tank, camp site, switch yard, tailrace	Possible extraction of timber for temporary camp construction	L (10)	L (20)	ST (5)	L
		Fire wood collection from nearby forest for cooking and heating	L (10)	L (20)	ST (5)	L
		Possibility of forest fire	L (10)	L (20)	ST (5)	L
		Conflict with forest users (including CFUGs) for use of forest products	M (20)	L (20)	ST (5)	M
Spoil disposal	Disposal sites, quarry site	Inhibition of regeneration of plants	M (20)	L (20)	ST (5)	L
Quarry operation	Quarry sites	Disturbance to vegetation in the adjoining areas due to increased soil erosion and land instability	M (20)	L (20)	ST (5)	M
		Degraded vegetation health due to dust pollution	M (20)	L (20)	ST (5)	M
Access road construction	Road development sites	Forest and habitat fragmentation	L (10)	L (20)	ST (5)	L
		Encroachment of forest	L (10)	L (20)	ST (5)	L
		Easy access to forests	M (20)	L (20)	LT (20)	L
Operation Phase						
Inundation of the forest area by the reservoir	Reservoir	Loss of forest area to reservoir	M (20)	SS (10)	LT (20)	M
		Riparian vegetation around the reservoir will benefit from availability of water from reservoir	L (10)	L (20)	LT (20)	L
		Sedimentation of the reservoir might promote growth of aquatic plant species reducing life of the reservoir.	L (10)	SS (10)	LT (20)	M
Presence of project operation staff and security personnel	Dam site, power house and project office	Increased pressure on forest due to collection of fire wood, NTFPs <i>etc.</i> by project staff and security personnel, which might result in conflict with the local forest user groups.	L (10)	L (20)	LT (20)	L
Increased vehicular traffic	Power house and head works sites	Access to forest for locals as well as outsiders will increase resulting in collection of forest and non-forest products	L (10)	L (20)	LT (20)	L

7.3 Terrestrial Ecological Resources

Degradation of Wildlife Habitat

Most of the structures of the project are underground. Only some of the structures like access roads, disposal site, quarry, camps, dam and portal of the adit sites are above ground. A total of about 20 ha of vegetation are expected to be cleared. The map below shows the distribution of forested area in the project area. The above ground structures occupy small part of the forested area, and most importantly these do not fragment the continuity of the forested habitat in the larger picture.

At the microlevel, however, we can consider that the access road that passes through the forested area, might disrupts the forest area. Furthermore the pondage inundates a forested area on opposite bank of the Selleri Village, which is considered as the grazing ground of Ghoral. Since the most of the project structures are outside the vegetated area and plenty of forested area is still present, the species are expected to continue living in the project area. The area of habitat loss is inhabited mostly by common wildlife species which are less sensitive to such change. Major Mammal species recorded in this area include Orange-bellied Himalayan squirrel, Malayan porcupine, Small Indian mongoose, Rhesus macaque, Yellow-throated marten and Golden jackal. No threatened faunal species utilize the area of habitat loss for breeding purposes. Moreover, no unique ecosystem was identified and the area of habitat loss holds no significance for the survival of threatened or endemic or restricted range species.

Clearance of vegetation does not significantly fragment the existing wildlife habitat (though minor scale by access road for powerhouse area). Some wild animals which are forced to live nearby forested area due to loss and degradation of habitat will return after habitat rehabilitation. *Therefore, the magnitude of impact is considered as medium, local extent, and short-term in duration. Since these project area borders with the Manaslu Conservation Area, we are considering this impact to be significant one.*

Disturbance to Wildlife and their Movement

The project activities that may disturb wildlife include road construction, blasting, river diversion, vehicular movements, crusher plant operation, quarry operation, dumping of excavated materials, batching plant operation *etc.* These activities generate noise, vibration or utilize light which will frighten or disturb movement of wild animals or degrade their natural habitats. Wild animals sensitive to such change move to safer habitat or adopt in the disturbed environment. Some animals scared of the noisy construction and move only at nights or use the adjacent contiguous habitat for refuge. Disturbance due to construction related activities will lead to a localized reduction in food and shelter for mammals, birds and herpeto-fauna.

Inadequate management and disposal of waste from the construction site & camping locations and spillage of fuels or chemicals can lead to deterioration of soil and habitat quality with consequent negative impacts on the flora and fauna.

Road was under the construction at powerhouse area along the right bank of the Budigandaki river. Noise & vibration (generated during blasting), vehicular movements and anthropogenic disturbances already exist in the area. As a result of these, the impact area is mostly inhabited by common wildlife species which are less sensitive to such change. The impact area holds no significance for the survival of threatened, endemic or restricted range species.

The magnitude of impact is considered as low, local extent, and short-term in duration. Since these project area borders with the Manaslu Conservation Area, we are considering this impact to be significant one.

Hunting and Poaching of Wildlife

Construction of road provides easy access for construction workers, staff and local residents to the wildlife habitat. Hunting and poaching of wild animals by these people may lead to decrease in the population of wild animals having special food and medicinal value such as Malayan porcupine, Barking deer, Common goral, and Kalij *etc.*

The magnitude of impact is considered as low, local extent, and short-term in duration. Since these project area borders with the Manaslu Conservation Area, we are considering this impact to be significant one.

Disturbance to Wildlife due to Project Operation Activities

The operation of the hydropower plant and associated activities during operation will result in some disturbances to wild species. These disturbances include noise and light. The lighting that required for operation and safety at the project can influence nocturnal foraging behaviors as well as disrupt sleep patterns of crepuscular and nocturnal species. Inadequate management and disposal of solid waste from the camping locations can lead to deterioration of soil and habitat quality with consequent negative impacts on the flora and fauna.

The magnitude of impact is considered as low, site-specific extent, and long-term in duration. Since these project area borders with the Manaslu Conservation Area, we are considering this impact to be significant one.

7.4 Aquatic Ecological Resources

Obstruction to the Fish Movement

Construction of the dam will be carried out by setting up the coffer dams, one upstream and second below of the proposed damsite, and the discharge is channeled through two diversion tunnels on the left bank. We expect this diversion will obstruct the fish movements. Out of two mid distance migratory fish species found in the river; *Schizothorachthys progastus* and *Schizothorax richardsonii*; the *Schizothorax richardsonii* has been reported from the dam area and downstream, thus its movement is expected to be obstructed. However, we have to consider presence of the natural dam about 3 km downstream from the proposed dam site, which is already obstructing the fish movement. We, thus, are hypothesizing that the population of *Schizothorax richardsonii* found upstream of natural dam is a local population. Furthermore, obstruction caused by the dam is only for about 3 km.

Thus, we have evaluated this impact to be low in magnitude, local is extent, and short-term in nature. Though it considered short-term, however, the dam will create similar impact during the operational phase, thus, we expect to have cumulative impact on this species population. The impact on the population, despite of being cumulative, is expected to be of low significance.

Degradation on Aquatic Habitat

Some of the project structures are located near the river bank or within the river such as intake structures, quarry and spoil disposal sites, tailrace etc. Thus, we expect loss or degradation of riparian habitat at these locations. Riparian habitat is essential to prevent bank erosion and to maintain habitat for fishes and water quality by trapping chemicals &

sediments coming in from the slopes. So, habitat and water quality will be degraded to some extent. Furthermore, the construction activities particularly disposal of spoils and quarrying will result in release of silt and sediments into the river, degrading the water quality.

Effect of silts on fishes can be devastating as it can block their gills. Furthermore, silt may also get deposited in the spawning ground, changing its substratum from silty to muddy, which becomes unsuitable for fishes as well as other aquatic life in general. The incubating fishes in spawning bed can be suffocated if they are covered by fine sediment and the adult fish might also get suffocated due to fine sediments deposit on gills. Secondary production as macro-invertebrates can also be affected when it cannot find stable refugia or when their food source is reduced. In addition to sediments and silt, run off from the construction sites (especially tunnel works) which might contain hazardous substances and wastewater from the camp may also affect fishes and the aquatic life. This effect is expected to be observed in the river stretch starting from the dam site to tailrace, and also beyond the tailrace. The effect might reduce downstream as the dilution will gradually take place. *This impact is expected to be of high in significance, local in extent and short term in duration as we expect it to occur during construction period, and gradually settlement down. This impact, however, is considered to be of high significance as it can affect large stretch of river.*

Transition from Lotic to Lentic Conditions

In the pondage area, the river is converted into the lake. Such conversion is expected to affect population dynamics of the aquatic life. The aquatic species that requires riverine and riffle habitats, particularly the blunt-nosed snow trout, will be affected, as a result of which the population is expected to decline in the pondage area. However, species that favors lacustrine condition will be flourished.

The deep pondage is expected to have thermal stratification, with warmer waters near the surface (epilimnion) and cooler water at depth (hypolimnion). Deep water (hypolimnetic) outlet from dam produces colder water temperatures in the downstream river. Cold water discharged in the summer can slow metabolic process, growth rates and reduce productivity of fish and aquatic invertebrates (Oak Ridge National Laboratory et al., 2010). In addition, cold bottom water released from dam may be supersaturated with dissolved gases and toxic redox products such as hydrogen sulphide that often cause fish kills. Migration of fish needs synchronism between environmental cues such as water temperature, environmental temperature, day length, food production, etc. which will be disrupted.

Thermal stratification can also decrease the concentrations of dissolved oxygen in the bottom layer of the reservoir. The relatively stagnant bottom water is isolated from the processes of atmospheric diffusion and wind mixing that replenishes dissolved gases at the surface. Plant and animal respiration, bacterial decomposition of organic matter, and chemical oxidation can all act to progressively remove dissolved oxygen from bottom water. This situation may be further exacerbated by the input of high levels of oxygen-consuming organic materials that enter the reservoir from the watershed upstream.

Few agricultural lands and settlements are present near the bank of Budigandaki River. Nutrients from agricultural lands, sewage and sediments may accumulate in the reservoir causing eutrophication. In the depth of the pondage, under eutrophic condition, dissolved oxygen is greatly reduced at night by the respiring algae and by microorganisms that feed on the increasing mass of dead algae. When dissolved oxygen levels decline to hypoxic levels, fish and other aquatic animals may suffocate or even die. Eutrophication

reduces species diversity, alters species composition and dominance and deteriorates water quality and perceived aesthetic value of the water body.

The pondage area is expected to support fewer local fish species as a result of changes in the flow regime, temperature, turbidity, allochthonous nutrient input and availability of food resources. This may happen for the Budigandaki reservoir.

This impact is considered to be of moderate in magnitude, local in extent and long term in duration. This impact is considered to be significant, as it can affect the population of fishes upstream from the dam to below tailrace.

Stranding and Mortality of Fishes

Downstream from the tailrace, the flow will be at a minimum every day when the power is shut down, usually 12 hours during the night time. The 12 hours of operating the power plant, the flow will go from zero to 2.0 m³/sec at peak operation for 12 hours.

The kind of peak operations will affect fish growth, production (Floodmark et al. 2006), habitat use and benthic fauna composition and density (Moog, 1993). Decrease in water level may lead to stranding risk for aquatic organisms because they may not be able to perform a lateral shift fast enough with a rapidly sinking water level (Greimel et al., 2018). Stranding is further affected by mode of operation, higher the ramping rate, higher the stranding. Thus, mode of peak operation will be an important aspect when mitigating aquatic impacts downstream of the tailrace.

Furthermore, fish population from the pondage may be drawn into the intake tunnels, which are exposed to physical stresses (pressure changes, shear, turbulence, strike) as they pass through the turbine that may cause disorientation, physiological stress, injury, or mortality (Oak Ridge National Laboratory et al., 2010). Bottom feeders such as *Schizothorax* sp may be pulled in the intake and killed by the hydropower turbines (ADB, 2018).

And lastly, the tail-water attracts fishes and makes them easy to catch, thus increasing the fishing activities.

This impact is considered to be of moderate magnitude, local in extent, and long term in duration, and high in significance.

Migration Barriers and Loss of Connectivity

River connectivity will be affected by the dam. Loss of connectivity affects both ecosystem (function and community structure) and population dynamics (migration, dispersal) of aquatic life. Impact of dam is most marked in migratory fish species which require different environments for the main phases of their life cycle which are reproduction, production of juveniles, growth and sexual maturation (Larinier, 2001).

Baseline survey recorded two mid-distance migratory fish species. Out of these, only *Schizothorax richardsonii* migrate upstream and downstream of proposed dam; *Schizothoraichthys progastus* was not reported to ascend upstream of powerhouse. So, loss of connectivity will have major impact on *Schizothorax richardsonii*. The effect can lead to decrease in the population of *Schizothorax richardsonii*, its spawning grounds present in the Budigandaki River and its tributary or decrease in length and weight of the species. *This impact is expected to be of high magnitude, local in extent, and long term in duration, and of high significance.*

Loss of Spawning Ground

Spawning grounds of Blunt-nosed snow trout were observed at Yaru Khola during the survey. Based on consultations with local fishermen, it is revealed that Budigandaki River and its tributaries provide spawning habitat for the reported fish species. Obstruction of

dam and reduced flow downstream will degrade and destroy spawning habitat of these species.

Dams block the natural flow of water, reducing water discharge in the downstream. Flowing water is vital as it cleans interstitial spaces of pebbles, gravel, and boulders and prepares spawning substrate for fish. In the absence of that, sediments can fill the interstitial spaces of gravels and cobbles; greatly decreasing the spawning habitat for fish and aquatic life.

Dam acts as physical barrier that obstructs fish migration which is essential for fish to get suitable spawning ground. Spawning in unsuitable water decreases reproductive success, as hatching of egg may not occur as a result of low/high temperature or fish fry or fingerlings may die due to lack of food or attacked by predator.

In reservoirs, spawning beds of fishes may be inundated and lost. *Schizothorax* prefer fast-flowing water over a gravel bottom for spawning. In stagnant water, the eggs sink to the bottom and larvae cannot swim to the surface to survive (ADB, 2018).

Sudden flow increases from tunnel can result in the disruption of spawning activity and the displacement of young fish, and invertebrates, as well as loss of the spawning grounds downstream of tailrace. *This impact is expected to be of high magnitude, local in extent, and long term in duration, and of high significance.*

Reduced Fish Production

Animals inhabiting on riparian areas and depending on fish and other aquatic organisms were recorded from the Budigandaki river which include birds such as White-throated kingfisher, Crested kingfisher, Cattle egret, Indian pond heron, Blue whistling thrush, White-capped water redstart and Plumbeous water redstart; amphibians such as Beautiful stream frog, Sikkimese frog and reptile such as Mountain Keelback. Reduction in fish or other aquatic organism production will directly affect their population and population of other species at higher tropic levels.

Thus this impact is considered to low in magnitude, site specific in extent and long term in duration, however, its significance is considered to be low.

Fishing and local livelihood

The study has not recorded any communities or family completely depending on the fishing for livelihood. Only very few people living close to the river practice part time fishing.

Thus this impact is considered to low in magnitude, site specific in extent and long term in duration, however, its significance is considered to be low.

Table 7-4: Impact Matrix on Terrestrial Ecological Resources

Project Activities	Project Location	Project Impacts	Impact Qualifier			
			Magnitude	Extent	Duration	Significance
Construction Phase						
Degradation of Wildlife Habitat	Project Activity areas	Shrinkage of wildlife habitat	M (20)	L (20)	ST (5)	M
		Movement of wildlife to nearby forested area	M (20)	L (20)	ST	L
Impact of construction activities on wildlife - (presence of workers, operation of construction equipment and vehicles, construction wastes)	Project Activity areas	Frighten or disturbances on movement of wild animals.	L (10)	L (20)	ST (5)	L
		Degrade the habitat of wildlife	L (10)	L (20)	ST (5)	L
Hunting and poaching of wildlife by construction works	Dam site, power house and area between dam and powerhouse	May decrease in the population of Malayan Porcupine, Barking Deer, Common Goral, and Kalij etc.	L (10)	L (20)	ST (5)	L
Operation Phase						
Disturbance due to noise and light and waste from camp site	Headwork, powerhouse and camp site.	Impact on behavior of nocturnal wildlife.	L (10)	SS (10)	LT (20)	M
		Degradation of wildlife habitat.	L (10)	SS (10)	LT (20)	L
Hunting and poaching of wildlife by project staffs	Dam site, power house and area between dam and powerhouse	May decrease in the population of Malayan Porcupine, Barking Deer, Common Goral, and Kalij etc.	L (10)	L (20)	LT (20)	L

Table 7-5: Impact Matrix on Aquatic Ecological Resources

Project Activities	Project Location	Project Impacts	Impact Qualifier			
			Magnitude	Extent	Duration	Significance
Construction Phase						
Impact of river diversion on migratory species	Headwork area	Migration of fish <i>Schizothorax richardsonii</i> may be blocked leading to decrease in their population	L (10)	L (20)	ST (5)	L
		Construction workforce may practice fishing in the river diversion	L (10)	L (20)	ST (5)	L
Impact on aquatic life due to loss or riparian habitat and deposition of silt and waste into the river.	Dam, reservoir, construction sites, power house, surge tank, camp site, tailrace	Loss of habitat for riparian species/aquatic life	L (10)	L (20)	ST (5)	H
		Possible degradation of spawning ground by deposition of mud into it.	L (10)	L (20)	ST (5)	H
		Possible deposition of hazardous substances and wastewater into the river affecting aquatic life	L (10)	L (20)	ST (5)	H

Operation Phase																																		
Increased erosion due to peak operations and seasonal drawdown	Headwork downstream and of tailrace	Incubating fish species in spawning beds may suffocate if they are covered by fine sediment	L (10)	SS (10)	LT (20)	M																												
		Sediments may decrease primary productivity of river by reducing light penetration into the water.	L (10)	SS (10)	LT (20)	M																												
		Sedimentation of the reservoir might promote growth of aquatic plant species reducing life of the reservoir.	L (10)	SS (10)	LT (20)	L																												
Transition from lotic to lentic conditions	Reservoir area	Population of <i>Schizothorax richardsonii</i> that requires riffle habitat may decrease	M (20)	L (20)	LT (20)	M																												
<p>* LEGENDS</p> <table> <tr> <td><u>MAGNITUDE</u></td> <td><u>EXTENT</u></td> <td><u>DURATION</u></td> <td colspan="4"><u>SIGNIFICANCE</u></td> </tr> <tr> <td>H: High</td> <td>SS: Site Specific</td> <td>ST: Short Term</td> <td>L: Low</td> <td colspan="3"></td> </tr> <tr> <td>M: Medium</td> <td>L: Local</td> <td>LT: Long Term</td> <td>M: Moderate</td> <td colspan="3"></td> </tr> <tr> <td>L: Low</td> <td>R: Regional</td> <td></td> <td>H: High</td> <td colspan="3"></td> </tr> </table>							<u>MAGNITUDE</u>	<u>EXTENT</u>	<u>DURATION</u>	<u>SIGNIFICANCE</u>				H: High	SS: Site Specific	ST: Short Term	L: Low				M: Medium	L: Local	LT: Long Term	M: Moderate				L: Low	R: Regional		H: High			
<u>MAGNITUDE</u>	<u>EXTENT</u>	<u>DURATION</u>	<u>SIGNIFICANCE</u>																															
H: High	SS: Site Specific	ST: Short Term	L: Low																															
M: Medium	L: Local	LT: Long Term	M: Moderate																															
L: Low	R: Regional		H: High																															

7.5 Socio-economic Impacts

Acquisition of Households Assets and Land

One of the most significant impacts of this project is acquisition of land and properties, which can have affected some families of the project area. However, most of the project structures are underground, this project is expected to have minimal impact. The analysis has revealed that the following structures affects the assets of the local households:

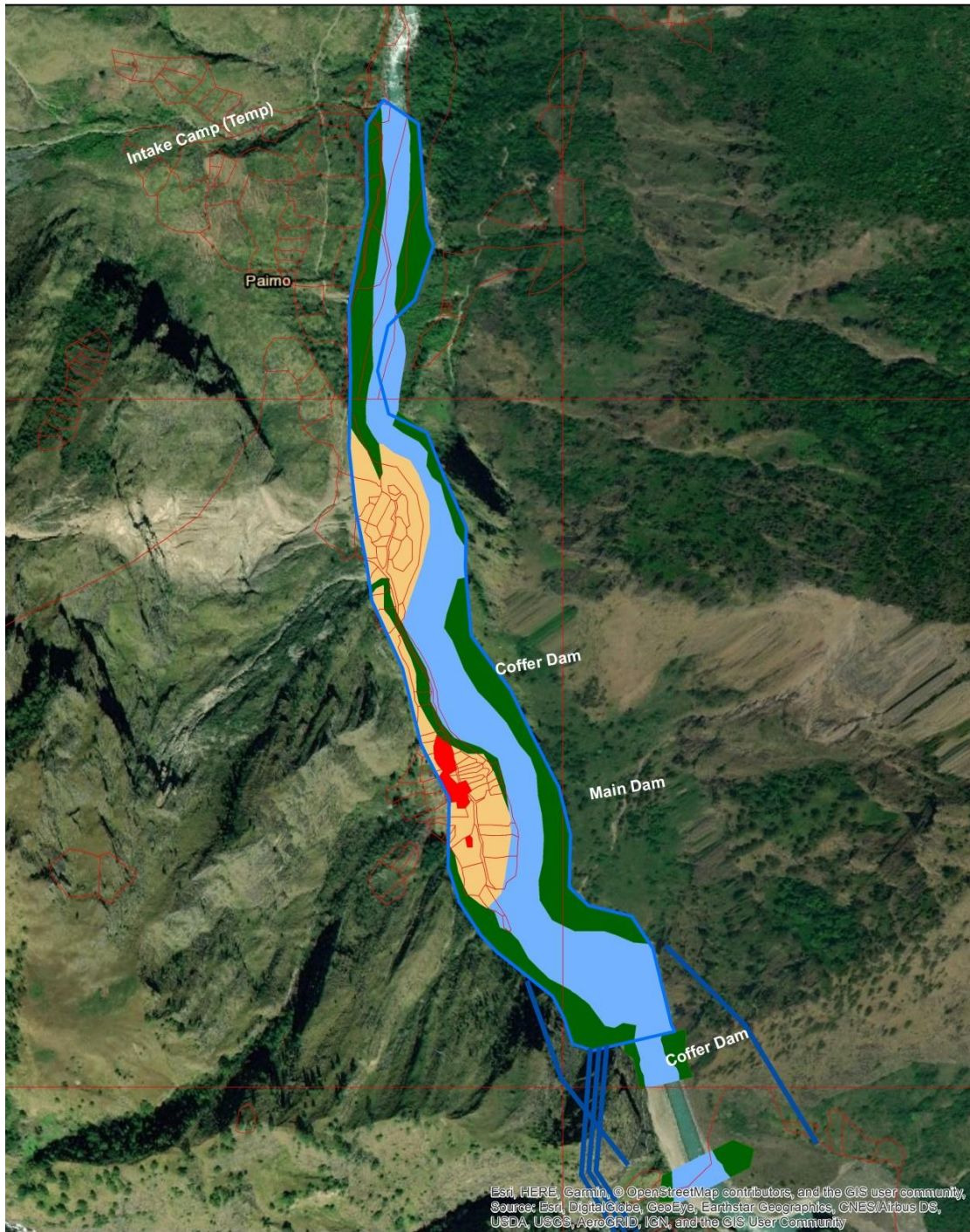
- intake structure particularly reservoir inundates houses and cultivated land of Salleri Village
- access road from tail race outlet to permanent camp site near Uiya Village requires land of the private forest.
- Permanent camp near Uiya Village require cultivated land

Pondage:

The pondage formed by the dam is expected to inundate some parts of the Salleri Village. Furthermore, the feasibility study has indicated necessity of relocating of the village as the pondage water can gradually erode the colluvial deposit on which the Salleri Village is settled, washing away the entire village in the long term. The relocation of Salleri Village can result in:

- A total of 24 HHs are present in Salleri Village, whose houses will have to be acquired permanently by the projects. Among these houses 21 HHs have concrete structures (*Pakki*) and the remaining 3 HHs have mud (*kacchi*) houses.
- Most of the Paki houses have toilets facilities whereas Kacchi houses do not have toilet facilities.
- Among these concrete houses 17 houses are of 1 storey, 6 houses of 2 storeys and 1 household is of 3 storeys.
- Among Pakki houses 5 are hotels with sophisticated infrastructures.
- Other infrastructures in the area are 5 sheds and 1 community building which is still under construction.

The land use analysis of revealed that a total of 6.26 ha of land consisting of 5.87 ha of cultivated land and 0.42 ha of built-up area will be inundated by the pondage in the Salleri Village. This is the minimum land area that has to be acquired. However, in order to determine actual land to be acquired, cadastral data has to be analysed. It has revealed that 14.64 ha of land have to be acquired that fall within 80 parcels. This difference occurred because of two reasons (a) the boundary of parcels of spread beyond the pondage boundary, and (b) the forest areas at the tip of the reservoir also are registered as parcel. This situation is shown in the map and the parcels that are affected by the pondage are presented in the table below.



Legend

- | | |
|--|---|
|  Tunnels |  Forest |
|  Pondage |  Water/ Sand |
|  Cadastral Boundary |  Intake |

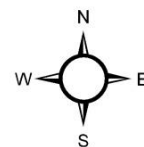
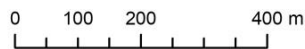


Figure 7-7: Affected landuse and cadastral boundary of the Salleri Village

Table 7-6: Affected parcels by the pondage in the Salleri Village

SN	PARCELKEY	PARCELNO	Area_Ha
1	09503500000078936004602	789	0.64255338642
2	0950350000007836004602	78	0.52029033030
3	09503500000077836004602	778	1.29534617022
4	09503500000077536004602	775	0.26205479883
5	09503500000077736004602	777	0.24264480750
6	09503500000075736004602	757	0.11431303854
7	09503500000075636004602	756	0.12627067052
8	09503500000077936004602	779	0.38000826842
9	09503500000079036004602	790	2.10701120658
10	09503900000007536004601	75	0.02408521119
11	09503900000007436004601	74	0.09804738829
12	09503900000007336004601	73	0.20497960381
13	09503900000007236004601	72	0.24725481059
14	09503900000004136004601	41	0.24338650910
15	09503900000004036004601	40	0.07817042146
16	09503900000003936004601	39	0.02471404463
17	09503900000003836004601	38	0.02421905153
18	095039000000027636004601	276	0.24066334305
19	09503900000004236004601	42	0.00844900767
20	09503900000004336004601	43	0.00225581880
21	09503900099999336004601	999993	0.00319993261
22	095039000000027736004601	277	0.00290897466
23	095039000000027436004601	274	0.00285450832
24	095039000000027536004601	275	0.00635326654
25	09503900000004636004601	46	0.04039131763
26	09503900000004836004601	48	0.09672825803
27	09503900000004936004601	49	0.04825125620
28	09503900000004736004601	47	0.10084674625
29	09503900000003236004601	32	0.18192883608
30	09503900000003136004601	31	0.16383020009
31	09503900000003036004601	30	0.12324878003
32	09503900000005036004601	50	0.09550371133
33	09503900000002936004601	29	0.12593035891
34	09503900000005436004601	54	0.02065290820
35	09503900000005336004601	53	0.01002353228
36	09503900000005236004601	52	0.01007269744
37	09503900000002836004601	28	0.12238924163
38	09503900000002736004601	27	0.06317512547
39	09503900000002636004601	26	0.17213456374
40	09503900000002536004601	25	0.06523263712
41	09503900000002436004601	24	0.22498586131

42	09503900000005136004601	51	0.00329542918
43	09503900000007136004601	71	0.26875859656
44	09503900000007036004601	70	0.25205458400
45	09503900000006936004601	69	0.13240589588
46	09503900000006836004601	68	0.33849124651
47	09503900000006636004601	66	0.04122890719
48	09503900000006536004601	65	0.02984485900
49	09503900000006736004601	67	0.06820572800
50	09503900000006336004601	63	0.04721354701
51	09503900000006236004601	62	0.04059429227
52	09503900000006136004601	61	0.05028190624
53	09503900000006036004601	60	0.02340899648
54	09503900000005936004601	59	0.03616994543
55	09503900000005836004601	58	0.03104742116
56	09503900000005736004601	57	0.03728197125
57	09503900000005636004601	56	0.04013397853
58	09503900000005536004601	55	0.03755051254
59	09503900000006436004601	64	0.05170926597
60	09503900000002336004601	23	0.26553956585
61	09503900000002236004601	22	0.03446509455
62	09503900000001936004601	19	0.70199277220
63	09503900000001836004601	18	0.15166461018
64	09503900000001636004601	16	0.07704205694
65	09503900000001536004601	15	0.09646617635
66	09503900000001036004601	10	0.12930885692
67	09503900000001736004601	17	0.05991404514
68	09503900000001436004601	14	0.02715361184
69	09503900000001136004601	11	0.04050778519
70	09503900000001236004601	12	0.06245648060
71	09503900000026636004601	266	0.19464907909
72	09503900000000736004601	7	0.01870765631
73	09503900000026736004601	267	0.05535001957
74	09503900000026936004601	269	0.12383066747
75	09503900000026836004601	268	0.06138260613
76	09503900000000636004601	6	0.89807321583
77	09503900000000536004601	5	0.92103739515
78	09503900000002136004601	21	0.13923804517
79	09503900000002036004601	20	0.13396760399
80	09503900000001336004601	13	0.35655989962

Permanent Camp

The proposed permanent camp near the Uiya Village is another structure over the ground that would require acquisition of private land. The land use analysis has shown that a total of 1.89 ha of land is required for the camp, out of which 1.18 ha is cultivated land, and 0.71 ha is forest. Furthermore, the cadastral analysis revealed that 15 parcels in the cultivated land and a portion of a parcel in private forest fall in the camp site.

Access Road

The proposed access road from the tailrace outlet to the permanent camp near the Uiya Village requires 3.83 ha of land, which falls in the 2 parcels of the private forest.

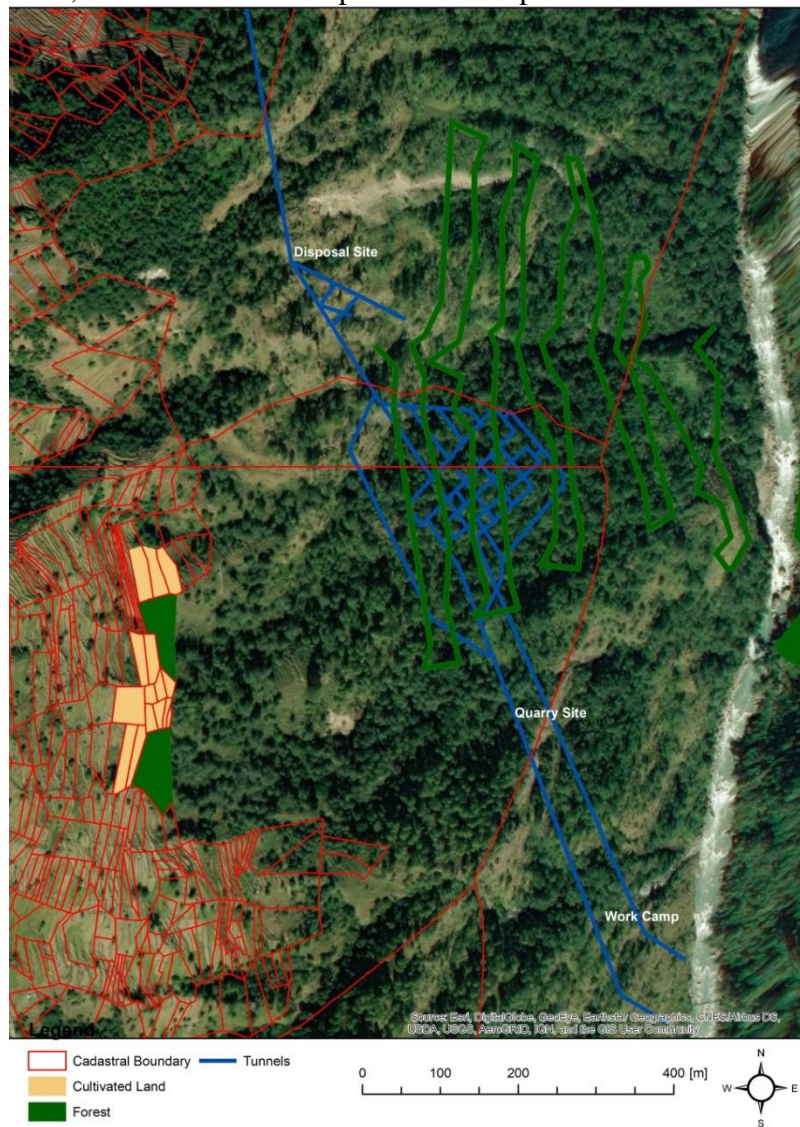


Figure 7-8: Cadastral map of campsite Uiya and access road

Table 7-7: Parcels affected by Uiya Campsite

SN	PARCELKEY	Land use
1	09506710000031536005407	Forest
2	09506710000017536005407	Cultivated land
3	09506710000017736005407	Cultivated land

4	09506710000017936005407	Cultivated land
5	09506710000018036005407	Cultivated land
6	09506710000017836005407	Cultivated land
7	09506710000011836005407	Cultivated land
8	09506710000011936005407	Cultivated land
9	09506710000012036005407	Cultivated land
10	09506710000016936005407	Cultivated land
11	09506710000017136005407	Cultivated land
12	09506710000017236005407	Cultivated land
13	09506710000016836005407	Cultivated land
14	09506710000017636005407	Cultivated land
15	09506710000017436005407	Cultivated land
16	09506710000017336005407	Cultivated land

Table 7-8: Parcels affected by the access road

SN	PARCELKEY	Land use
1	09506710000031536005407	Forest
2	09506310000002536005406	Forest

This impact is assessed to be moderate magnitude, local in extend and long term in duration. This is one of the major impacts of the project, thus, considered to have high significance.

Alteration or Disruption of Social Networks

The displacement of households from Salleri Village is going is expected to disrupt social network. In one hand the populations of Salleri has social and family ties with the settlements close to it, such as Jagat. Their disruption will result in physically distancing them, and ultimately breaking the social ties. This disruption might affect the older population more. *This impact is expected to be of low magnitude, site specific in extent and long term in duration. This impact is considered to be of low significance.*

Disruption of Foot Trail

The foot trail that passes through Jagat and Salleri is expected to be affected by the construction as well as operation of the proposed project. This trail, at this moment, is an essential part of the Manaslu Conservation trekking route as well as provides access for the locals to deliver goods and services. However, currently a motarable road is being constructed as the replacement of this trail, which is expected to minimize disruption for delivery of good and access, however, the trekking experience for tourist might be affected. *Thus, we have evaluated this impact to be of moderate magnitude, regional extent, and long-term duration. The overall significance of this impact is moderate.*



Figure 7-9: Foot trail connecting Jagat with Salleri at the proposed intake site

Pressure to local institutions, social services and community infrastructure

Increased demand for public services and institutions

Direct workforce engaged by the project construction as well as induced migration into the project area will have some impacts on local institutions, such as schools, health posts, police stations, water supply and sanitation, as well as on local government agencies. The area does not have adequate number of services and facilities such as hospital, school, market, *etc.* This will further increase the demand for public services and institutions which are expected to grow exponentially.

The existing schools, health post and police stations, and the local governments are minimally equipped in terms of human resources, physical facilities, and budgetary allocation in the project area. These resources are often inadequate to meet the demands for local population. There are minimal numbers of teachers in schools, health related personnel in health posts, and policemen for the police posts. The arrival of a significant number of workers and induced migrants with families may overload the existing current capacity of these services.

During the peak construction period it is expected that around 1600 to 2000 workforce will be working in the project area. Important shares of them are expected to come from nearby areas and there will be increased demand for accommodation in the adjoining villages. Concentration of population at one of few locations may cause several health-related problems. The case of Kaligandaki HEP can be mentioned as an illustration of this risk. In September 1997 during the peak period of construction, the project experienced an outbreak of Cholera, diarrhea, giardiasis, amebiasis, tuberculosis, hepatitis and meningitis because of the lack of latrines, safe water supplies, and general poor hygienic condition. This situation may arise when a large number of workers from outside the project area live in overcrowded housing facilities with poor sanitary conditions. *The magnitude of impact on the capacity of public services is considered to be high and of regional extent for a duration of short term (mainly during construction). The overall importance of this impact is considered as high.*

Loss or modification of existing service infrastructure

Public taps and water from streams are the major sources of water in the area. Drinking water is not usually treated. In the proposed inundation area community and households taps may be affected by

the project construction. The irrigation system might not be affected because most of farmlands in project affected area are located uphill. The impact of the project construction on the existing infrastructure can be predicted as *medium in magnitude, local extent, and long-term duration*. The overall importance of the impact is considered to be medium.

Increased traffic loads due to construction materials

During the construction phase of the project, heavy load transportation can be envisaged over the existing road network. Movement of heavy construction vehicles, machines, trucks, buses, cars for transporting construction materials will further create heavy traffic congestion. *The increase in traffic load due to construction activities can be predicted to cause medium impact to a regional extent but for short term duration. The overall importance of this impact is medium.*

Impact on Indigenous and Caste Group

Indigenous groups and caste groups to be affected by the project construction include Janajati such as Gurung, Ghale, Tamang and caste group (Karki) in the project areas. The majority of people among the 24 households in the inundated area are Gurungs. The direct impact area among other households which were sampled comprised of 36 Janajati with Gurung being the dominant and 7 households belonging to other caste group.

Table 7-9: Sampled households in project area by indigenous and caste group

Project area	Indigenous groups					Total
	Brahmin	Chhetri	Janajati			
			Tamang	Gurung	Ghale	
Inundation Area (Salleri- Chum nubri 3 Rural Municipality)	-	-	-	24	-	24
Direct impact areas (Jagat and Yaru bagar)	-	7	-	36	12	55

Source: Field Survey 2019

Loss of household assets among indigenous households

According to the information presented above, 24 Janajati households may lose their houses permanently in the inundation area. The project will affect their land, cultivation, livestock and other tourism activities. *Hence, the magnitude of impact is high with an extent of local/regional term for long term duration. Therefore, the overall importance of the impact is high.*

Disruption of social networks and social capital among indigenous households

Dislocation of the communities from their land, assets and social networks may have an adverse impact on the livelihoods of the people residing there. The project construction also brings a large number of workers from other areas into these communities which may create conflicts among their social relationships, cultural and traditional norms and values. These changes may be greatest in the vicinity of the main project components such as the dam, headwork and powerhouse. In addition, there could be the disruption of social networks (access to school, religious sites, social activities, users' groups, women's group etc.) which might have negative impacts. The people residing in the inundation area will be relocated which might create a huge impact at a regional extent affecting for a long term of duration. Therefore, the overall importance of the impact is high.

Loss of livelihoods due to loss or reduction in access to natural resources among indigenous groups

The construction of dam and other project structures may impact the access and availability of natural resources among the indigenous communities. The magnitude of the impact of BGHEP on livelihoods among indigenous communities is expected to be moderate while the extent is local/site specific and the duration is long term (permanent). The overall importance of this impact is thus, considered medium.

Impacts on Social and Cultural Characteristics

Cultural Disruption and Social Disorders

The construction of BGHEP requires a large number of workers particularly during the peak construction period. There may be a sudden increase in population in the project influence area. According to the feasibility study, the direct workforce requirement will be large with different degrees of skills during peak construction period. However, it is known from other experiences that an important number of induced migrants can also be expected to arrive to the project influence area looking for jobs or business opportunities. The majority of the workforce will be concentrated at the dam and powerhouse construction sites. The closest settlement nearby the dam site is: Salleri, Jagat. It is likely that workers from other districts and regions will be attracted to the skilled, semi-skilled and unskilled jobs. Induced migrants from different part of the country may arrive at the project influence area not only for direct employment but also for business and other purposes.

The incoming workforce from other regions may bring with them different socio-cultural backgrounds and may induce (negative and positive) impacts on the local traditional methods of social control and interaction.

Since there is a relatively high degree of unemployment in the project influence area, the local workforce will be very interested in being engaged in the construction of the HEP. However, due to the different skill levels required for the construction of the HEP not all the local supply of workforce may be engaged. This situation, if not managed appropriately, may lead to conflicts between local and external workforce.

The arrival of workers from other regions may have a number of effects on the local environment. They may include:

- greater demand for, and pressure on, social services and other facilities (health, education and water supply, etc.)
- increase in incidence of diseases (e.g., alcoholism, sexually transmitted diseases (STD), HIV-AIDS, and tuberculosis, etc.)
- conflicts between the incoming workforce and the local community, civil disturbances, and
- disturbances to social practices and fabric of the local community

These impacts will depend on the size, timing and composition of the incoming workforce. The larger the size of the incoming workforce the higher the risks for social disturbances. Furthermore, the capabilities of local institutions in the host communities will also determine the extent of the likely social disturbances.

The significance of the impact of BGHEP on cultural values and on security in local communities will have a moderate magnitude, regional extent and long term duration. The overall importance of this impact is considered to be high.

Impacts on Livelihoods and General Economic Condition

Alteration or loss of recreation areas and touristic sites

Tourist flow is likely to be reduced during the construction phase affecting the employment opportunities of local population engaged in tourism activities. The HEP may affect the route to Manaslu Conservation area which is one of the top tourist spots of Gorkha district. The magnitude of this impact is medium, the extent is regional, and the duration will be short-term (during construction). The overall importance of this impact can be classified as medium.

Alteration of cultural and religious sites

Tamang and Gurung community bury their deceased in the upper side of hills, whereas Hindus cremate their deceased in cremation sites along the riverside. The population in the project area belongs mostly to Christian religion and very few to Hindu and Buddhist. Temple, shrine and church in the project influenced area are used for worships and devotion rituals by local population. A church, a small temple and a Ghaat at Salleri will be disturbed by the construction as well as operation of the project.

Increased demand of housing and land

The construction of BGHEP requires a large number of workers particularly during the peak construction period. There may be a sudden increase in population in the project influence area. According to the feasibility study, the direct workforce requirement will be large with different degrees of skills during peak construction period. However, it is known from other experiences that an important number of induced migrants can also be expected to arrive to the project influence area looking for jobs or business opportunities resulting increased demand of housing and land.

Alteration in food and other commodity markets

The demand of daily necessities at the construction sites will increase drastically. Many people are involved in operating tea shop, retail shops, and hotels. These shops, hotels will definitely experience a growing demand of food and other basic commodities. In addition, the existing businesses, service providers and shops might not be able to cope with the increase demand, which will put pressure on the availability of basic commodity and eventually increased prices.

The magnitude of impact might be medium covering up to the regional level for a short duration of time lasting only during the peak period of project construction. Thus, the overall importance of this impact is considered medium.

Change in livelihoods due to loss/modification in accessibility to natural resources

Livestock holdings: Livestock is an integral part of the farming system in the project area. Almost all the households have cattle, buffalo, and goats. Each household comprises of more than one cattle and a buffalo. Goat holding is in majority in the project area. The number of livestock may be reduced due to lack of manpower in the households. Household members can find employment opportunity with the project construction. Indirectly, this can affect the agricultural production because due to

lack of animal manure. The impact of reduced labor supply for farm activities on the livestock holdings are expected to be minimal; with regional extent and over a short duration. *Hence, the overall importance of this impact is considered to be low.*

Competition for the access of natural resources

The construction of BGHEP requires large number of workers particularly during the peak construction period. There may be a sudden increase in population in the project influence area. People might have to compete to access drinking water and forest resources (such as timber, herbs, shrubs, fruits etc.). Collection increase of such natural resources might result in conflicts amongst project workers and locals. Moreover, chances of illegal hunting of wild animals might also increase. *Thus, the magnitude of this impact is considered medium and occurs at local extent, for short term duration. The overall importance of this impact is medium.*

Income from fishing activities

People living at the vicinity of Budhi Gandaki River earn by selling fish harvested from the river. The amount of cash earned might range from NRs. 1000 to Rs. 6,000 per month. Tamang, Ghale, Gurung are the indigenous group who practice fishing for a part time occupation. The magnitude of impact of the creation of reservoir on fish harvest will be low. This might be covered up to the regional extent and for a long-termed duration. *The overall importance of this impact on household's livelihoods is considered low.*

Income from collecting stone, gravel and sand

People residing at Machhi khola, (low flow area) collect stone and grind them to make gravel and sell it. Likewise, they collect sand for the construction of house and sell it to the contractors as a source of income. The magnitude of impact while constructing the reservoir on the income-earning activities of people utilizing stones and sand from river bed and river channel will be medium, with local/site specific extent and long-termed duration. The overall importance of this impact on households' livelihoods is considered medium.

Alteration of natural and touristic sites

Generation of spoils such as excavated materials from dam site and mucks from tunnel and their disposal to different sites may produce significant impacts on natural landscape of the project area. The visual impact of the construction activities might affect the scenic quality of the landscape. Moreover, construction activities might also cause disturbance in trekking and also degrade the natural aesthetic of the area reducing tourism attractions. Revenue from tourism industry might decrease creating a high impact on a local level. This might occur for a long duration creating a medium level of importance.

Impact on Local Business and Industries

Loss of income for local trade and industry

People residing near the project affected areas are engaged in tourism related business. The local people run guest houses, hotels and other tourism related activities. Construction of BGHEP (construction of intakes dam, construction related activities) may have adverse impact on the project

area due to the alteration of route to Manaslu conservation area which might change. Moreover, this might also obstruct the supply route to the market. This further pressurizes the nearest local market to meet increasing demand which might create a deficit of supplies. So, the magnitude of this impact is medium, of local extent, and for long term duration. The overall importance of this impact is considered to be medium.

Market boom due to increased number of workers

The project workforce, visiting people, establishment of teashops and restaurants, lodges, hotels, convenience shops demand for agro products, factory products and this will motivate people in business activities. The increased demand for goods and services generated by the construction of the HEP is one of the positive impacts of the project. The magnitude of this impact is medium, of local extent, and for long term duration. The overall importance of this impact is considered to be medium.

Loss of local business in inundation area

People residing in Salleri will lose their houses, hotels, cultivated land and livestock's. In short, they will not only lose their properties but also their long run businesses and sources of income. There are approximately four shops (tea and convenience shop) and 4 hotels to be affected which will cause profound effects on the people residing. The magnitude of this impact is considered to be low, of regional extent, and long term duration. The overall importance of this impact is high.

Loss of business activities

People residing at project affected areas have been engaged in tourism related business as there are no other significant big companies, industries, business institutions. Locals operate tea shop, convenience shops, guest houses, hotels. The construction of BGHEP (construction of intakes dam, construction related activities) may affect the existing foot trail stretch between Jagat and Salleri. This foot trail is a part of Manaslu Trekking Route and the primary access for the locals to deliver goods and services. It may reduce the tourist flow reducing employment opportunities from their hotels and lodges. Moreover, it obstructs the supply route of products to the market affecting their local business as well.

Alteration or loss of recreation areas and potential touristic sites

Tourist flow is likely to be reduced during the construction phase affecting the employment opportunities of local population engaged in tourism activities. The HEP may affect the route of Manaslu Conservation area which is one of the top tourist spots of Gorkha district. The magnitude of this impact is medium, the extent is regional, and the duration will be short-term (during construction). The overall importance of this impact can be classified as medium.

Alterations of landscape and visual impacts

The construction of dam, head works and other construction activities will degrade the natural aesthetics of the project area reducing its touristic appeal, especially at Salleri and Jagat of Chum nubri rural municipality. Generation of spoils such as excavated materials from the dam site and mucks from the tunnel and their disposal to different sites may produce significant impacts on natural landscape of the project area as well. The visual impact of the construction activities may affect the

scenic quality of the landscape. The magnitude of the visual impact will be medium, the extent will be local and the duration will be short term, assuming that mitigation measures will be in place to restore the affected areas. The overall importance of this impact is classified as low.

Inflation

The demands of daily necessities include food at the construction sites which will increase drastically. Most of the food items have to be brought from other markets. The price of food and other commodities will increase during construction phase, creating a crunch for the local people to pay higher price for daily necessities.

Boom in Demand for Agro Products

The project workforce, establishment of teashops and restaurants, lodges etc., will increase demand for agro-products such as milk, meat, eggs, vegetables, fruits, and cereal crops. This will motivate farmers to go for commercial agricultural farming using improved technology and production materials.

Impacts on Public Health, Water and Sanitation

Loss of health facilities

Implementation of the proposed Budhi Gandaki HEP will not incur significant loss of health facilities. There are no government hospitals, public health facilities, no clinics or medical shops in the reservoir area of the project. The people residing at Salleri have to go to Philim or Aarkhet for medical checkup and treatment.

Increased pressure in existing health facilities

During construction phase, large number of populations will be added in the area as labor force, their dependents and local traders or businessmen who carry out business activities for the project. The increased population will increase pressure in and around the existing health facilities of the project rural municipalities. Health workers, treatment facilities and medicines might not be sufficient in the existing population which will furthermore increase pressures. Health services to the existing community and increased population both may become inadequate and inefficient. The impact of increased pressure in existing health facilities is direct, moderate magnitude, regional extent and medium-term duration.

Increased pressure in existing drinking water sources

Population growth in the project area will create pressure on the natural resources including drinking water sources around the project area. At present, the drinking water status is good with majority of households equipped with piped drinking water which is sourced from the nearby forest source with year round availability. Increased population in the project area especially in the project construction sites, camps, offices and housing area will demand more drinking water eventually putting pressure on the existing drinking water sources.

Drinking water sources of settlements lying close to the major construction areas such as Tatopani, Salleri, and Jagat are more likely to face pressure from the demand of this increased population. Settlements around construction sites as well as project facility sites are likely to face pressure on drinking water as there will be added extra populations in the form of labors, project officers, outsider

businessmen and vendors along with their dependents. There is a likely emergence of conflict between the local communities and outside migrants. However, there is a possibility of supplying drinking water from the Budhi Gandaki River and its tributaries after some purification treatment for human consumption. Considering this fact, the impact is considered to be of low magnitude, for a short period of time and of local extent.

Diseases

Water borne diseases

Consumption of contaminated water leads to water borne, water washed, water based and water related diseases such as diarrhea, dysentery, cholera, typhoid, gastroenteritis, paratyphoid, jaundice, hepatitis, intestinal worms and other parasitic diseases. Based on the households and settlement survey results the water borne diseases such as diarrhea, intestinal worms, and typhoid have higher incidence in the project settlements. These diseases are communicable and there is likely occurrence of epidemics in the project area among the village community as well as the workers community. Water borne diseases are more likely to emerge during summer/rainy season. The risk of water borne diseases is considered to be of high magnitude, local and medium term.

Air Borne Diseases

Increased dust in the air will impair the health of people through increased incidence of Acute Respiratory Infections (ARI), wheezing, shortness of breath and dust allergies. Prolonged exposures to dust can cause in respiratory diseases like asthma and bronchitis. Air borne diseases are considered to be of moderate magnitude, local and for medium term.

Vector Borne Diseases

Solid waste especially organic wastes attract vectors like rats, fleas, mosquitoes, flies etc which transmit diseases such as typhoid fever, cholera, dysentery, gastroenteritis, conjunctivitis, and others. Vector borne diseases can spread over a wide area and affect larger mass of population creating pandemic situation. The community population, worker's community, camps and housing residents all are in risk to vector borne diseases. Vector borne diseases are considered to be of moderate magnitude, local and for medium term.

Increased incidence of STDs

Increased incidence of STDs as an impact has been illustrated by many EIAs of hydropower projects including Kaligandaki 'A' HEP, Middle Marsyangdi HEP, West Seti HEP etc. Developmental projects in any area are likely to cause the changes in social setting of the project area. Outsiders will immigrate into the project area: some as direct construction workers and others seeking economic opportunities. Particularly, the predominance of single men (workers) in the project area, as well as the availability of the disposable income will lead to increase in prostitution activities and unsafe sex practices which will lead to increased incidence of sexually transmitted diseases (STDs) such as Gonorrhea, Syphilis, and HIV etc.

Occupational Health and Safety

Occupational health and safety impacts are more likely to occur in major construction areas such as dam, tunnels, powerhouse, quarries and access roads. Occupational health risks can range from simple injuries influencing work performance and efficiency of workers to fatal accidents and illness leading to deaths. Construction activities like blasting, quarrying and excavation pose more risk to accidents causing cuts/wounds/injuries/fractures and to the worst-case death of workers. Injuries and deaths from vehicular accidents are also likely. Also, contacts and/or exposures to harmful chemicals and toxic fumes also pose threat to occupational health. Impacts on occupational health is direct and/or indirect, low, moderate or high in magnitude considering the fatality of the risk, site specific and short term or medium term or long term.

Likely Introduction of Alien Vector Species and Associated Health Impacts

During hauling of construction materials into the project area from outside, there is probability of transportation of alien vector species which could act as a carrier of diseases. Such a case occurred in the case of Kali Gandaki 'A' HEP in Syangja, Nepal. During the construction phase of the Kali Gandaki 'A' HEP, a new alien species of mollusca called, African Giant Land Snail, *Lissachatina fulica* was introduced to the project area. This species is very fast breeding and known to be carrier of infesting nematode known as Rat worm which can form cysts in the human brain and cause eosinophilic meningitis. Excessive accumulation of these parasites in human brain can also lead to death of the infected host. There is likely introduction of these snails infested with the infecting nematode in the project area through along with the transportation vehicles. This impact is indirect, low to moderate in magnitude, of regional extent, and for long term duration.

Psychosocial Impacts

The proposed Budhi Gandaki is likely to displace about 24 families from the reservoir area in Gorkha District. Involuntary displacements are, most of the time associated with psychological problems caused by a number of reasons. People have to leave their ancestral dwelling which is attached to their sentiments. Moreover, loss of livelihood and uncertainty to get secure livelihood in a new resettlement place may also create fear among the people for a secure future. Additionally, the established community associations, cultural values and norms will be disrupted when people are displaced and they fear if they will be able to cope in new surroundings.

Downstream Impacts

During the operation phase, the water will be diverted through the tunnel and released back to the river after generation of electricity in the powerhouse. This activity will create reduced water zone in the river stretch of Budhigandaki between dam and tailrace, whereas a sudden discharge increases in the stretch downstream of the tailrace.

The field survey has confirmed there are no water right issues in the reduced water zone as none of the water use from Budhi Gandaki River was recorded. The settlements were found to be using the water from the tributaries like Bhalu Khola, Yaru Khola, *etc.* Recreational fishing and/or fishing as supplement to diet or income have been recorded in this stretch, which will be compromised once the hydropower operation starts. The dam, on the other hand, is expected to control and/or prevent flood control.

The proposed project is a PROR, thus, we can expect sudden release of water from the tailrace. Casualty and injury can be expected amongst local residents unless they are informed about the schedule of hydropower operation.

Table 7-10: Summary of the Socio-Economic Impacts

Project area	Project activities	Project impact	Impact Qualifier			
			Magnitude	Extent	Duration	Importance
Impact on household assets						
Salleri Village Chum Numbri 3	Creation of reservoir	Loss of residential housing and change of settlement locations	M (20)	L (20)	LT (20)	H
		Alterations or disruptions of social networks	L (10)	SS (10)	LT (20)	L
	Establishment of work grounds and facilities in Dam site surroundings	Disruption of foot trail. This foot trail is part of Manaslu Trekking Route and the primary access for the locals to deliver goods and services.	M (20)	R (60)	LT (20)	M
		Loss of land	H (60)	L (20)	LT (20)	H
		Loss of trees	L (10)	SS (10)	LT (20)	L
Impact on local institutions, social services and community infrastructure						
Project Structure and Activity areas; Chum Numbri 3, Dharche 1, 3	Increase population (direct workers and induced migration)	Increase demand for public services and institutions expect to grow exponentially as currently the location population is very low. Furthermore, the area does not have adequate services and facilities (hospital, school, market, etc.)	H (60)	R (60)	ST (5)	H
	Loss or modification of existing service infrastructure	Public taps and water from streams are the major sources of water in the area. In the proposed inundation area community and households' taps may be affected by the project construction.	M (20)	L (20)	LT (20)	M
Gorkha district	Transportation of goods (materials and machines) and personnel for construction purposes	Increase in traffic loads	M (20)	R (60)	ST (5)	M
Impacts on indigenous groups						
Project Structure and Activity areas; Chum Numbri 3, Dharche 1, 3	Creation of reservoir	Loss of properties (house, land etc.) and livelihoods sources (cultivation, hotels, tourism services, livestock etc.)	H (60)	R (60)	LT (20)	H
	Establishment of work grounds and facilities in Dam site surroundings	Disruption of social networks (access to school, religious sites, social activities, users groups, women's group etc.)	H (60)	R (60)	LT (20)	H
	Project construction activities	The construction of dam and other project structures may impact livelihoods due to loss or reduction in access to natural resources among indigenous groups.	M (20)	L/SS	LT (20)	H
Impact on Social and Cultural Characteristics						

Project Structure and Activity areas; Chum Numbri RM-3, Dharche 1, 3	Construction related activities and the movement of heavy vehicles	Alteration of cultural and religious sites – church at Salleri will be disturbed by the construction as well as operation of the project.	L (10)	SS (10)	LT (20)	H
	Population influx into the project area	Cultural disruption and social problems due to influx of external population	M (20)	R (60)	LT (20)	H
Impacts on livelihoods and General Economic Condition						
Project Structure and Activity areas; Chum Numbri 3, Dharche 1, 3	Construction related activities affecting the tourist flow	Alteration or loss of recreation areas and touristic sites as the tourist flow is likely to be reduced during the construction phase affecting the employment opportunities of local population engaged in tourism activities.	M (20)	R (60)	ST (5)	M
	Land acquisition	Alterations in livelihood due loss of agricultural production	H (60)	L (20)	LT (20)	H
	Population influx into project area	Increased demand for housing and land	M (20)	R (60)	ST (5)	M
		Alterations in supply of food and other commodity markets	M (20)	R (60)	ST (5)	M
Changes in livelihoods due to modification in access to natural resource						
Inundation area (Salleri village (Chum Nubri-3)) + Gorkha District	Land acquisition	Impacts on livestock holdings	L (10)	R (60)	ST (5)	L
	Population influx into project area	Competition to access of drinking water and forest resource (timber, herbs, shrubs, fruits) collection will increase, resulting in conflicts amongst project workers and locals.	M (20)	L (20)	ST (5)	M
	Dam construction and creation of reservoir	Impacts on livelihoods due to reduced fish catches	L (10)	R (60)	LT (20)	L
Project Structure and Activity areas; Chum Numbri 3, Dharche 1, 3	Construction related activities	Impact on income from collecting stone, gravel and sand	M (20)	L/SS	LT (20)	M
	Construction related activities such as blasting, excavation, mucking, quarrying, aggregate crushing, materials hauling	The construction activities might disrupt trekking, as well as degrade natural aesthetics reducing tourism attractions of the area. The revenue from tourism might go down.	H (60)	L (20)	LT (20)	M
Impacts in Local Business and Industries						
Project Structure and Activity areas; Chum Numbri-3, Dharche 1, 3	Construction related activities	Loss of income for local trade and industry as the construction of BGHEP may result in an alternate route to Manaslu conservation area, changing the route of tourists as well as the supply route to the market.	M (20)	L (20)	LT (20)	M
		Market boom due to increased number of workers. The increase in demand for goods and services will be generated by the construction of the HEP.	M (20)	L (20)	LT (20)	M
Salleri Village – Chum Numbri3	Creation and operation of reservoir	Loss of local business in inundation area	L (10)	R (60)	LT (20)	H

Project Structure and Activity areas; Chum Numbri-3, Dharche 1, 3	Construction related activities	Loss recreation areas, potential touristic sites and business activities	M (20)	R (60)	ST (5)	M
		Alterations of landscape and visual impacts. The construction activities will degrade the natural aesthetics of the project area reducing its touristic appeal.	M (20)	L (20)	ST (5)	L
Impacts on public health, water and sanitation						
Project Structure and Activity areas; Chum Numbri RM-3, Dharche 1, 3	Population in the areas of project structures	Significant loss of health facilities with increased pressure in existing health facilities	M (20)	R (60)	MT (10)	M
	Population influx into project area	Population growth in the project area will create pressure on the natural resources including the existing drinking water sources. However, the drinking water status is good as the residents use piped drinking water sourced from the nearby forest source with year round availability.	L (10)	L (20)	ST (5)	L
	Construction of the project structures	Water related diseases such as diarrhea, dysentery, cholera, typhoid and other water borne diseases are communicable and there is a likely occurrence of epidemics in the project area among the village community.	H (60)	L (20)	MT (10)	M
	Construction related activities	Incidences of Air Borne Diseases due to increased dust in the air can impair the health of people through increased incidence of Acute Respiratory Infections (ARI)	M (20)	L (20)	MT (10)	M
		Vector borne diseases such as typhoid fever, cholera, dysentery can spread over a wide area and affect larger mass of population creating pandemic situation.	M (20)	L (20)	MT (10)	M
		Occupational health and safety can range from simple injuries influencing work performance and efficiency of workers to fatal accidents and illness leading to deaths	L/M/H	SS (10)	ST/MT/L T	
		While the construction activities are going on, there is a probability of the transportation of an alien vector species which could act as a carrier of diseases.	M (20)	R (60)	LT (20)	M

CHAPTER 8. ENVIRONMENTAL MITIGATION MEASURES

The environmental impacts of hydropower projects can be significant as well as permanent, and if proper mitigation is not conducted at the appropriate time, the consequences can be dire. Similarly, the loss of land and properties and displacement of population are probably among the major social and cultural impacts of the project. Part of the impact mitigation process has already taken place during the project design and optimization phase. As part of the project optimization process a number of measures have been taken to minimize the social and ecological footprint of the proposed project. For instance, among the alternative locations for the different project components (dam site, tunnel alignment, power house location, tailrace location, *etc.*) the technical team has selected optimal locations taking into account multiple criteria (social, environmental, economic, bio-physical, *etc.*).

This chapter provides details on the mitigation and enhancement measures. A summary of the measures are provided in a mitigation matrix at the end of the Chapter. The measures listed in the matrix combine and integrate measures across physical, biological, and socio-economic and cultural themes.

8.1 Physical Environmental Mitigation and Enhancement Measures

Slope Stability and Catchment Area Management

This project is not expected to cause significant slope stability issues due to the geological condition of the project area. However, the construction activities such as blasting, excavation, tunneling, slope cutting might result in some slope instabilities. To prevent these, geology of the project area was evaluated during the feasibility study, but will be furtherly evaluated by the survey of reservoir slopes, to make sure that possible slope instabilities will not cause the safety problems to the Project structures. Wherever unstable slopes potentially affected by the reservoir fluctuations are identified the project shall provide proper design to prevent landslides. Similarly, for the management and maintenance of the catchment area, forest plantation in degraded forest area and in vulnerable areas will be carried out. Ongoing monitoring will be required because of possible increased of logging activity within and in the vicinity of the reservoir and other project areas, as well as increased activity in general in the project area.

During the initial storage of the reservoir, as a precautionary measure, annual observations will be made for all steep slopes and remedial actions taken. As a precautionary measure, routine inspections shall also be carried out on the slopes around the construction area and the reservoir to check for signs of any landslides. Continuous monitoring is recommended also after project commencement.

Responsible unit will be the Proponent's Environmental Management Office (EMO). No additional cost is envisaged.

The monitoring activities are supposed to be carried out once a year and continue during all the pre-construction and construction phase.

Control of Erosion and Sedimentation

The main targets of these measures are:

- to minimize sediment generation from construction activities *i.e.* site clearing, excavation;
- to protect and minimize soil erosion from cut/fill activities;
- to prevent sedimentation in the river from erosion caused by construction activities or from topsoil stockpiles, or surplus waste piles;

- to monitor and report on the planned control measures related to soil erosion and sedimentation;
- to estimate the predicted level of sediment-related situations which will occur at the Project site (*i.e.* soil erosion).

These measures shall be developed and implemented by the Proponent, Contractors and Sub-contractors. In terms of erosion control as part of the Project, the major effort at construction sites shall focus on the management of erosion of excavated surfaces, especially during the wet season when the volume of runoff is expected to be high. A Site Management Plan, which includes a sub-plan for erosion and sediment control to be prepared by the Main Contractor for all the construction sites. It shall include environmental management and pollution control techniques for all areas of activity, including drainage measures for underground works. It shall also include a Water Quality Monitoring Plan. The plan shall meet the appropriate standards and include the development of drainage works, diversions, culverts and other structures designed to treat water to reach an acceptable quality before discharge into natural and/or constructed watercourses.

The control measures shall be regularly monitored to assure they are effective and that follow the best practices.

Key mitigation measures are:

- to minimize the location of works in sensitive erosion and/or unstable areas;
- to restrict in dry season works in sensitive erosion areas, where possible;
- to clear sites according to the construction schedule needs (not too much earlier and not when not necessary) and protect slopes until permanent protection is established;
- to install soil erosion and sediment control practices since the beginning of the activities causing soil erosion impacts;
- to protect any and all disturbed areas that are not subject to construction traffic with specific protection measures (*i.e.* erosion blankets/mats or temporary seeding capable of protecting the areas until permanent stabilization measures are put in place);
- to stockpile in stable way (with a maximum slope angle depending on the type of material stockpiled) soil and spoil removed during the construction process separately. Stockpiles shall be constructed with gentle slopes and free draining patterns. Topsoil stockpiles shall be deep ripped to provide for moisture retention and re-growth. Drainage and erosion from the stockpiles shall be controlled by locating them in areas away from drainage lines. The erosion of the base of the dump shall be prevented by providing a diversion bank uphill to prevent any runoff from reaching the pile, and at the same time constructing a silt fence, if necessary, to contain any runoff resulting from the pile;
- to create ridges on topsoil stockpiles to provide for moisture retention to assist re-growth and slow runoff;
- to place soil and spoil piles so to avoid areas of drainage lines in order to control drainage and reduce erosion discharge from the stockpiles. Such piles shall be placed in a manner that does not interfere with temporary surface flows or established watercourses;
- to prepare site specific plans for each construction site, including plans for monitoring erosion and sediment control.

Responsible unit for prevention and mitigation measures shall be Proponent, the Main Contractor and the Sub Contractors, for monitoring the Proponent's Environmental Management Office (EMO).

The costs for prevention and mitigation are included in the construction costs. The monitoring and controlling costs can be considered USD 15,000 per year.

The monitoring activities are supposed to be carried out monthly and to continue during all the construction phase.

Flood Safety

Regarding the impacts on river water flows the specific downstream and upstream measures are as follows:

- in case of floods, the contractor must prepare emergency plans and procedures to release excess water in ways that will not affect downstream communities;
- the possibility of flash floods during the rainy season shall be included in safety plans during construction period;

warning system on water level fluctuation must be installed at major locations/communities downstream of the proposed dam site. Training shall be given to local residents in downstream communities to provide public readiness in case of emergency situations;

Responsible unit for to ensure safety measures shall be Proponent's Environmental Management Office (EMO).

The monitoring and controlling costs can be considered USD 100,000 for the installation of two warning system and a cost of 5,000 USD per year for the public consultation, monitoring and reporting.

Control of Air Pollution

Most of the air quality issues will be temporary for the construction period. They will likely have low significance. Such impacts can be easily controlled through best practices such as:

- minimize and prevent nuisance from construction activities (i.e. heavy machine, vehicle, quarry, blasting, etc.) and transportation on access road to people, wildlife, and sensitive areas;
- minimize dust emission from transportation, stockpiling, quarry and construction activities;
- protect health impacts of construction workforce;
- monitor air quality during construction period;
- report measurements to the relevant organization(s).

Air quality control plan and mitigation measures shall be developed and implemented by the Proponent, Contractors and Sub-contractors.

Key mitigation measures are:

- Machinery and other dust-causing activities should be located away from sensitive receptors.
- All vehicles should switch off engines when stopped, and vehicles should not be left idling.
- All vehicles should be washed or cleaned before leaving the site.
- Loads entering and leaving the site should be covered if they are expected to contribute to the creation of particles or dust.

The emissions from construction equipment that result from diesel fuel combustion are expected to be relatively minor and localized. However, combustion engines should be inspected on a regular basis and adjusted as required to minimize pollution levels.

When combustion engines are used underground, suitable ventilation measures must be taken to avoid air pollution and health/safety issues. Additional ventilation may also be needed to limit the exposure of workers to toxic gases released from excavated rock in underground work.

Cutting equipment should use water as suppressant or other practical ventilation systems.

Watering of exposed surfaces shall be implemented in the following situations:

- during windy conditions.

- when visual inspection indicates excessive dust generation.
- in response to complaints by external parties.
- during period of heavy traffic uses on unsealed haul roads, if necessary.

Regularly monitor the dust to verify compliance with the applicable standards.

Responsible unit for prevention and mitigation measures shall be Proponent, the Contractor and the Subcontractors. The monitoring responsibility is of the Proponent's Environmental Management Office (EMO).

The costs for implementing the mitigation measures shall be included in good management practices of the construction site. The monitoring and controlling costs can be considered USD 10,000 for the instruments, analysis and reporting.

An air monitoring program in the area of construction activities that generate dust shall be routinely conducted. Sampling locations and parameters specified in applicable standards shall be identified in the Site-Specific Environmental Management Plan, however parameters should include, at a minimum, those required by the Nepalese National Environmental Standard for ambient air quality standard , 2012

Control of Noise and Vibration

Most of the noise and vibration issues are easily controllable through best practices. Impacts will be temporary, during the construction period, and of limited significance.

The actions to be taken are:

- to reduce the potential impacts of noise and vibrations on sensitive receptors and structures, if any.
- to monitor noise and vibrations during construction and from transportation and construction activities.
- to report measurements to the relevant organization(s).

Noise and vibration control and mitigation measures will be developed and implemented by the Proponent, Contractors and Sub-contractors.

Noise and vibration standard level shall be in compliance with the Nepal National Environmental Standard for Noise and Vibration.

Key noise mitigation measures are:

- to minimize noise generation at source by verifying that all noise-generating construction equipment are operated with sound control mechanisms, by using proper sound reduction devices and good maintenance and providing workers with ear protection;
- to reduce transmission of noise to receivers by siting noise sources as far as possible from villages, construction camps and settlement areas, providing noise protection gears to persons subjected to noise levels greater than 80 dB(A) and by installing noise barriers at the construction camp and near villages along access roads if noise levels are found to exceed standards during monitoring;
- to adequately schedule construction and blasting hours by preparing blasting procedures and blasting schedule, and informing and posting in all nearby communities; restricting to reasonable hours (6:00 to 22:00) or starting at an earlier time or ending at a later time if agreed upon with the affected residents in the nearby communities activities generating harmful noise and located within 1 km of a settlement. If blasting is found to exceed specified levels of noise

and vibration in nearby communities, controlled blasting or alternative blasting or excavation measures shall be used in the specified areas, so noise or vibration levels are not exceeded.

Key vibration mitigation measures are:

- blasting vibration, as measured on the ground adjacent to a residential or other occupied structure, shall be allowed to exceed the frequency-dependent limits specified in the Alternative Blasting Level Criteria contained in USBM (United States Bureau of Mines) Report of Investigations 8507;
- air blasts nearby residential and other occupied structures shall be as low as possible; air blasts, as measured at a residence or other occupied structure, shall be allowed to exceed the 0.013-psi (133 dB) limit recommended in USBM Report of Investigations 8485;
- verify that air blast(s) and vibration(s) nearby worker's camps and other occupied structures are within the recommended limits.

Additional key mitigation measures are:

- maintaining all construction vehicles and heavy equipment in good mechanical condition
- limiting the speed of all vehicles to 30 km/hr. in community areas;
- switching off all vehicles engines when parked;
- conducting noise and vibration monitoring program routinely and verifying that noise and vibration levels are in compliance with the Nepalese National Environmental Standard for noise and vibration standards.

Responsible unit for prevention and mitigation measures shall be Proponent, the Contractor and the Subcontractors. The monitoring responsibility is of the Proponent's Environmental Management Office (EMO).

The costs for implementing the mitigation measures shall be included in good management practices of the construction site. The monitoring and controlling costs can be considered USD 10,000 for the instruments, analysis and reporting.

Control of Water Quality

Water quality monitoring of river water shall be developed and implemented by the proponent, contractors and sub-contractors. Most of the potential sources of water pollution shall be controllable by using best practices on-site, for example:

- Installation of wastewater treatment plant for worker camps;
- Safe disposal of vehicle maintenance oils;
- Safe storage of chemicals and disposal of used containers;
- Safe absorption of sudden spills of aliphatic compounds;
- Attention in selecting explosives that give lowest leakage of toxins to the aquatic environment;
- Attention to concrete shuttering to prevent accidental spillage of wet cement into water courses, and prevention of washing cement mixing equipment in water courses;
- Attention to best practices for earth moving and other heavy works when working near water courses.

The construction sites including the worker camps, offices and construction areas will need to be provided with potable water and adequate sanitation facilities, including installation of wastewater treatment facilities. In order to avoid water pollution caused by waste generated from construction sites and worker camps, regular waste collection shall be part of the camp requirements. Solid waste shall be taken to a managed waste disposal facility by the Proponent and the Contractor. The location of the

temporary and permanent camps and water and waste treatment facilities shall be determined during the detailed design phase after discussions with the Contractor.

Water quality issues related to construction activities shall be managed by the Contractors, under the monitoring and supervision of the Proponent, which shall check on a regular basis, the water quality parameters measured by the Contractors by doing its own analysis.

Reservoir impoundment may cause, as well, disruption of water quality: the breakdown of vegetation left in the reservoir area has the potential to cause reductions in water quality in the reservoir due to biological oxygen demand, oxygen depletion, and release of hydrogen sulphide and methane. To minimize such risk the most important measure to be implemented is Biomass Removal. If a proper Biomass Removal Plan (BMP) is duly implemented the effects on water quality would be:

- to minimize adverse impacts of high initial oxygen demand;
- to reduce the amount of floating debris in the reservoir;
- to control nutrient concentrations and risk of eutrophication during initial filling;
- to improve the conditions for aquatic life and fisheries potential of the reservoir;
- to clear the way reservoir navigation and artisanal and commercial fisheries;
- to minimize greenhouse gas emissions.

A monitoring program shall be carried out to assure that water quality is maintained. Samples shall be collected at different locations: upstream the dam (at least 2 locations sites – one relatively far from the construction area and one near the dam site), in the construction area (at least one site), and downstream (at least 2 sites – one just downstream from the dam site and one downstream the water release form the Main powerhouse) before the start of construction as the baseline.

If possible, the water quality stations should be selected among the sampling stations used to test water quality (see chapter 4), to keep continuity with the findings and to use the data already achieved as baseline. Monthly samples should be collected, throughout the whole construction period, to analyse the parameters of physical and chemical water quality (temperature, pH, conductivity, turbidity, suspended solid, total dissolved solid), chemical water quality (calcium, phosphorus, magnesium, sodium, potassium, arsenic, iron, chloride, total nitrogen, nitrate, ammonia) biological water quality (DO, COD, BOD5, planktonic algae, chlorophyll), and bacteriological water quality (total coliform and faecal coliform), heavy metals such as lead, copper and mercury and explosive metabolites.

It is recommended to establish a laboratory at site, provided with proper field kit analysis for some of the water parameters and an adequately equipped laboratory for the other parameters. The results should be reported in tables, accompanied by narrative explanation and interpretation in the monthly report. Responsible unit for prevention and mitigation measures shall be Proponent, the Main Contactor and the Sub Contractors, for monitoring the Proponent's Environmental Management Office (EMO).

Total yearly budget for River Quality Monitoring Program: USD 15,000/year or USD 105,000 for the 1+6 years of preconstruction and construction phase.

Treatment of Run-off from Construction Sites

All run-offs from construction sites have to be captured, especially of tunnel works, through bunding and sedimentation ponds and traps before being discharged into the river. All hazardous substances will be stored and properly managed in sealed areas with drainage to capture all wastewater for treatment, and avoidance and management of spills. The water coming out from the tunnel excavation

should pass a sedimentation pond prior to be discharged into the river. In the low flow period, the sedimentation pond should be monitored with respect to ammonium, free ammonia and pH. If necessary, pH should be adjusted to neutrality before discharged into the river. In the wet season, the ammonia discharge will not harm the river biota.

In the first period after a major tunnel and hydropower construction work the spoil rock deposit is normally used for construction purposes, filling material for road construction, quarries, etc. After some years they are abandoned, and should be closed in a proper way. To prevent impact on water environment, the location is important, the water handling is important and the final rehabilitation is important. Pick the sites for the soil and spoil deposits to avoid runoff directly in the river. If it is runoff to the river, lining should be considered. Runoff from blasted tunnel material should be controlled with respect to the content of nitrogen and particularly ammonia and pH. Water with high concentration of ammonia and high pH can cause fish kills in low flow periods. In such cases the pH in the sedimentation pond should be adjusted to neutrality before released from the pond.

Rehabilitation of the Disposal Sites and Quarry

When there is no more use of the spoil rock, the deposit should be levelled and formed into nature-looking terrain and covered by vegetation. Deposits with material from full profile drilling can often be sowed and planted directly, while material from blasted tunnels first must be covered by fertile top soil. The top soil, gravel and soil from the tunnel ideally need to be separately deposited. Upon spoil deposition top soil needs to spread onto the spoil material, and a multilayered technique ought to be used. This will allow roots of trees to reach and proliferate into rich soil zones within the spoil thus increasing anchorage and overall stability of the spoil. Most of the top soil must be placed on top. Planting of tree species needs to be done immediately at edges and grass lines on contours. Open flat areas of the spoil deposits where top soil is deposited, should be immediately made available to the local people for agricultural practices of agro-forestry. It is vital that the rehabilitated areas is not open for grazing until all vegetation is established, 6 years minimum, as this will result in spoil slope weakening.

Treatment of the Sanitary Effluents from the Construction Workers Camp

During the construction phase there will be much activity at the different construction sites. There will partly be residential camps for construction workers, administration buildings, workshops, machine parks etc as mentioned above. At these sites there have to be built sanitary systems with no direct discharge to the river. If possible, the camps should be placed in areas with good infiltration capacity. In such areas standard pit latrines may prevent hygienic pollution to enter the river. If suitable infiltration soils cannot be found, toilet water (black water) and wash water (gray water) should be separated. Toilet water should be collected in watertight tanks and infiltrated at a safe place. The gray water can be infiltrated in the terrain. An alternative is to have mobile latrines. These can be emptied every day/every second day etc. at the sewage system of the nearest town or at a safe infiltration site.

Accidental water releases and dry-ups – testing and warning systems

The functioning of the spillway gates should be tested out properly with respect to both opening and closing before filling the reservoir. A flood warning system to people living downstream the dam and the outlet of the power plant construction site should be established. The initial filling of the reservoir is suggested to be done only in the wet season with bypass of at least of the proposed environmental flow. It is important that the river is not dry.

Site Pollution Risk Control with Hazardous Materials

The project construction will require the contractors to handle potentially polluting materials, therefore, to prevent pollution risks several mitigation and management measures shall be established. The Proponent, and the Contractor have to be responsible to follow best practices to avoid contamination of the sites and waters with hazardous waste, explosives, and chemicals.

Explosives shall be registered and stored in locked and guarded facilities located underground or sufficiently protected by bunding and located close to the areas for use. Whenever the explosives are moved, the amount, date, and name of user shall be entered in logbooks at the storage facility and at other critical sites, to the place where it is being used. Only sufficient supplies of explosive material, adequate for a reasonable period, shall be stored in these facilities, to limit the possibility of any leakage or other accidents.

Explosive boxes shall be labelled with an explosives sign, and explosives posters shall be clearly shown at each site storage facility. Firefighting equipment shall be kept available next to each storage facility.

Similarly, all chemicals that are considered potentially hazardous shall be stored safely and registered, so that the types of chemicals, the quantities being stored, and the amounts being used will be known. Whenever the chemicals are moved, the amount, date, and name of user shall be entered in logbooks at the storage facility and at other critical sites, to the place it is being used. Hazardous chemicals should only be handled by trained personnel.

Acids, coagulants and flocculants shall be stored within a separate containment area to avoid comprising the water treatment facility. A bund shall be constructed around the perimeter to contain a spill if it were to take place. Acids are also stored at batching plant sites where they are used to buffer plant effluents before discharge in a stream.

Hazardous chemicals shall be stored sufficiently separate to avoid accidental mixture. Fuel shall be stored safely, in banded storage yards. There shall be registers of fuel deliveries and fuel disbursements, to reconcile the quantities brought into the site and the quantities used.

All areas where hazardous materials are stored or used shall have separate water drainage systems so that storm water is collected and contained. Only after being determined safe can it be released. If determined not safe, it shall be treated before being released or, if that is not possible, collected and discarded according to the hazardous waste management procedures.

The Proponen and the contractor will be responsible for regular monitoring of the storage and use of chemicals and other hazardous materials.

Environmental Flow

Releasing of water flow for environmental requirements and downstream users is not a new concept in Nepal. In the year 1996, the Integrated Treaty on the Mahakali River had a provision for releasing 10 m³/s flow for ecosystem and social needs. The treaty says that 'hydropower use shall not preclude the use of the water of the Mahakali River by local communities living along both sides of the Mahakali River not exceeding five percent of the average flow at Pancheswar'. The design of the Kali Gandaki hydropower project provided for the release of 4 m³/s.

According to the Hydropower Development Policy 2001, 'provision shall be made to release such quantum of water which is higher or either at least ten per cent of the minimum monthly average discharge of the river/stream or the minimum required quantum as identified in the environmental

impact assessment study report'. Each and every new hydroelectric project is to follow this policy, and the flow is to be monitored.

Most compensation flow falls within the range of 10 to 20% of the long-term flow, for the conservation of macro and microflora, aquatic insects and fishes in dewatering zone. The minimum recommended compensation flow during dry season in other Nepalese projects ranges from 0.5 to 15 m³/s. (Mewa: 0.5 m³/s, Melamchi: 0.5 to 1.0 m³/s, Likhu: 0.6 m³/s, Budhiganga: 1.7 m³/s, Tamur: 3.5 m³/s, and Upper Karnali: 12 to 15 m³/s). The Environmental Impact Assessment 2004 of Upper Tamakoshi hydropower project mentioned that a policy compliance release of 1.3 m³/s at the dam was required. This would result in a minimum average monthly flow increasing from 1.55 to 2.06 m³/s down the river course from the dam. In this case the discharge, from an ecological perspective, is considered more than sufficient for the maintenance of adequate wetness conditions to support the ecosystems that may exist in this boulder bed river, riparian vegetation, water resources, and fisheries.

In Nepal, knowledge of minimum requirements for the survival and growth of fish in nursery pools and general river habitats during dry seasons is limited. Knowledge on the influence between physical factors such as characteristic, temperature, dissolved oxygen or water quality parameters and the migration and spawning of commonly found fish species is limited. In the international arena it appears that rivers and associated species behave differently and there is no common standard for minimum flow needs, and thus a case specific decision has to be made (Bain 2007), and where there is room for adapting flows may be the solution.

The operation of BGHEP will result in creation of the "Reduced Water Zone" in the river stretch of about 9.5 km, downstream from the dam up to the tailrace of the project. The water of Budhi Gandaki River is not used by local people except occasional fishing by the locals.

Considering minimum environmental discharge of 10% of minimum of the monthly discharge as suggested by the Strategy for Construction and Operation of Physical Infrastructures within protected areas 2065 BS, the Budhi Gandaki has lowest mean monthly discharge of 23.98 m³/s in the month of Feb, thus, 2.39 m³/s will be released from the dam. This amount might not be sufficient to maintain surface water along the stretch of 9.5 km of reduced water zone. However, five significant perennial snow-fed rivers confluences the Budhi Gandaki River. These rivers have significant discharge. We have estimated their discharge in the month of Feb, which is in average 3 – 5 m³/s. Thus, we estimate, a total of 15 – 20 m³/s flowing in the stretch for the Budhi Gandaki River as environmental flow.

During the rainy season (from June to October), once the reservoir is full, the water will start spilling through the spillway, being the incoming amount of water much higher than the generation capacity of the main powerhouse. This water flow variation into the Budhi Gandaki River, between the dam and the tailrace, will be significantly higher, mimicking the natural flow pattern.

Table 8-1: Environmental Flow Table

Month	Available Flow in River	Environmental Flow	Diversion for Power	Excess Downstream Flow
Jan	28.078	2.808	25.270	NA
Feb	23.982	2.398	21.584	NA
Mar	27.745	2.775	24.971	NA
Apr	45.706	4.571	41.135	NA
May	80.888	8.089	72.799	NA
Jun	176.940	17.694	100.270	58.976

Jul	322.129	32.213	100.270	189.647
Aug	346.874	34.687	100.270	211.917
Sep	249.413	24.941	100.270	124.202
Oct	121.381	12.138	100.270	8.973
Nov	62.570	6.257	56.313	NA
Dec	38.946	3.895	35.051	NA

Hydrology, Sediments and Reservoir

The sedimentological study carried out to verify the sediment yield and the sediment accumulation rate into the pondage concluded that, in the expected lifetime period of the project, the storage volume is not compromised and the energy production is not drastically affected.

In the catchment the rainfall doesn't result a determining factor of erosion as in other Nepalese basins. Values obtained by the measurements result underestimate the potential sediment load in comparison to different methodologies. The estimated values of the sediment yield by regional approaches are reasonably in the medium range of the investigated literature.

The sediment accumulation in the pondage will be insignificant. So, even in case of extreme events, which could cause the transport of large and sudden amounts of sediment, the remaining volume of the reservoir would still be able to mitigate the impact. The sediments potentially accumulated in the proximity of the toe of the dam will be cleaned by the coming floods, transported downstream and distributed along the river stretch, thus mitigating the erosion of the river bed.

GLOF Hazards

As discussed earlier, BGHEP does not have any known significant GLOF risk. Regardless of the low risk, preparedness for unprecedented event is necessary, thus, we are proposing measures that should be in place must include both warning systems and procedures for evacuation plan, which must be finalized before the construction period. In addition, studies should be carried out to access the possibility of undertaking direct measures at the most dangerous (GLOF prone) lakes, for instance by permanent lowering of the water levels in the lakes.

Safe Disposal of Spoil and Muck

The project is expected to generate a large amount of spoil and muck as majority of the structures are proposed to be under ground. There are two major sites identified as the disposal site. The project will have a clear protocol on undertaking disposal activities, which will have three principals (a) reduce the amount to be generated, (b) reuse of materials, (c) disposal.

The failed slopes are the major source of spoil production. The slope cutting will be minimized by balancing materials between cuts and fills, which on one side minimize disturbance of natural slopes, maintain gentle slope angle as well as produce less amount of spoil to be disposed. The figure below illustrates the techniques. However, this method might not be applicable in all of the terrain.

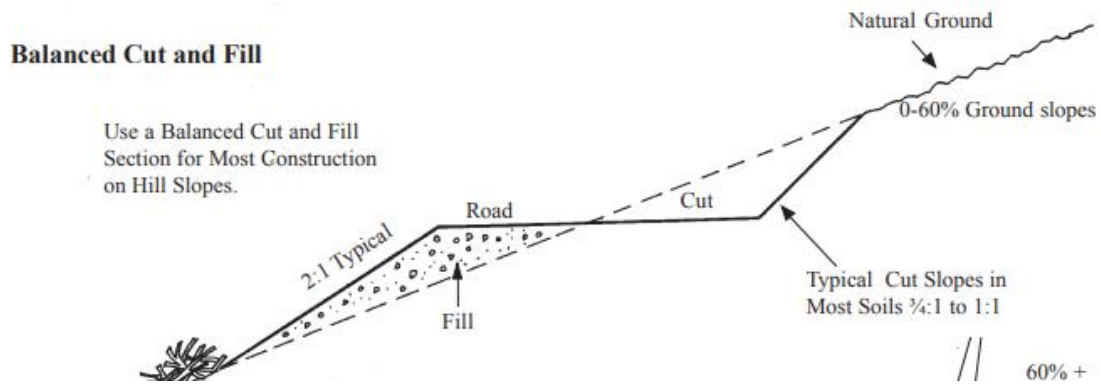


Figure 8-1: Balanced Cut and Fill

source: https://www.fs.fed.us/t-d/programs/forest_mgmt/projects/lowvolroads/ch11.pdf

Second approach to minimize spoil production is its reutilization for construction works. The dam constructions, road constructions, as well camps will require construction materials. The project will maximize utilization of the spoil and muck in the construction works, thus, reducing the volume of spoil to be disposed.

Disposal of the spoil – the spoil and muck generate will be hauled to the designated site for disposal. The toppling down of spoil into the river will be strictly prohibited. Management of disposal site is important to minimize its impacts: (a) coverage of the site by drainage to control the run-off water. (b) The run-off from the disposal site will be ran through sediment traps. (c) The terracing of the spoil while disposing so that gentle slope can be maintained, (d) reinforce the terraces by retraining walls, (e) rehabilitation of the sites by applying top soil and vegetation coverage.

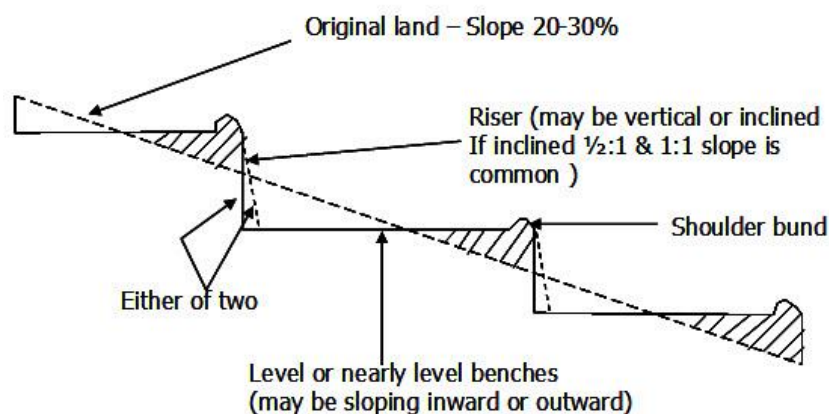


Figure 8-2: Bench terrace of its components

(source: <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2098>)

Removal of vegetation in the pondage area to minimize GHG emission

The hydropower's are not completely devoid of GHG emission. The primary source of GHG in hydropower is anaerobic decomposition of the biomass (vegetation) inundated under the reservoir. Thus, the pondage area has to be cleared of the vegetation to minimize the GHG emission. This process will be part of the tree cutting for site preparation, which is elaborated in the biological mitigation measure component.

8.2 Biological Environmental Mitigation Measures

Mitigation measures for protection of Vegetation (Construction Phase)

Site Preparation

As mentioned above vegetation clearing in the reservoir area prior to inundation is critical to the water quality of the pondage and downstream of constructions during the first years of operation. With less vegetative matter remaining in the water, there is less organic matter to decay, which will prevent deterioration of water quality as well as reduce methane release from the pondage.

Vegetation clearing plan shall be developed and implemented by the Proponent, Contractors and Sub-contractors. Logging should start with cutting the commercially valuable trees as in accordance with the existing forestry laws and regulations. Upon completion of the commercial logging operations, contracts shall be made available for bidding for timber salvage operations that remove timber of marginal use from the inundated area. It is important to ensure that these operations are constrained to the reservoir area. Affected villagers may be encouraged to collect all non-timber forest products (NTFPs) from the reservoir area prior to clearing and burning.

The final slashing and burning of the reservoir area shall commence at the dam wall and shall progress upstream so to be completed before impoundment starts. The clearing operation shall avoid removing stumps as disturbed soil may release a far greater amount of nutrients into water courses. This requirement favours the use of manual labour as heavy machinery tends to push over the standing timber and attached stumps. The work shall be largely undertaken by hand, but heavy machinery may be used as necessary where remnant timber is too large to be effectively cleared manually; additionally, machinery may be used after burning where large timber remnants need to be restacked and burned for a second time.

The vegetation clearing operation shall maintain a buffer zone of vegetation around the perimeter of the reservoir, or from FSL to minus 5 m height, so that the intact root structure of the trees will help maintain the structural integrity of the soil embankments and reduce shoreline erosion and wave erosion. This may also provide shelter for fish.

Guidance on clearance operations might include:

- removing the maximum quantity of commercially viable timber (except in some designated buffer zones). As evacuation of logs from the reservoir area may be difficult, costly and cause negative impacts on surrounding forest areas (because of the creation of access roads), transformation on-site with portable sawmills and removal of logs by flotation during the filling phase shall be considered;
- cutting, clearing and burning a maximum of the remaining vegetation. Experience from other related Projects indicates that it is possible, and indeed preferable, to rely on hand clearing in areas inaccessible by heavy equipment. This approach is also in line with the request of major funding agencies that this major infrastructure Project generate benefits not only to the national government but also to local communities: hand clearing will certainly create labour needs which can be fulfilled through local hiring;
- avoiding the removal of stumps that can destabilize ground conditions, since disturbed soil may accelerate the release of nutrients in the water, and increase the quantity of such nutrients;
- hauling as much as possible of the burnt vegetation residual from the reservoir area to avoid nutrient loading in the reservoir and downstream.

In order to reduce intrusion into restricted areas outside the Projected clearance zone, strict rules which prohibit poaching and logging outside the approved construction areas shall be imposed on Project

staff, workers, and all contractors engaged to the Project, with penalties levied for anyone cutting trees, collecting NTFPs or burning vegetation outside approved areas. The Proponent shall be directly responsible for dissemination of all regulations and information concerned to its staffs and employees as well as for any misconduct made by its staff and workers.

The Proponent will have the overall responsibility for the implementation of the Biomass Clearance Plan by:

- managing, planning and controlling it through SEMD;
- engaging a Contractor with appropriate technical and management expertise to clear the proposed reservoir area; and
- providing training for clearance team staff in operations methods, health and safety, physical cultural resources (PCR) Chance Find Procedures, environmental awareness, etc.

Total harvesting and collection cost will be USD 33,125 (see the table with the estimates below) for vegetation clearing and timber logging; the budget must be prepared during preconstruction phase and the clearance shall be finished before impounding.

Control Damage to Standing Trees and Ground Vegetation

Forest survey and inventory works carried out in forests require alignments to be cleared to maintain good sight and visibility between the two pegging points and this implies breaking of limited tree branches and clearing the shrubs. Chances are there to chop down the saplings and branches of trees for making the pegs and trees marked by chopping on bark to memorize the counted number during enumeration. Field workers may damage the ground vegetation growing underneath.

Compensatory Plantation

The impacts due to the loss of vegetated area will have to be mitigated through the compensatory plantation and conservation practices of the remaining forest areas. According to the Government Rules (Forest Rules 2079 BS), for every felled tree it is mandatory to plant 25 saplings for both protected and common species. Furthermore, trans-plantation program will be carried out for other shrub and herb species of protection category in suitable habitat conditions in nearby areas for their survival and multiplication in nature as a part of *ex-situ* conservation.

The compensatory plantation will be carried out at 1:25 ratio for the trees to be cleared in the Manaslu Conservation Area, whereas for rest of the area, it will be carried out at ratio of 1:10. A total of 275 trees are expected to be felled for construction of the project structures, of which 44 trees are in the Manaslu Conservation Area, and 231 are outside of the conservation area. Therefore, the total number of saplings required for the compensatory plantation is 3410, out of which 1100 saplings will be planted inside the MCA, and rest 2310 will be planted outside of the MCA.. Moreover, the cost required for felling, stockpiling and transportation of the felled trees will be also provided to related institution and stakeholder. Appropriate areas will be selected in coordination with DFO (Division Forest Office) and executives of (CFUG) Community Forestry Users Group under Manaslu Conservation Area Management System and for conservation of planted species through fencing, regular water treatment, caring and watching.

Furthermore, the project implementation will require a total of 19.67 ha of forest land, of which 14.74 ha is require on permanent basis for pondage (9.68 ha), main dam (0.43 ha), access road (3.83 ha) and permanent camp (0.8 ha). Remaining 4.93 ha of forest land is required on temporary basis. Therefore, loss of forest area has to be compensated, either with the cash or replacement with the land.

The details of the compensatory plantation are given in the tables below:

Table 8-2: Number of trees for the compensatory plantation

Trees to be felled inside MCA	44
Trees to be felled outside MCA	231
Total tree to be fell	275
Saplings to be planted within MCA	44*25 = 1100
Saplings to be planted outside MCA	231*10 = 2310
Total sapling for plantation	2420

The proponent will require "Forest Clearance Permit" for removal of the vegetation. The detail on the vegetation removal and cost associated given above forms the basis for the permit application, however, it will only be processed after approval of this EIA report. The proponent, contractor/subcontractor has to coordinate with and ensure participation of the Divisional Forest Office (DFO), Manaslu Conservation Area, Private Forest deed holders, and Conservation Area Forest Management Committee (CAFMC) for executing this measure.

Forest Fragmentation

In view of the distribution and extent of forests in the project area, the project structures are selected in small and scattered forest patches, except in the access road. This portion has relatively denser forest. Thus, as discussed earlier the project is not expected to cause significant forest fragmentation. However, it has been recorded that some of the forest area are occasionally used by *Ghorals* for grazing that can be considered as the forest fragmentation. For this purpose, an integrated plan will be made in coordination with the MCA and CAFMCs and will be addressed along with the mitigation plan associated with 'Impacts on MCA'.

Loss of non-timber forest products

The project construction sites are found to be rich in medicinal and non-timber forest products. The site clearance will sweep away these valuable plant species. The project and contractors/sub-contractors will coordinate with DFO, MCA, CAFMCs and private forest deed holders for collection and/or relocation these products prior to the site clearance work. Furthermore, for protection/conservation of the plants in vicinity of the project area, instruction and awareness programs will be conducted for locals as well as construction workforces to enrich their knowledge and self-motivate. Moreover, for people who will try to take illegal benefit will be penalized according to the code of conduct already approved from the project implementation authority in coordination with DFO and MCA. The proponent will coordinate and ensure participation of DFO and MCA in this process, which is expected to cost Rs. 2, 00,000, *i.e.* USD 16,666.

Loss of biodiversity and ground flora

The labors will be instructed to walk and carry their duties with due care and not to damage the plant species. They will also be taught about the value of biodiversity and the role of these species for maintaining the environmental balance through awareness program. However, as complete safeguard of these species from such type of construction work is unavoidable, nearby unproductive and degraded lands will be re-vegetated and emergence of plant species will be secured. No mitigation cost required; species will come out inside compensatory plantation area.

Conservation/ protection of the protected species of flora

Due to adverse physiographical settings the project construction site does not harbor tree species of protection category. However, for climbers and herbs of such category observed at the surroundings of the project area, transplantation program is recommended. They will be translocated in suitable habitat conditions in nearby areas for their survival and multiplication in nature as a part of *ex-situ* conservation.

Cost for awareness and translocation program: USD 5000.

Management of the Access to Conservation of Forests in vicinity

Lasting actions through mitigation will be achieved only after forestry plantation and application of conservation programs and proper environmental protection measures. However, everyday control for the forest resource, from being harvested by the work forces that are prompted by easy access, will be achieved by applying strict regulations and awareness programs to the targeted groups up to the dismissal of job.

Ensure Alternate Source Energy to Control demand for firewood and timber

Alternate source of energy such as kerosene will be supplied to the workforce and labors. Dead logs and branches only will be allowed to take from the forest areas in case of inadequacy of the alternate sources. Awareness program will be conducted to the working staff and labors about the importance of forest environment and healthy ecosystem that will help to a great extent to control the unwanted use of firewood and timber.

Cost for awareness program: USD 1000 for first few years of construction period.

Conserve traditional agro-diversity practices

Local residents will be encouraged to grow traditionally cultivated agricultural crops as far as practicable. DADO (District Agriculture Development Office) will also be consulted for providing seeds and necessary technical support.

Control of Incidences of Forest Fire

Cost for awareness program: Rs. 1, 00,000.00 *i.e.* USD 893.

Cooperation with MCA and DFO

The project will designed its activities by prioritizing biodiversity conservation and accessibility to the natural resources for locals while implementing the project. It is obvious that the construction activities might result in disturbance such as - (a) clearance of vegetation in the intake sites for construction and (b) inundation of MCA forest area including a grazing land of Ghoral by pondage in construction and more pronouncedly in operation phase. The project will design a collaborative approach with MCA and DFO to minimize these impacts.

Furthermore, the collaboration with MCA and DFO will also address to prevent forest fires. The forest vegetation in the project vicinity might have susceptibility to the forest fire and difficult to control, if caught by fire. Numbers of wild animals and birds have been observed during the field study. Awareness programs will be conducted not only to the construction forces but also to the local residents about its serious consequences and unpredictable losses. Division forest office also will be consulted that are equipped to control such fire hazards

Cost for integrated program with MCA and DFO: USD 10,000 per year for 5 years of construction and 3 years of operation.

Mitigation Measures for Protection of Vegetation (Operation Phase)

Control Access to protect the forest

The project area, especially the sites of immediate vicinity of the project implementation, will be adequately afforested and the impact upon the forest will be minimized to a great extent. This ensures suitable habitat formation for the wildlife species of the area. However, for the protection of illegal timber and firewood collection will require strong vigilance mechanism along with awareness program about the value of forest and wildlife species. The proponent will coordinate with MCA, DFO, and CAFMCs and allocate funding upto USD 10,000 per year for these initiatives.

Impact on rare, endangered, vulnerable and protected species

During operation phase afforested tree species, especially to those ones under protection category, will be nurtured with priority for five years and handed over to the forest officials. The proponent will coordinate with MCA, DFO, and CAFMCs and allocate funding upto USD 10,000 per year for these initiatives.

Mitigation measures for Protection of Fauna (Construction Phase)

Wildlife and birds might become more vulnerable to the project implementation, particularly, from the disturbance to and loss of habitat caused by the project and increase in poaching and hunting incidences by construction workers as well as by the locals. Therefore, protection of wildlife and birds becomes important to maintain environmental balance of the area. The following measures are proposed:

Minimize Disturbance from the Construction Works

The proponent and contractor/sub-contractor have to make construction work more sensitive to the wildlife. It can be achieved by incorporating the following measures into their working protocol: minimizing removal of vegetation by restricting removal only for the areas which absolutely requires clearance. For instance, tree shall be removed to construct road formation width, whereas the trees and vegetation in the rest of the ROW can be preserved.

Breeding season is crucial to maintain healthy wildlife population. Thus, the construction works have to consider vegetation clearance to be restricted during breeding season, particularly of the threatened species. The breeding season is presented below

Extensive greenbelt development will be carried out along the access roads and boundaries of most project features, to mitigate the loss of forest cover, provide habitat and mitigate the loss of biodiversity and environmental degradation.

Table 8-3: Estimated breeding season of threatened species

Name of Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Common leopard	Light Orange					Red		Light Orange					
Bengal Fox	Red											Red	
Assam Macaque											Red		Red
Barking Deer	Light Orange												
Himalayan Griffon	Red						Light Orange						

Lammergeier

Small-eared Toad*

Note:

* Breeding habitat is not known (www.iucnredlist.org); probably rainy season.

The full red color indicates the main breeding season and the light (pink) indicates possible breeding in other months.

Construction activities and light will be limited or restricted at night.

Large flood lights will not be installed outside 50 m of the Project fence.

Lights will be directed towards Project facilities and not towards the natural habitats.

Construction equipment that could potentially generate high noise levels will have an adequate muffler system.

A preventive maintenance procedure for project vehicles and equipment will be set and followed which will help reduce noise levels and oil leakage from deteriorating with use.

Pressure horn will be restricted and speed limits will be enforced to project vehicles.

Controlled blasting shall be carried out to minimize vibration and noise. Sirens will be used prior to blasting and blasting time will be fixed.

Enforcement of Wildlife Protection Legislations

Hunting as well as poaching incidences might rise once the project starts its operation in the area, mainly because (a) accessibility to wildlife habitat will increase for hunting/poaching, and (b) demand for the wildlife might increase. These activities might be carried out by workforce, but also by locals and game hunters. Furthermore, due to the proximity to the Manaslu Conservation Area, the project has to be extra cautious and responsible towards this issue.

The legislations against poaching and hunting have to be enforced in the project area. The project has to coordinate and facilitate the lines agencies to enforce these legislations. The EMO of proponent has to support the DFO to carry out regular monitoring on hunting and poaching activities in participation of local law enforcement agencies, and execute the law. Furthermore, "anti-hunting and poaching" clause has to be included into the contractual agreements with the contractors, sub-contractors as well as the employees of the project, with the possibility of legal implications.

Rescue and Rehabilitation Centers

Accidents in the project construction sites might be difficult to avoid completely. The wildlife animals might be injured, trapped, and/or human –wildlife conflict scenario might come arise. Therefore, we are recommending establishment of "Rescue and Rehabilitation Centre" in coordination with DFO, Gorkha and Manaslu Conservation Area in the project area, which can take care of young ones and injured wildlife found during construction. They will be treated, cared and rehabilitated in captivity so that they can be safely trans-located to their habitats.

Awareness and Training Programs on Biodiversity Conservation

The project's EMO will ensure participation of locals in coordination with DFO, MCA and Community Forestry User Groups and Conservation Area Forest Management Committees (under MCA) to generate awareness on the value of biodiversity, conservation initiatives, threatened species, and rules and regulations for the conservation of animals. Similarly, conservation activities, ways of biodiversity

loss, public participation in biodiversity conservation are some interesting topics which are needed to include in the awareness and training courses.

The project will also put-up posters, pamphlets and signboards in local languages as part of awareness generation. It has been proved to be an essential tool in the conservation efforts, particularly for the threatened wildlife species. Related information about rules and regulations about wildlife killing/hunting will be displayed in several areas. To minimize disturbance to wild animals and birds by many activities such as direct stone pelting, destruction of breeding nests of animals and birds, killing of herpetofauna due to misconception that all snakes are poisonous, blowing unnecessary horns and hunting activities will be strictly prohibited.

General awareness posters and pamphlets will be published and distributed to the local area. Occasional poachers invading from outside reported to visit the area and reported killing variety wild animals including threatened species. People were reported to support unknowingly in such illegal hunting practices due to lack of knowledge of the legal provisions. Such illegal hunting practices need to be informed to local people, workers, contractors and the project staff.

Killing practice of encountered snakes should be minimized. Many rare snakes supposed to be killed by local people by thinking that all snakes are poisonous. Information about such activities need to be distributed at the local level by producing educational information for minimizing negative impacts on wild animals during the project construction.

Training of Contractors, Supervisors and Labour Force on Conservation

Local contractors, supervisors and even followers can influence on local labour force. If they are taught about the existing rules and regulation related to biodiversity conservation and legal provisions for the punishment for the misuse of local biodiversity, it will play a vital role in controlling illegal hunting and wildlife trade in the area. Training manuals need to be developed for local contractors, supervisors and labour force about existing rules and regulations, importance of biodiversity conservation, threats to wild fauna, responsibility of project implementing agencies, institutes and individuals.

Mitigation Measures for Aquatic Life (Construction Phase)

Protection of Aquatic habitat

The project construction has numbers of impacts on the aquatic life. For example the construction sites will dispose of sediments into the rivers degrading water quality by increasing turbidity. The increased amounts of sediments can change the habitat quality, impacting both macro invertebrates and fish. Reduced visibility will normally reduce primary production (algae and periphyton) affecting the invertebrates and fish, thus eventually fishery activities. Moreover, the water can also be contaminated by disposal of solid waste and faecal waste from the camp sites. Similarly, the fish population can also be affected by the obstructions from the dam construction on one hand. On the other hand, the project related workforce and visitors might raise demand for the fish; significantly rising in fishing activities. The impacts are discussed in the impact chapter in details. The mitigation measures for protection of aquatic life focuses on these issues for the construction phase.

Minimize obstruction to fish movement

The coffer dam will be set up in immediate upstream of the proposed dam site to divert the river discharge through diversion tunnels for construction of the dam, which is expect to obstruct the migration of the fishes. It is necessary that the hydraulic characteristics of the diversion have to be designed in a fish friendly as much as possible. The slope of the diversion tunnel has to be gentle which

can sustain a minimum depth about 40 cm water. This condition is necessary for movement of *Schizothorax richardsonii*. However, we have to consider that the natural dam about 3 km downstream of the proposed dam already have been obstructing the long-distance migration of the fishes. This measure is started to facilitate movement of local population of the fishes.

Mitigation Measures for Protection of Aquatic Life (Operation Phase)

Mitigation against transition from lotic to lentic conditions

Enhanced protection of the riverine ecosystem upstream of reservoir will be carried out that will mitigate the impact to riverine species such as blunt-nosed snow trout. Adequate attention will be given to the protection of the spawning and nursery gravel beds at reservoir area. Where needed, additional measures will be taken to improve the spawning ground. Loss of spawning habitat and subsequent loss of reproduction will be replaced by establishing fish hatchery. A fish hatchery will be established for vulnerable *Schizothorax richardsonii* (blunt-nosed snow trout). Fish fingerlings developed from fish hatchery will be released upstream and downstream of the dam and the powerhouse area.

The project will divert water of the Budigandaki River through tunnel. At tailrace, water from tunnel outlet mixes with e-flow from Budigandaki and water from feeder streams- Jagat Khola, Yaru Khola, Dovan khola present between dam and powerhouse. So, there is only slightly decrease in temperature at lower reaches of powerhouse even in low flow summer season (mid of March to May). Stratification is typical of the summer season (May to August) and breaks down after autumn overturn. So, impact is insignificant, no mitigation is required.

To mitigate the impact of eutrophication and low dissolved oxygen, farmers will be guided and encourage to reduce the use of chemical fertilizers and pesticides. Over-dosage of harmful toxic chemicals in farms and agricultural runoff into rivers will be restricted through regulation, monitoring, and cooperation. Pollution to water body will be restricted (those arise from household or from camp). Domestic wastewater will be treated and solid waste will be properly managed. Vegetation will be removed from the impoundment area. Loose slopes will be stabilized with the plantation of various local species (bioengineering approach). All the mitigation measures will be focused to maintain the adequate levels of dissolved oxygen (at least >5 mg/L) for aquatic life (Oak Ridge National Laboratory et al. 2010).

Mitigation against the effect of peak operations – downstream tailrace

Rapid increases or decreases in flow rates can adversely affect downstream ecosystems. To mitigate this, extended ramp-up and ramp-down periods are preferred over abrupt changes. The use of very short-term flow reductions prior to the main reduction i.e. conditioning flows (the practice of rapidly decreasing and then rapidly increasing river flows within one hour of a planned major flow reduction) will be done. It creates learned behavior in juvenile fishes and other aquatic life to emigrate to deeper water during flow reduction; this procedure will be an effective mitigation strategy, particularly for decreasing stranding in side-channels or pools (Irvine et al., 2009).

Mitigation against migration barriers and loss of connectivity

Upstream and downstream of fish migration will be carried out through fish trapping and hauling activities with the involvement of local fisherman. Fish trapping and hauling activities will be frequently carried out by considering the migratory season and migratory pattern of the fish. A fish hatchery will be established for *Schizothorax richardsonii* for the production juvenile fishes. Fish

fingerlings developed from fish hatchery will be released in Budigandaki River; upstream and downstream of the dam and powerhouse areas as a compensatory measure.

Mitigation against Loss of Spawning Ground

Environmental Flow

To maintain the spawning ground of aquatic animals and their population, Ten per cent of the minimum monthly average discharge ($2.2 \text{ m}^3/\text{s}$) as a minimum environmental flow will be maintained throughout the year.

Protection and Maintenance of spawning grounds: Adequate attention will be given to the protection of the spawning and nursery gravel beds. Where needed, additional measures will be taken for protection and maintenance.

Upstream and downstream migration for *Schizothorax richardsonii* will be carried out through fish trapping and hauling activities.

Loss of spawning habitat and subsequent loss of reproduction will be replaced by establishing fish hatchery. A fish hatchery will be established for *Schizothorax richardsonii*. Fish fingerlings developed from fish hatchery will be released upstream and downstream of the dam and powerhouse area.

Fishing in Budigandaki River between Headworks to Powerhouse area will be restricted. Fishing in the tributaries (Jagat khola, Yarukhola, Doban Khola) that are the breeding grounds of Snow trout will be banned during the breeding season (March-April) & (September-October). Sediment mining will only be allowed in designated areas and banned from ecologically sensitive areas such as tributaries and fish breeding locations. The above rules and regulations will be strictly implemented with an efficient and effective watch and ward system.

Mitigation of Impact of Project Operation Activities on Fishes

A physical mesh or a behavioural screen (such as electrical barriers, strobe lights, bubble curtains, or acoustics) with a trash rack will be provided to prevent fish entrainment and impingement through turbines or over spillways.

Rapid increases or decreases in flow rates can adversely affect downstream ecosystems. To mitigate this, extended ramp-up and ramp-down periods are preferred over abrupt changes. It creates learned behaviour in juvenile fishes to emigrate to deeper water during flow reduction; this procedure may be an effective mitigation strategy, particularly for decreasing stranding in side-channels or pools (Irvine et al., 2009).

To mitigate the impact of eutrophication and low dissolved oxygen, farmers will be guided and encouraged to reduce the use of chemical fertilizers and pesticides. Over-dosage of harmful toxic chemicals in farms and agricultural runoff into rivers will be restricted through regulation, monitoring, and cooperation. Pollution to water body will be restricted (those arise from household or from camp). Domestic wastewater will be treated and solid waste will be properly managed. Loose slopes will be stabilized with the plantation of various local species (bioengineering approach).

Fishing in the tributaries (Jagat khola, Yarukhola, Doban Khola) that are the breeding grounds of Snow trout will be banned during the breeding season (March-April) & (September-October). Budigandaki River between 2 km upstream of Dam to 2 km downstream of tailrace will be declared as "Fishing Restricted Zone". Hording boards with 'Fishing Restricted Zone' will be kept. Awareness program will be launched to local fishermen and people.

Mitigate the Livelihood Based on Fish

Job opportunity will be provided to some of the fishermen based on their skill and intensity of impact. Fish trapping and hauling will be offered as a source of job opportunities for affected fishermen families. Some of the affected fishermen will be offered in fish hatchery.

Fishes will be monitored in three seasons of the year starting from the commencement of work. On the basis of the result, if population is found below the considerable level, practical mitigation strategies to increase the population of fishes will be formulated and implemented.

Fish Hatchery

Loss of fish population due to various project activities and structures during construction and after establishment of project will be replaced by establishing a fish hatchery. A fish hatchery will be established for vulnerable *Schizothorax richardsonii* (blunt-nosed snow trout). Fish fries developed from fish hatchery will be released in the impact area of Budigandaki River.

Two potential fish hatchery sites are selected in this stage of survey based on topography, soil, source of water, natural breeding area etc. These potential sites are:

Dobhan: Immediately downstream of the confluence between Dobhan khola and Budigandaki River; at the left bank of the Budigandaki River. Dobhan khola is a perennial stream that joins with Budigandaki River at its left bank.

Yaru Phant: Immediately downstream of the confluence between Yaru khola and Budigandaki River; at the left bank of Budigandaki River. Yaru khola is a perennial stream that joins with Budigandaki River at its left bank.

Table 8-4: Proposed sites for establishment of Fish Hatchery

Characteristics of Fish Hatchery	Dobhan	Yaru Phant
Location	Dobhan	Yaru Phant
Latitude , Longitude	28°17'44.02"N, 84°54'16.28"E	28°19'38.76"N, 84°54'30.02"E
Altitude	About 1000 masl	About 1265 masl
Available land area	>0.6 hectares	> 0.6 hectares
Required land area	>0.5 hectares	>0.5 hectares
Source and water Type	Dobhan khola /perennial source	Yaru Khola/perennial source
Water quality (visual estimation)	Good	Good
Water temperature	Good for breeding of blunt nosed snow-trout	Good for breeding of blunt nosed snow-trout
Physiochemical parameters of source water	Not evaluated	Not evaluated
Soil texture	Not evaluated	Not evaluated
Spawning ground of blunt nosed Snow-trout	Reported at Dobhan khola	Reported at Yaru khola
Vegetation Loss	No	Very few pole size tree
Chances of flooding	No	Not sure

Households	Present	Absent
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Figure 8-3: Proposed Fish hatchery site at Dobhan



Figure 8-4: Proposed Fish Hatchery site at Yaru Phant

Out of these two sites, first site (located at Dobhan) will be given the first preferences. Based on the habitat quality and other requirements, final location and detail design of the hatchery will be finalized. Two years will be allocated for construction of the fish hatchery and will be operated at least one year before the dam construction so that fish fingerlings are available for stocking on the first year of the project operation.

Breeding and research on blunt nosed snow trout has been going on fisheries Research Centre, Trishuli, Kaligandaki Hydroelectric Project A, Fisheries Research Centre Pokhara and other hydropower projects. Output of research and lesson learned from these areas will be utilized for the development of fish hatchery and the production of fish fries. Related design experts and fish hatchery experts will work together during design, planning and implementation of the hatchery. Fish hatchery and restocking will be planned in detail during the first year of project construction. After closely monitoring the result, the plan will be rectified in subsequent years.

8.3 Socio-Economic Mitigation Measures

Construction Phase

The project area is thinly populated area with low economic activities, thus, the project impact on socio-economic aspect is relatively lower. However, the project will still result in loss of properties, displacement of population, which are among some of the major social impacts. Although the optimization process has selected for the locations with the least foreseen impacts the final selected project layout has social and cultural impacts as it shown in the previous chapter. In order to minimize and compensate for these negative impacts a set of compensatory and enhancement measures are described in following sections.

Income Generation and Employment Opportunity

The project implementation will generate relatively large-scale employment opportunity for the project area. Transforming this opportunity to the local population can significantly improve the economic condition of the area. Therefore, the project will prioritize affected families and then local inhabitants of the project area in the recruitment process for the project, which has been repeatedly demanded by the locals during consultations. In order to make this obligatory, the project will make prioritization a working protocol for the project as well as include it as a clause in the contractor's agreements.

The skill level of locals might not match the skill required by the project. Thus, the project will conduct training programs on such as electrical wiring; plumbing and welding will be given to project affected families to enhance their skills. An indicative cost for the trainings is presented below:

Table 8-5: Indicative costs for the training programs

SN	Training	Number of training (20 participants per training)	Cost [USD]	Total [USD]	Remarks
1	Electrical wiring	2	2000	4000	
2	Plumbing	2	2000	4000	
3	Welding	2	2000	4000	
4	Driving	2	2000	4000	
	Total			16,000	

Skill Enhancement Measures

The project will adapt to the policy of maintaining the life of locals at the current level and/or improve. Thus, the project will support programs that can improve the livelihood skills and capacity of local population, particularly of those affected by the project, women, disadvantaged groups, and children. The training programs that are envisioned for the skill enhancement and the indicative costs are presented below, which will be revised by Social and Environmental Management Division (SEMD)¹ during its implementation.

Table 8-6: Indicative budget for the Skill Enhancement

¹ SEMD is a project body with overall responsibility of implementing EIA recommendations. This is discussed in details in the chapter - the Environmental Management Plan – of this report.

SN	Training	Number of training (20 participants per training)	Cost [USD]	Total [USD]	Remarks
1	Tourist service traing	2	2000	4000	
2	NTFP collection and processing	2	3000	6000	
3	Livestock farming	2	2000	4000	
4	Vegetable farming	2	2000	4000	
5	Bee keeping	2	2000	4000	
	Total			22,000	

Community Infrastructure and Facility Improvement

The project is expected to affect existing community infrastructures on which the local population is directly and sometimes indirectly dependent on.

The *health facilities* in the project area, particularly those lying within easy accessibility from the project sites will face pressures from the newly added populations in the project area caused by the implementation of the project. In this context health facilities in the project districts are likely to experience more pressure since these will be easily accessible from the project sites. The project will have to support existing health facilities as well as establish health units within the camps.

The *drinking water* sources of the settlements around the construction sites as well as project facilities sites are likely to face pressure from the influx of labourers and their dependants, project officers and their dependants, seasonal visitors, outsider businessmen and vendors, *etc.* A number of actions may be required,

Establishment of new drinking water systems,

Upgrading and enhancement of existing drinking water systems of the settlements,

Explore using the Dudhkoshi River water for drinking purposes and

Monitor water sources in the vicinity of the tunnel.

The project is expected to disrupt existing **foot trail connection**. A portion of the foot trail at the intake site that connects Jagat with Salleri, which is the main trekking route in the Manslu Conservation, will be affected by the project. The project has proposed alternative routes so that the accesses are not disrupted. As a result, the connection is expected to improve the road connectivity for local population.

Compensation for Household and Community Assets

The compensation will be provided to the affected families for the land acquisition for the different project components. The project will acquire land required permanently by compensating the land for cash. The consultation with the local inhabitants during the household survey, as well as, consultation and public hearing meeting, cash for land provision has been clearly stated by the local inhabitants. Therefore, this study strongly recommends land for cash compensation as viable methods of compensation. The land required temporarily will be acquired on lease. The temporary lands will be restored after completion of the construction phase.

OPTION 1: Cash Compensation for Project Affected Population

The first option is cash compensation for the affected households with their private assets such as land, residential structures, toilet, cow sheds, water taps, kitchen, fruit trees, and banana trees.

As practiced in other projects in Nepal, the compensation will be carried out for forming a Compensation Determining Committee, which will have representation of the representative of affected municipalities/wards, district level government officials, project officials, and affected families. This committee will determine the cost, which is usually determined by considering 30% of the government rate of the land, and 70% of the price of market price. The highest price of the locality is considered as per the decision made by the locals including affected people in the area.

Similarly, for the compensation of residential structures and minor structures, the price is calculated as maximum as possible as per the municipality evaluation practices of the locality. The business opportunity is calculated as per the existing monthly income by rent and earning by the shops/hotels as per the information provided by the community people.

For the severely affected people, in addition to the price of land, house and minor structure including business opportunity cost/allowance, shifting allowance will be as restoration allowance of 180 days at the rate of district wage rate for household head.

For the loss of socio-cultural resources, the project offers several training programs such as skill development and financial management training and other livelihood restoration programs.

Moreover, for the loss of public structures such as foot trails, resting places, temples, Church, Ghat, and others, the project will offer the actual cost proposed in cost estimate or decision made by the local meetings.

OPTION 2: Land for Land Compensation

Though land for land compensation has been ruled out by the locals, the study team has identified Jagatbagar or Yaruphat as possible the relocation. These sites are located in the existing foottrail, and will soon be connected by the road, which is being constructed. The proposed relocation sites already have settlement. The land can be purchased by the project. The Project can improve or add community facilities such as water supply (if needed), access roads (if needed), relocation of religious structures (churches, etc.), school (ECDC and Primary if needed) and bridges and ghats, if need.

Restoration of Cultural Sites

The construction and operation of the project will cause alterations to a few sites with important cultural and religious values. To minimize and compensate for the negative impacts on these cultural and religious values mitigation initiatives. The followings mitigation initiatives aimed at minimizing, mitigating and compensating the negative impacts:

All of the affected cremation sites will be restored in adjacent sites after proper consultation with the affected communities. In addition to the physical restoration of the affected sites, the project should consider covering the associated costs of rituals and ceremonies that may accompany the restoration of such sites.

All the affected temples and shrine will be restored in adjacent locations through proper consultation with the affected communities.

Disease Control Measures

There is likely incidence of water borne, air borne, noise and vibration related and vector borne disease during project construction period. Similarly, incidence of STDs and spreading of contagious diseases among camp population, worker's community and population in the vicinity of working areas and

camp areas are also likely. Measures should be taken to ensure rapid response when disease outbreaks occur and monitor the general health status working closely with the district authorities and health posts. An emergency unit set-up should be also able to handle disease outbreaks.

Psycho Social Impact Mitigation Measure

Involuntary displacement is often associated with psychological problems caused by a number of reasons such as the (i) sentimental attachment with their ancestral dwellings, (ii) fear for a secure future caused by the loss of livelihood and uncertainty to get secure livelihood in a new resettlement place, (iii) uncertainty and fear to cope in new surroundings, and (iv) the loss of social networks. Measures should be in place to provide psychological counselling, and making the resettlement process smooth and assuring livelihoods are secured.

Improving Social Cohesion

The project is likely to disrupt social cohesion due to the influx populations from different cultures, and disrupting social cohesion. Alcoholism, gambling, vandalism, prostitution, crime rate, communal violence etc may increase leading to social disorders and ultimately affecting social well-being adversely. In addition, pressure of the natural resources like wood and fodder may increase. Likewise, an increase in tree clearing for agricultural land may occur leading to conflicts. Measures should include creating ample employment opportunities and population influx should be monitored to the extent possible.

Social Conflict due to Influx of Work Force

Following mitigation measures will be adopted to mitigate such impacts;

Maximizing the use of local labors in the project work

Strict code of conduct will be operated to regulate the workforce

Awareness to be given to the workforce about the local norms and condition

Livelihood Support

Agriculturally based Approach

The project area is thinly populated with limited area under cultivation. Mostly subsistence agriculture is practiced by the locals, as majority of them are either engaged in tourism, wage laborer, and migrant workers. However, cultivated land in Salleri Village and small part of Uiya Village I'll be affected. Thus, extensive agricultural program is not expected by the project. However, the project is proposing to support farmers of Uiya Village to improve their farming capabilities.

The first task of this mitigation measure is to compensate farmers for the loss of their agricultural produce due to land acquisition. The project will provide a cut-off date to the farmers to stop cultivation of their farms. However, perennial crops and fruit trees will be compensated by the project. Secondly, the project will carry out agriculture-based livelihood support to the locals so that local residents could improve their livelihoods. This includes measures and plans aiming to compensate the production losses, enhance productivity, diversify production and improve marketing in both agriculture and livestock. These measures are organized into different sub-plans, including:

Intensification of Food Production will focus to the affected municipalities-wards to support the local farmer to improve their farming practices, make availability of improved seeds and fertilizers and other necessary inputs. The project will facilitate the farmers and existing agriculture cooperatives in the project area in order to effectively implement the proposed mitigation plan. The project will collaborate

with DADO to improve accessibility of farmers to the agricultural inputs – such as fertilizers, irrigation, seeds *etc.*

Project will prioritize promotion of fruit cultivation on Bari and *Pakhobari* farmlands, particularly in sloppy lands, where possible, also extend this programme in rest of the affected Municipality. The fruit tree saplings planted on slopes could start fruiting in 4-5 years time and in the long run, farmers would get more economic benefit from fruit trees compared to maize and other annual crops. Initially, till the trees start fruiting farmers would lose production of cereal grains to feed their family members. Harvest of ground cover could increase fodder availability for improved livestock under stall-fed management system. Project will work in collaboration with DADO, DLSO and District Soil Conservation Office. This programme should include, among other components, (i) Compensation package for replacing annual crops with perennial crops or fruit trees till they start fruiting. (ii) Training to farmers on ecological land and pest management system, fruit tree management and production, post harvest technology, packaging, storage and marketing, provision of drip irrigation system, supply of suitable fruit tree saplings and (iii) diversification of crops in general (*e.g.*, coffee).

The project will also promote farming of commercial vegetable in the project area. Once the project implementation starts, demand of fresh vegetable will exponentially grow. The project will use this opportunity to support local farming to produce fresh vegetable. This would include training to participating farmers, improvement in irrigation system – launching drip irrigation practices on slopes, water management, improved seeds, fruit tree saplings, integrated pest management, organic farming, and other farm inputs. The vegetable production will be started at commercial scale in comparatively flatland area and the irrigation system will be improved as basic need for vegetable farming. The project will encourage local farmers to take up the role of supplying their agricultural products to the workforce. This will also ensure that the benefit of the project is distributed to the locals as well as motivate farmers to commercialize the agriculture. The enterprising initiatives started by PAFs families will be supported by the project by providing guarantees facilitating loans from the Local Commercial Bank. The cooperatives would facilitate business on animal husbandry and agriculture (fruits and vegetables).

Commercial Poultry and Dairy Farming: The project will prepare and implement a Commercial Poultry and Dairy farming Plan in accessible and in selected parts of project areas. DLSO has already initiated poultry and dairy farming in the project affected wards. Besides, there are few entrepreneurs who have started selling poultry chicks, feed and veterinary medicines, as well as milk collection and transaction. This action plan is proposed to (i) encouraging potential farmers to adopt commercial poultry and dairy farming, (ii) assist in the establishment of small to medium-scale poultry farming to interested farmers, (iii) facilitate the provision of veterinary and animal management services, (iv) facilitate the provision of improved breed of poultry chicks and dairy animals, (v) Intensive forage production including fodder trees in farmland and in community forests and leasehold forests, (vi) establishment of small-scale processing plants where possible, and (v) training to farmers on commercial poultry and dairy farming, milk production, processing, storage and marketing. The establishment of medium-scale chilling centre would be looked at during detailed project design phase. The project will implement these plans in the project area in collaboration with the District Agriculture Development Office (DADO), District Livestock Services Office (DLSO). The plans below are to be formulated during the design phase of the project and implemented during the project construction phase.

Non-Agricultural Strategy

Unlike to other parts of Nepal, only limited local inhabitants are engaged in farming, furthermore, only subsistence farming is practiced. Therefore, non-agricultural livelihood support is necessary for the locals. The following guidelines are proposed as the livelihood support for the project.

Preferential access to project construction employment opportunities, to the extent possible

Assistance with training in life skills that would help in obtaining employment and/or earning livelihood

The project will facilitate the assessment and (where feasible) establishment of small-scale income-generating schemes (micro-enterprise development) for affected households in the Project area.

Counselling regarding project impacts, compensation alternatives and risks, and resettlement options (where required).

Counselling on saving schemes and cash management

Support to establish retail or other business in a suitable location in the Project sites. This also includes facilitation and encouragement to affected people to open noodles, bakery and other cottage industries so that it serves both the people working for the Project and affected people themselves.

Promotion of tourism in the project area participating local inhabitant.

Mosquito Vector Borne Diseases

Creation of a reservoir by damming on Tamakoshi River will create a reservoir which will become a favorable breeding ground for mosquitoes which serve as carriers of diseases like malaria, filariasis, encephalitis, dengue, Kala Azar etc. The reservoir due to its planned operation where the water level fluctuates on a daily basis may however not be congenial for mosquitoes requiring stagnant water. The water quality sampling of the reservoir should include analyses for mosquito larvae.

Health and Sanitation

In order to ensure that the project does not contribute to the spreading of communicable diseases, the project proponent will make an effort to keep the project area clean and hygienic. The labor camps and the project area will have an adequate supply of clean drinking water. Water at the sources will be tested and treated as necessary. Public taps will be installed at appropriate locations in the project affected area/s. Adequate drains will be constructed in order to avoid stagnant pools of wastewater.

Toilet facilities will be made available in camps of the project site/s with an allocation of a maximum of 20 people per toilet. A dry system of sewerage disposal, such as ventilated improved pit latrines, would be appropriate for the project area. These are easy to construct and do not require a flushing system. The latrines will be located at a distance of at least 6 m away from residential areas and at least 30 m away from water sources. If septic tank systems are to be used, the soak pits will be located at a safe distance from water sources. Latrines will also be constructed in areas that are likely to be visited frequently by the construction workers. Domestic solid waste generated in the project will be buried in designated landfill areas. Organic waste will be composted in pits.

Limited resources and services in the project area are likely to be affected due to the increase in pressure resulting from the influx of laborers during the construction period. However, adopting the following measures will mitigate such impacts:

- Local people will be employed as far as possible to reduce the pressure on local health institutions and other services;

- The project will provide funds for the improvement of the existing local services like water supply, health posts etc;
- The project will also support for educational programs;
- The project will build adequate construction camps to cater the necessities of the workers.

Occupational Health and Safety

The contractor(s) should adopt Safe Construction Practices (SCP) in order to minimize construction related accidents. Measures to be practiced by the contractor will be as follows:

- trainings will be provided to all construction workers about SCP;
- Fencing will be done to restrict public movement around the construction sites;
- Protective gear such as helmets, boots, gloves and masks will be provided to construction workers, supervisors and visitors;
- Warning signs/posts will be installed for informing the local people about the potentially dangerous areas such as quarry site, weir site (dam site), tunnel outlets and tailrace outlet;
- Only authorized persons will be given responsibility to operate machinery and other heavy equipment;
- Temporary support structures will be constructed to avoid rock falls, erosion and landslides during construction. Soil excavation during monsoon in unstable areas will be minimized, if not totally avoided;
- Adequate lighting and ventilation facilities will be maintained at all construction sites;
- Emergency equipment like first-aid kits, flashlights, fire extinguishers, siren, emergency vehicles and phones will be made available at construction sites;
- Qualified medical personnel will be appointed at the construction sites to oversee emergencies related to occupational health and safety;
- An emergency response contingency plan will be prepared to appropriately deal with emergencies. The workers will be trained to follow the plan in case of accidents;

The contractor(s) or the client will obtain insurance against any possible harm to all project staff/workers including client's personnel. Furthermore, the responsible party will also obtain third party insurance against any possible harm to visitors and possible victims.

Operation Phase

Withdrawal of economic activities and people's behavior

Upon the completion of the project, most of the skilled labor will lose jobs. They will not be able to utilize their skills locally. In order to maintain their economy through the utilization of their skills, they will have two options: either, they have to leave the area and go elsewhere in search of jobs that match their skills or they have to remain in the local area and find jobs which are locally available. In order to mitigate such kind of trauma of job loss after the project, the following measures will be adopted by the project:

- The project will try to appoint maximum number of local people as far as possible during the operation period;
- Training sessions will be conducted at least 3 months prior to the project completion, so that the labor force will be able to start their own businesses immediately upon the termination of their jobs in the project;

- Training programs will be organized particularly targeting the skilled labor force willing to establish their own entrepreneurship, where they can utilize their skills and make a living; and
- Possible efforts will be made by the project to help the trained and interested local human resources obtain employment in new hydroelectric projects.

Impact due to Sudden Release of Water

During the operation phase, the sudden release of water downstream of the headworks may cause accidents. Thus, as a mitigation measure, a siren system will be established to make the downstream people aware about the timings of the release of water. Similarly local people will be made aware about the siren system. Beside this, the project will

- notify the concerned communities about the plan of release through written notices, mouth to mouth information.
- install alarm warning system (Siren) at appropriate location so that alarm sound is disseminated to all concerned. Warning signal (Siren) will be made at least three times (before 1 hour, 30 minutes and 15 minutes) before water is released.
- install a special alarm system so that in case of sudden shut down of powerhouse or tunnel, the system will automatically ring loudly at least 5 minutes. The released water will take some time to travel downwards during which people nearby bank will have sufficient time to move safely.

Possibility of Accident to the Local people

Following mitigation measures will be adopted to control accidents during the operation phase:

- All dangerous sites such as switch yard, surge tank area will be fenced as a precautionary measure to restrict people's movement in the area;
- Safety signs and posts will be erected at critical areas, and
- Local people will be made aware of dangerous project areas

Royalty and project share

After the completion of the project certain amount of the royalty will be shared to the local body which will help to development activities in the project affected area. The project will open its share to the local and project affected families as per the Government Rules.

CHAPTER 9. ENVIRONMENTAL MANAGEMENT PLAN

An integrated Environmental Management Plan (EMP) has been prepared for the Budhi Gandaki HEP to set out environmental management requirements. Besides, it also proposes procedural frameworks to ensure that all mitigation measures and monitoring requirements specified in the Environmental Impact Assessment (EIA) study report will actually be carried out in subsequent stages of project construction and operation. The EMP as written now is to function as a framework for the formulation of in-depth plans, programs and specific mitigation measures during the pre-construction phase and at the on-set of the construction phase of the project. When its contents are fully formulated it is envisaged to serve as an environmental operation manual for the Budhi Gandaki HEP management group and staff employed by the management.

The basic objectives of the EMP are to:

- formulate environmental management requirements to ensure that all mitigation measures and monitoring requirements specified in EIA report is actually being carried out in different stages of the implementation of the project,
- define environmental management principles and guidelines for the pre-construction, construction, post construction and operation phase of Budhi Gandaki HEP,
- establish environmental resource needs,
- recommend a plan of action and a means of testing to meet the existing and projected environmental problems,
- establish the roles and responsibilities of all parties involved in project environmental management,
- describe mitigation measures that shall be implemented to avoid or mitigate adverse environmental impacts by maximizing the positive ones,
- establish a supervision, monitoring, auditing and reporting framework,
- ensure implementation of recommended corrective actions aimed for environmental management and its enhancement, and
- ensure that the environment of Budhi Gandaki HEP construction sites and the region of influence is developed to meet the needs of the local people, the stakeholders and safeguard the national interest.

9.1 Implementation approach and mechanism

The proponent will be responsible for the overall implementation of the EMP. It will hire the experts and staff necessary to formulate the proposed plans in the EMP through consultative processes with relevant stakeholders. Each plan/program/measure will be disclosed to the stakeholders and agreements made with them to ensure implementation viability. The EMP is meant to be adaptable to the changes that may occur in the project area, policy and regulatory mechanisms, and stakeholder concerns and views. An Environmental Management Unit of the Social and Environmental Management Division (SEMD) from the proponent will actively liaison with the CSR group of SNP and GON agencies to assure that implementation is smooth. The PCDDP will provide a frame for consultative and disclosure during the EMP formulation and implementation.

Different parties to be involved directly and indirectly for environmental management of the proposed Budhi Gandaki HEP components include among others:

- Ministry of Forests and Environment (MOFE);
- Ministry of Energy, Water Resources and Irrigation (MoEWRI)

- Funding Agencies;
- Project Management Unit of the proponent of Budhi Gandaki HEP;
- Department of Electricity Development (DoED)
- Department of Forest
- Department of National Parks and Wildlife Conservation
- Manaslu Conservation Area
- Supervising Engineers for Budhi Gandaki HEP implementation;
- Construction Contractor; and
- Regional and local level political and governmental institutions (Rural and Urban Municipalities), line Community-based Organizations (CBOs) *etc.*

The effective implementation of EMP will require a continuous monitoring of its environmental performance, and where necessary initiate appropriate planning and implement corrective actions.

9.2 Institutional Arrangement and Responsibility

Budhi Gandaki Hydroelectric Project Pvt Ltd headed by a Chief Executive Officer (CEO) will be established to implement the proposed project. There will be a provision for Budhi Gandaki HEP Board which will guide the implementation of the Project during construction and operation phase. Under CEO, Project Director Office will be established and the later, among other offices/divisions, will have Budhi Gandaki HEP Social and Environment Management Division.

9.2.1 Budhi Gandaki HEP Project Director Office

The Budhi Gandaki HEP Project Director Office will establish Budhi Gandaki SEMD as implementing agency for environmental programmes. The Project Director will coordinate and make final decisions on the implementation of environment mitigation and monitoring plan, however, the Director may delegate some authority to Budhi Gandaki SEMD. Most of the mitigation measures will be implemented during the construction phase as part of tender document clauses and by the project with technical assistance or in partnership with line agencies, NGOs and CBOs. The Project Director will approve the Environment Protection Plan, Health and Safety Plan, Waste Management Plan and other relevant environmental programmes prepared by the Contractors as recommended by Budhi Gandaki SEMD. The Budhi Gandaki HEP Board may authorize the Project Director Office to stop work or penalize Contractors for breaching environmental tender clauses or non-compliance or non-performance. The Project Director Office will ensure timely and quality implementation of mitigation and enhancement measures as well as monitoring. The Project Director will sign agreements with public and private or NGO agencies to implement approved environmental and social programmes as recommended by Budhi Gandaki SEMD.

9.2.2 Budhi Gandaki Social and Environment Management Division (Budhi Gandaki SEMD)

The Budhi Gandaki SEMD headed by Social and Environmental Manager will be established in Project Director Office at the very beginning of the project implementation. SEMD will report directly to the Project Director Office. As shown, SEMD will have three sections namely Environment Section, Monitoring and Evaluation Section, and Social Section.

Environment Section will be responsible for implementing bio-physical and socio-economical mitigation and enhancement programmes, land acquisition and compensation, resettlement and rehabilitation, community development, livelihood programmes, health related programmes.

Monitoring and Evaluation Section will be responsible for monitoring of environmental and social programmes implemented by the project and the contractors as per contractual agreement; it will report on compliance.

During the project construction phase, SEMD will be a full-fledged office but it will be reduced in size as Social and Environmental Management Unit (SEMU) during the operation phase. Functions and responsibility of SEMU will be influenced by the findings of the Environmental Audit conducted by the project through outsourced agency within three months of the completion of the construction work, which will assess the environmental compliance during construction phase, identify the emerging problems, assessing the environmental and social works to be done, and recommend mitigation and enhancement measures to be implemented during operation phase. After the Environmental Audit, regular works of SEMD may be considerably reduced or ceased. The Budhi Gandaki SEMD will review

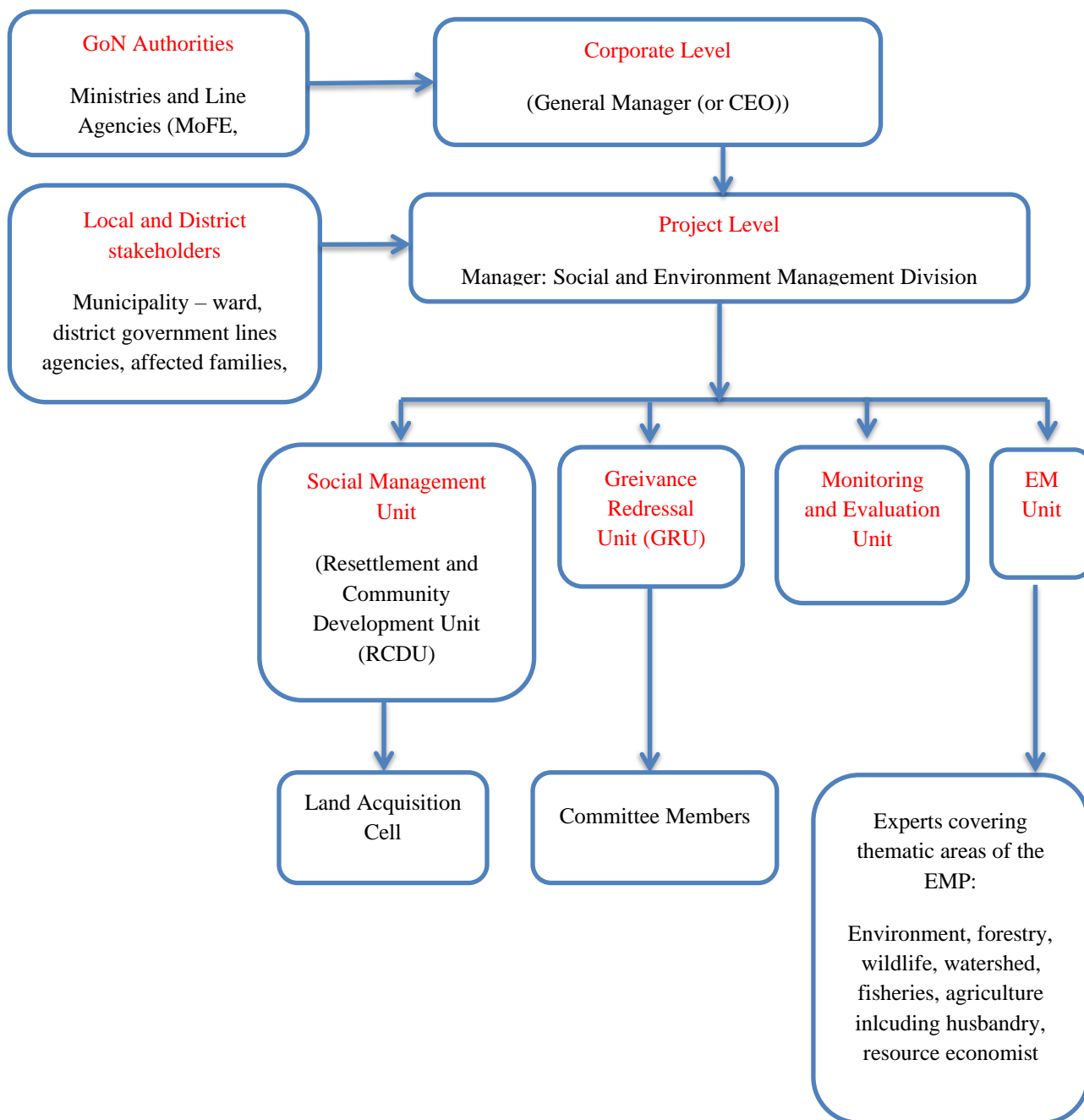


Figure 9-1: Organizational set-up for Social and Environmental Management

Environment Protection Plan, Health and Safety Plan, Waste Management Plan, and other environmental and social plans prepared by the contractors and assist the Project Director Office for their timely approval. The EMD will prepare an Annual Environmental and Social Management Plan for implementation and coordinate with Budhi Gandaki HEP Divisions and other district or national level public, private and NGO agencies for programme implementation, and prepare monthly reports, quarterly reports and annual reports. Liaison with local communities, agencies, NGOs/CBOs, and other major stakeholders will be the major task of EMD Environment Manager. The Budhi Gandaki SEMD will manage the Project Information Centre established in Kathmandu, project districts, and project sites.

9.2.3 Staff Positions and Responsibility

The staff positions and their qualification, staff responsibilities, duration of staff, reporting types and frequencies, and other related matters will be developed during the Design Phase of the project.

9.2.4 Construction Contractors

The construction contractors are responsible to prepare site specific plans for mitigation implementation and monitoring components discussed in this chapter. The contractor has to prepare "Environmental Management Execution Plan (EMEP)" to be submitted to the client. The EMEP has to explicitly discuss roles and responsibilities, methods, monitoring and reporting mechanisms.

9.3 Regulatory Mechanism and Environmental Permits and Approval

Implementation of environmental and social mitigation measures will be regulated by GON policies and legal framework. The EPA, 2019 and EPR, 2020 have made provisions for the compliance of EIA Report, monitoring and evaluation, environmental audit, and restrict discharge of radio-active emission and other waste materials in convention to the criteria fixed by the government. Land Acquisitions Act, 1977 regulates the land acquisition and compensation fixation process. The Hydropower Policy, 2001 fixes the environmental flow downstream from the dam. There are many other Acts, Rules and policies which directly or indirectly regulate the socio-economic and environmental activities to be implemented by the project.

The Budhi Gandaki HEP Project Director will acquire permits for clear felling or cutting trees in the national forests in the project area from the Department of Forestry. While the Community Forest User Groups and leasehold Forest User Groups and the DFO will give permit to fell trees from the community and leasehold forests. In the project construction sites, contractors will make request to the Project Director through Budhi Gandaki SEMD for the approval for clear felling or felling few trees, and with the recommendation of SEMD the Project Director would make official request to DFO for tree felling approval.

As per the Local Governance Act, Contractors would require permit for quarrying sand, stone and other materials. Permit or negotiation with the landowners is required to temporarily acquire agricultural land for the project.

9.4 Environmental Standards

Benchmarks for limits must be established based on GON and International Finance Institutions (IFIs). The Environmental Management Plan is presented below. This will further fully formulate and will be prepared for the contractual purposes during the pre-construction stage.

Budhi Gandaki -EMU will prepare monthly, trimester and annual progress reports, and send them to district line agencies and Budhi Gandaki HEP for sharing information. The Budhi Gandaki -EMU will organize trimester meetings, which can also be called as project coordination meeting. The trimester

progress of the project activities can be reviewed and openly discussed during this time. Similarly, the project will organize the annual meeting either in Kathmandu or in project's district headquarters, Gorkha to review yearly progress of the project activities. It will be targeted to concerned line ministries and departments and other principal stakeholders in the districts. The reporting may be altered to fit IFI requirements.

9.5 Permit and Approval Plan

The project proponent has to obtain permits and approvals prior to start of the project

Table 9-1: Permits and approvals

Permit and approvals	Authority	Timeline	Responsibility
EIA approval	MoFE	Preconstruction	Proponent
Generation license	MoEWRI	Preconstruction	Proponent
Tree clearance	MoFE, DFo, MCA, Private forest	Preconstruction	Proponent
Permanent land acquisition	Chief District Office	Preconstruction	Proponent
Temporary land acquisition	Land owner	Preconstruction	Proponent
Entry and works on private land and property	Land owner	Preconstruction	Proponent

9.6 Environmental Mitigation Plan

The environmental mitigation measures for the impacts are discussed in the Chapter **Error! Reference source not found.**. The measures discussed are presented in a form of plan in this section.

9.6.1 Pollution Abatement Plan

The objective of the pollution abatement plan is to avoid or minimize contamination - gaseous, liquid, or solid - from the project activities during construction and operation periods of the project. Both preventive and remedial measures will be implemented by the project. A number of measures have been listed in the mitigation measures in Chapter 8 for air, water, land, and noise pollution. Table 9-3 highlights the key features of the pollution abatement plan.

Table 9-2: Pollution Abatement Plan

Activities	Schedule	Location	Responsibility
Air Pollution Abatement			
The roads in the project area will be regularly sprinkled to minimize fugitive dust during the dry seasons.	Construction	All active construction sites, particularly near settlement area	Contractor/ Project/ SEMD
Temporary road black topping shall be carried out in the portions close to the major settlements and houses	Construction	Settlements along the major access roads	Contractor/ Project/ SEMD
The major construction sites and plants (aggregation plant, stockpiles <i>etc.</i>) have to be covered by the Green Scaffolding Netting Clothes, and the area will be sprinkled regularly.	Construction	All construction sites	Contractor/ Project/ SEMD

Loads entering and leaving the site should be covered if they are expected to contribute to the creation of particles or dust.	Construction	Construction sites	Contractor/ Project/ SEMD
Application breathing mask by the workers and visitors entering the dust-prone area like crushing plants, batching plants, rock drilling.	Construction	All construction sites	Contractor/ Project/ SEMD
All vehicles used in the projects should comply with the national emission standards	Construction/ Operation	Project area	Contractor/ Project/ SEMD
When combustion engines are used underground, suitable ventilation measures must be taken to avoid air pollution and health/safety issues. Additional ventilation may also be needed to limit the exposure of workers to toxic gases released from excavated rock in underground work	Construction	Underground structures – headwork, adits, tunnels, powerhouses	Contractor/ Project/ SEMD
<i>Water and Land Pollution Abatement</i>			
Water discharged from the construction sites will be accumulated by the drainage system, which is collected in the settling tank/pond before releasing to the nature. Minimum water retention period has to be 2 hrs.	Construction/ Operation	Construction and Project sites	Contractor/ Project/ SEMD
Storage of lubricants and chemicals has to store in covered area in drums and containers.	Construction	Construction and Project sites	Contractor/ Project/ SEMD
The waste water from the mechanical yards will be collected and released only after treatment.	Construction/ Operation	Construction and Project sites	Contractor/ Project/ SEMD
The construction sites and camp sites will have toilets with septic tank. The waste water will be treated before releasing	Construction/ Operation	Construction and Project sites	Contractor/ Project/ SEMD
Open defecation and urination will be prohibited. Temporary toilets will be installed for the workers and visitors. Signs will be placed about it.	Construction	Construction and Project sites	Contractor/ Project/ SEMD
Garbage bins will be placed in the camp and work sites, which will be collected. Composting will be practiced for the kitchen waste and organic waste. Non degradable waste will disposed in the designated site.	Construction/ Operation	Construction and Project sites	Contractor/ Project/ SEMD
The spoil disposal will be carried out in the designated sites. The site will be covered by drainage and collected in a settling tank before releasing. Terracing will be practiced for spoil disposal. Gabion and retaining walls will be place to stabilize the terraces.	Construction	Disposal site	Contractor/ Project/ SEMD
<i>Noise Abatement Plan</i>			
Noisy construction works will be carried out during the day time, as far as possible	Construction	Construction sites	Contractor
Vehicular movement in the settlement area with speed limit (10 - 40 km/hour) and prohibition on use of horns	Construction/ Operation	Project area	Contractor/ Project/ Department of Roads/ Municipalities
Low noise generators shall be used, noise reducing measures (enclosed structures, mufflers etc.) shall be applied in noisy equipment. Ear mufflers shall be provided to workers	Construction/ Operation	Construction sites	Contractor/ Project/ SEMD
Controlled blasting shall be carried out doing day time only. Public shall be notified of the	Construction	Construction sites	Contractor/ project/ Security body

blasting. Security will be provided to prevent entry of non-authorized personnel and/or visitors in blasting zone.			
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The contractor will prepare issue based and site specific pollution abatement plan incorporating the minimum provisions listed above and in the mitigation section of Chapter 8. This plan will be submitted to the supervising engineers for a prior approval of a concerned environmental officer before the project construction works start. The approved pollution abatement plan of the contractor will be documented and placed in the public information center at the site office as a reference document.

9.6.2 Slope Stability and Erosion Prevention

The construction works of the project involve massive earth work, blasting, tunneling, which is expected to disturb the slopes of the project area as well as the spoil and muck generated have to be dispose safely. The mitigation measures to either prevent or reduce slope instabilities and erosion have been incorporated into this plan.

Table 9-3: Slope stability and Erosion Prevention Plan

Activities	Schedule	Location	Responsibility
Conservation of top soil by stockpiling it for the site rehabilitation in the construction sites – camp and quarry sites.	Contraction	Temporary project sites	Contractor/ Project
Surface excavation above 3 m vertical height will be extracted through benching	Construction	All project sites	Contractor/ Project
Slope stability measures: reconfirmation/ identification of slope instability area Reducing slope angle Surface drains to divert water from flowing into the slide area Retaining structure to prevent slope failure Plantation of the slopes application of grass turfing on gentle slopes and concrete on the steep slopes	Construction	Project area	Contractor/ Project
The excavated sites will be protected against water erosion by adequate vertical and horizontal drainages and the water collected will be safely discharges	Construction	All project sites	Contractor/ Project
Minimize spoil production by using cut and fill techniques in the slopes, use of the spoil as construction material as much as possible	Construction	Project sites	Contractor
The spoil disposal sites will be managed as discussed earlier – drainage coverage, bench terracing of spoil, reinforcement of terraces by walls, sediment trapping in the run-off from disposal site.	Construction	Disposal sites	Contractor/ Project
Stockpiling and storage of the construction materials will be done in designated sites only. Prohibition on the stockpiling of construction materials in other areas.	Construction	All project sites	Contractor/ Project

The contractor will prepare a spoil disposal plan and topsoil saving and reuse plan in the designated areas provided by the project management at least a month before the actual excavation works and will take approval from the project environmental officer. The spoil disposal and top soil saving plan will incorporate the minimum provisions as stipulated in the mitigation section in Chapter 8. This document will be placed in the project information Centre as a reference document.

9.6.3 Construction Camps and Traffic Management Plan

Transportation of construction equipment and accessories and establishment of various camps for engineers, contractors, workers, storage yards, and mechanical yards are the first activities of the inception phase of the project. The construction preparation activities at the site might have lasting consequences. Therefore, planning for traffic management (on site and along the road corridor) and management of construction camps and storage facilities (fuel and hazardous materials) are crucial for the overall environmental management plan. A proper and sensible planning at this stage will avoid likely environmental and social adverse consequences in the future.

Table 9-4: Construction camp and traffic management plan

Activities	Schedule	Location	Responsibility
Coordination with local authorities and people on commencement of the project	Contraction	Project area	Project
Preparation of detailed environmental management plan	Construction	Project area	Project/ Contractor
Marking and clearance of sites for establishment of the project work camps	Construction	Project sites	Project/ Contractor
Environmental guidelines for operation of construction equipment and vehicle	Construction	Project sites	Project/ Contractor

9.6.4 Terrestrial Ecological Management Plan

The objective of terrestrial ecological management plan is to ensure that the terrestrial resources such as forests/vegetation, and wildlife of the project site and surroundings will not face adverse impact due to the project implementation. However, project efforts will help to safeguard ecosystem and enhance its goods and services.

The contractor will be made contractually responsible for provisioning local employment, supply of kerosene and LPG at the labor camps, for prohibiting the use of local NTFP and wildlife within the camp etc. The project management will ensure that the above provisions are adequately covered in the bid documents. The project management and its environment and community development unit will be responsible for drawing terrestrial ecology management plan, particularly the public awareness and compensatory afforestation management plan, based on the wider consultation with the local communities and concerned government line agencies.

Table 9-5: Terrestrial Ecological Management Plan

Activities	Schedule	Location	Responsibility
Marking of protected species from the sites to be cleared. Removal threatened species as much as possible.	Construction	Project sites	SEMD/ Contractor/ DFO/ MCA
Minimize vegetation removal by marking trees only in the sites that required to be compulsorily cleared of vegetation, e.g. vegetation in the Right of way of road do not required to be removed.	Construction	Project sites	SEMD/ Contractor/ DFO/ MCA
Removal of vegetation Acquisition of forest clearance permit Marking of trees to be removed in participation of DFO Removal of marked trees and stockpiling	Construction	Project sites	SEMD/ Contractor/ DFO/ DFUG/ MCA Forest Management Committee

Compensatory plantation Identification of compensatory plantation in consultation with the DFO, MCA, CFUG and MCA FMC Seedling procurement Plantation of the seedlings Assisting DFO, DFUG, MCA FMC for management of plantation area for at least 5 years	Construction/ Operation	Area designated by the committee	Contractor/ SEMD
Prohibition of use of Fire wood use from the forest to be used in the project, and supply LPG and/or Kerosene for cooking purposes.	Construction	Project area	Contractor/ SEMD
Prohibit trading of Forest and Non-Forest Products by the project personnel through contractual binding and awareness campaigns	Construction	Project area	SEMD/ Contractor/ DFO/ MCA
Posting of signage on restriction of misconducts on forest resources, and enforcement compliance of rules in coordination with DFO and MCA	Construction	Project area	SEMD/ Contractor/ MCA/ DFO
Public awareness campaign and trainings for workforce and project staff	Construction	Project area	SEMD/ Contractor/ MCA/ DFO
Collaboration with MCA for biodiversity conservation – plantation, wildlife protection activities – protected species, strengthening forest management committee, control access to forest in Manaslu Conservation Area,	Construction and Operation	Head works	SEMD/ MCA/ DFO
Breeding season is crucial to maintain healthy wildlife population. Thus, the construction works have to consider vegetation clearance to be restricted during breeding season, particularly of the threatened species. The breeding season is presented below	Construction	Project area	SEMD/ DFO/ MCA/ Contractor
Control lighting of the sites to minimize disturbance to nocturnal wildlife and minimize noise disturbance	Construction	Project area	SEMD/ Contractor
Controlled blasting	Construction	Project area	Contractor/ SEMD. Nepal Army
Coordinate with DFO, Department of National Parks and Wildlife Conservation, and MCA to enforce forest and wildlife related rules and regulations	Construction/ Operation	Project area	Contractor/ SEMD/ DFO/ DNPWC/ MCA
Rescue and rehabilitation centre for wildlife	Construction	Project area	Contractor/ SEMD/ DFO/ DNPWC/ MCA

9.6.5 Aquatic Ecology Management Plan

One of the key impacts of proposed hydropower project will be on the aquatic ecology of the Budhi Gandaki River. Though the impacts of the river diversion cannot be completely avoided, however, it could be minimized to the extent possible by implementing the activities listed as a part of the aquatic management plan in the project life cycle.

Table 9-6: Aquatic Ecology Management Plan

Activities	Schedule	Location	Responsibility
Ensure provision of releasing 10% of the minimum mean monthly flow as in-built structure of the dam	Design/ Construction/ Operation	Dam	Project/ SEMD/ Contractor
Construction of Hatchery	Construction	Project area (Dobhan or Yaru Phat)	Project/ SEMD
Production fingerlings and their release upstream to the dam	Construction/ Operation	Upstream to dam of the Budhi Gandaki River	SEMD/ Project

Restriction of fishing by the work force and project staff through contractual binding, posting of the signage on the rules, and enforce the rules	Construction	Rivers and tributaries in the project area	SEMD/ Project/ Contractor
Prohibit disposal of muck and spoil into the river. Ensure functioning of sediment trapping, lubricant and sewage treatments for the run-off/ discharge at all the project sites before releasing to the rivers	Construction	Project sites	SEMD/ Project/ Contractor
Protection and maintenance of identified spawning grounds	Construction	Project sites	SEMD/ Project/ Contractor
Rapid increases or decreases in flow rates can adversely affect downstream ecosystems. To mitigate this, extended ramp-up and ramp-down periods are preferred over abrupt changes. It creates learned behaviour in juvenile fishes to emigrate to deeper water during flow reduction.	Operation	Downstream from the tailrace	SEMD/ Project/ Contractor

9.6.6 Public Health and Occupational Safety Management Plan

The commencement of project construction will result in sudden boost of population. The current sanitary and public health services in the project area are not designed to accommodate large population, thus, obviously these facilities/service will be going to be under pressure. Furthermore, sanitary condition might also deteriorate due to higher amount of waste generated. Apart from these, workforce migrating from other places might bring in diseases to which locals might not be exposed to, and thus, the locals as well as the health facility, might be not prepared for them.

The project construction is associated with risks of accident resulting in injuries, and even fatality. The increased traffic of construction vehicles and associated fugitive dust and noise are yet another source of direct health effects, even fatal to both the project area people and workers.

Taking the above-mentioned probabilities into consideration, this public health and occupational safety management plan will be developed to minimize the risk on public health and occupation health of the construction workers.

Table 9-7: Public Health and Occupational Safety Management Plan

Activities	Schedule	Location	Responsibility
Ensure implementation of pollution abatement plan	Construction/ Operation	Project area	SEMD/ Project/ Contractor
Ensure the provision of Immediate Health Response Facility/ First Aid Facility at the project sites	Construction/ Operation	Project sites	SEMD/ Project/ Contractor
Regular medical check-up for workforce and staff (every 6 months)	Construction	Project sites	SEMD/ Project/ Contractor
Support existing health facilities so that these are capable to address health care of workforce as well, as well as to respond to cares of water borne diseases - Malaria	Construction	Project area	SEMD/ Project
Supply of clean drinking water for workforce and staff	Construction	Project area	SEMD/ Project
Fencing of the project sites, and control access to the outsiders to these sites	Construction	Project sites	SEMD/ Project
Waste collection, treatment, and disposal services for the camps	Construction	Project sites	Contractor/ SEMD/ Project
Posting of signage warning the accidents	Construction	Project sites	Contractor/ SEMD/ Project
Provision of protective equipment for workers, staff and visitors	Construction	Project sites	Contractor/ SEMD/ Project
Regular training for workforce and staff on health and safety measures, and occupation health	Construction	Project sites	Contractor/SEMD/ Project
Ensure insurance and compensation for the workers and staff to the accidents	Construction	Project sites	Contractor/ SEMD/ Project

Make local people aware of the peaking releases downstream of the powerhouse for safety purposes. Install siren warning all along the riverbanks at critical areas about the peaking releases.	Operation	Water fluctuation area downstream of tailrace outlet	SEMD/ Project
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9.6.7 Site Rehabilitation Plan

The primary objective of the plan is to rehabilitate the affected land area, facilities, construction sites, muck/spoil disposal sites, quarry sites, storage and mechanical yards, temporary camp sites, solid and liquid waste storage and treatment sites etc. once the construction works and its utility for the construction period is over in the designated site. This activity is envisaged to clean up the pollution created by the construction activities on land, water and air and help to restore the general aesthetic of the area similar to pre-construction period. The key highlights of the plan are presented in below.

Table 9-8: Site Rehabilitation Plan

Activities	Schedule	Location	Responsibility
Rehabilitate the excavated slopes top soil reinstatement bioengineering plantation and vegetation coverage	Construction/ Operation	Access roads, headwork, adit sites, disposal sites, camps	SEMD/ Project/ Contractor
Demolition of unnecessary structures	Construction/ Operation	Project sites	SEMD/ Project/ Contractor

9.6.8 Emergency Management Plan

The emergency management needs to be prepared to handle unforeseen events during emergency operations. This emergency management plan highlights some key features of the emergency preparedness in the event of such unforeseen events.

Table 9-9: Emergency Management Plan

Activities	Schedule	Location	Responsibility
Provision of helipad for emergency evacuation of injured or other people	Construction	Construction sites	SEMD/Project/ Contractor
Provision of immediate medical care services as specified in Public Health and Occupational Safety Management Plan	Construction	Construction site	SEMD/Project/ Contractor
Provision of fire fighting equipment and regular emergency preparedness trainings/ drills	Construction	Construction site	SEMD/Project/C ontractor
Installation of siren to warn workers and public about the emergencies such as accidents, flash flood	Construction	Construction sites	SEMD/ Project/ Contractor
Warning system on water level fluctuation must be installed at major locations/communities downstream of the proposed dam site. Training shall be given to local residents in downstream communities to provide public readiness in case of emergency situations	Operation	Downstream from Tailrace in the River	SEMD/ Project

9.6.9 Community Infrastructure Development Plan

Negative social impacts affecting different aspects of community infrastructure will be minimized, mitigated and compensated properly by a set of measures organized towards a Community Infrastructure Development Plan. Potential positive impacts will be enhanced by corresponding measures where appropriate.

Activities	Schedule	Location	Responsibility
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Alternative road will be constructed to connection Jagat with Salleri main.	Construction	Construction sites	SEMD/Project/ Contractor
Minimize traffic congestion			

9.6.10 Compensation and Rehabilitation Plan

The project is expected to affect private properties of local inhabitants. The compensation will be provided to the affected families for the land acquisition for the different project components. The following activities are proposed to be carried out.

Table 9-10: Compensation and Rehabilitation Plan

Activities	Schedule	Location	Responsibility
Formation of Compensation Committee	Construction	Construction sites	SEMD/ Project
Survey of land and property to be compensated and determination of the compensation	Construction	Construction sites	SEMD/ Project/ Compensation Committee/ District
Compensation and rehabilitation of lost land, houses, trees and other assets	Construction	Construction sites	SEMD/Project/ Compensation Committee
Employment opportunity to the affected population as per the livelihood Support and Enhancement Plan	Construction/ Operation	Project sites	SEMD/ Project
Provide compensation to the loss of crop yield to be paid to land owners as compensation to crop loss	Construction	Project sites	SEMD/ Project/ Contractor

9.6.11 Livelihood Support and Enhancement Plan

A Livelihood Support and Enhancement Plan (LSEP) have been designed especially for the project affected areas. The basic objective of LSEP is to ensure that the directly and indirectly affected population of project affected area may also benefit from the project implementation. In addition, the long term goal of the LSEP is poverty alleviation and the improvement of living conditions of the people through improvement in natural resource management, provision of adequate health and education services, and promoting income generation activities.

Indirect impacts on the physical and biological environment may result from the project induced demand for natural resources by the local communities and by the incoming population. In this process the natural resource base may be exploited beyond its regeneration capacity, which ultimately results into degradation of the natural resource base.

The LSEP is designed to achieve sustainability by working within the existing local government structure and strengthening their structures by promoting capacity building among local authorities and using participatory approaches.

Table 9-11: Livelihood Support and Enhancement Plan

Activities	Schedule	Location	Responsibility
Recruitment of project affected people in the project	Construction/ Operation	Project sites	SEMD/ Project
Recruiting locals in the fish hatchery plant	Construction/ Operation	Project sites	SEMD/ Project
Mobilization of local community in operation of the fish hatchery.	Operation	Fish Hatchery	SEMD/ Project/ DADO
Mobilization of local community – CFUG and MCA FMC for plantation and management of plantations.	Operation	Project area	SEMD/ Project/ DFO/ MCA

Support local farmers with technical and agricultural inputs to improve their farming capacity. Training and awareness programs on improved farming practices.	Construction/ Operation	Project area	SEMD/ Project/ DADO
Minimize dependency of locals on fire wood by supporting in locals in getting electric connection and availability of electric appliances.	Construction/ Operation	Project area	SEMD/Project
Promoting improved cooking stoves	Construction/ Operation	Project area	SEMD/ Project
Skill training and promoting income generating activities.	Construction/ Operation	Project area	SEMD/ Project
Collaborate with MCA in promoting tourism in the area be engaging locals	Construction/ Operation	Project area	SEMD/ Project/ MCA

9.7 Grievance redress mechanism

The Grievance Redress Mechanism (GRM) provides the system wherein the Project Affected People (PAP) will be able to lodge or present their complaints during Project implementation related to Resettlement Plan (RP) implementation and that necessary and appropriate mechanism in redressing the complaints are addressed. It allows for ventilation of grievances and facilitates resolution within a specified time-frame. The proposed GRM for the BGHP considers the existing Grievance and Redress Mechanism which is described in the Land Acquisition Act 2034 (1977) and Land Acquisition, Resettlement and Rehabilitation Policy for Infrastructure (2014) and the existing mechanism practiced in the local communities.

The GRM aims to resolve complaints or grievances at the lowest level within the community at the shortest time possible. The lowest level of GRM considers the existing practices in the local communities wherein the community people go to their recognized leader to seek the solution of their complaints. They also go to the local government bodies specially municipality and ward offices, as quasi-judicial bodies, which are obliged to objectively determine the facts and draw conclusions from them in order to provide official actions or solutions. Hence, the local bodies also support the affected people for resolving their grievances.

In the present mechanism of local government body, there is a Justice Committee in each municipality. The Justice Committee may resolve grievances of the PAP in coordination with Project Implementation Unit (PIU) of NEA and Chief District Office (CDC, particularly the Chief of Compensation Determination Committee). Above the two layers of GRM (Community Leader and Municipal-Justice Committee), the District Administration Office (Chief District Officer) is the district level mechanism of GRM for PAPs. The project affected people may also go to Court directly if they are not satisfied with the project decision or the decision of the Chief District Officer/Compensation Determination Committee. They can also file a complaint with the Ministry of Home Affairs regarding compensation on land and assets.

The proposed GRM for BGHP is described below:

Stage 1: Complaints from PAPs on any aspect of compensation, relocation or unaddressed losses are lodged verbally or in written form with the Community Leader (CL) known in the community whether of caste or ethnic groups/indigenous people. The complaint is discussed in an informal meeting with the project affected families and the CL. It is the responsibility of the CL to resolve the issue within a week from the date of complaint is received. If the CL is unable to resolve the complaint within a week then s/he must advice the AP to go to either Municipality/Ward Office or

PIU or District Administration Office (Office of Compensation Determination Committee) directly.

Stage 2: If no understanding or amicable solution can be reached or if no response is received from the CL within a week of registering the complaint, the PAP can appeal to the Municipality/Ward Office. Justice Committee is formed in each municipality now a day which is the main body of grievance resolution. The Municipality/Ward Office via Justice Committee should resolve the complaint within 15 days from the date the complaint is received. There is no time limit to the PAP for lodging the complaint to the Municipality/Ward Office, but s/he must produce documents that support his/her claim. The Municipality/Ward Office (Justice Committee) will provide a decision within 15 days from the date the complaint is received.

Stage 3: If the PAP is not satisfied with the decision of Municipality/Ward Office or have not received any response within 15 days, the PAP can appeal to the Chief District Officer (CDO). The original jurisdiction with respect to offences punishable under Land Acquisition Act (1977) is lodged in the office of the Chief District Officer. The CDO together with the PIU will provide a decision on the appeal within 30 days from the date it is received.

Stage 4a: If the PAP is not satisfied with the decision of CDO on his appeal, or has not received any response for quite a long time, the PAP as the last resort can "appeal against the decision made by CDO/CDC and file a case in the Court of Appeal within 35 days (Land Acquisition Act 1977, Article 40, Sec 2). In this case, the government of Nepal will be responsible to pay the compensation, or any claim made by the AP as per the court decision.

Stage 4b: The PAP may file a complaint with the Ministry of Home Affairs within 15 days from the date of the issue of the notice of fixation of compensation, if s/he is not satisfied with the amount of compensation. The decision of the Ministry of Home Affairs (MHA) shall be final (LAA, 1977, Article 25, Sec 7). In addition, vulnerable households of single women, poor, elderly households, and the disabled, illiterate may get legal support, from the local government agencies, judicial bodies, through their representatives (family, relatives, political and social organizations) in order to get their legal entitlements.

The PAFs will be provided with support and assistance by local authorities and judicial bodies, in case they lose the capacity for civil acts or they have limited capacity for civil acts, The local authorities and judicial bodies will assist these PAPs through their representatives in receiving compensation and in effective management and use of their money.

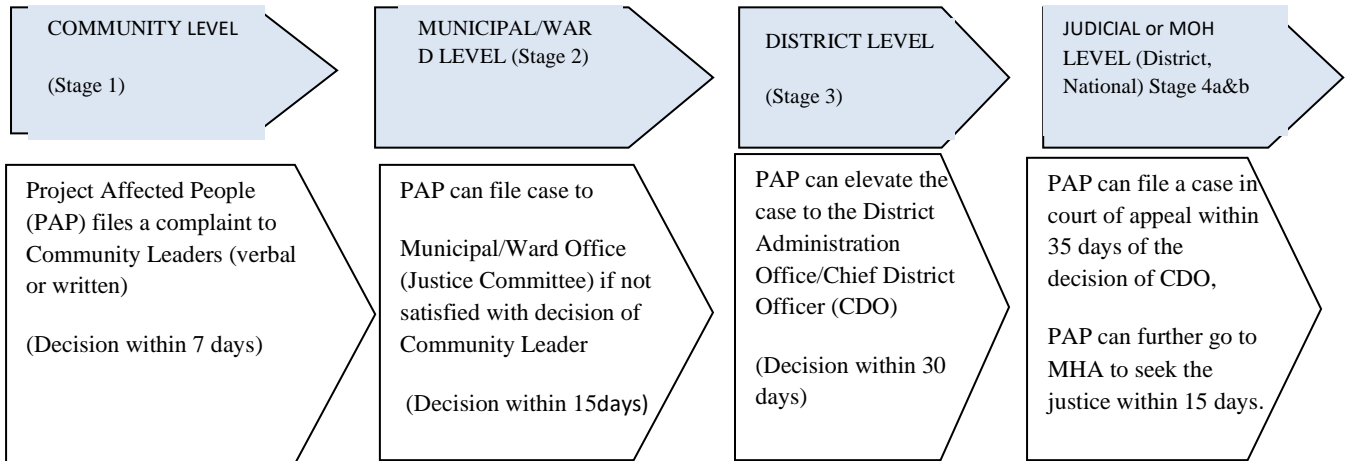
In families with known cases of domestic violence or alcohol and drug addiction, gambling, or other criminal cases, the CDC should invite both husband and wife to receive compensation. The compensation amount can be given to the wife for management (with the protection of local authorities, municipality/ward office and Women's organization).

Considering the cultural practices of Nepal (patriarchy, patrilocality), CDC has to offer compensation in the name of both husband and wife. The form of payment of compensation should be in cheque and not in cash. The PAF has to open a joint bank account in the name of husband

and wife and provide the Bank Account details (name of bank, address, name of bank account holder, account number) to the CDC in advance.

This Grievance Redress Mechanism should be disclosed to all PAPs and people in the Project area through community meetings, public consultation, distribution of leaflets and pasting of posters in strategic locations so that they are all aware of the mechanism.

The structure of GRM for BGHP is presented below:



CHAPTER 10. ENVIRONMENTAL MONITORING

10.1 Rational for Environmental Monitoring

As per the EPR (2020) the proponent shall comply with the matters mentioned in the approved EIA Report while the Concerned Agency has to monitor the impact on environment resulting from the implementation of the project. The MoFE has developed a Hydropower Environmental Impact Assessment Manual in 2018. Similarly, DOED has developed a “Manual for Preparing Environment Management Plan for Hydropower Projects” in 2002 and the then MOEST in 2006 has developed ‘A Guide to Environmental Monitoring of Hydropower Projects’; these documents describe the monitoring mechanism.

The effective monitoring of the mitigation measures requires constant feedback between those charged with administering the compensation schedule and the intended beneficiaries. The monitoring should include, among other environmental and social aspects:

Disbursement of compensation should take place promptly and according to procedures.

Communities in the affected areas share some benefits from the implementation of the project.

Local population is engaged/hired whenever possible.

Access to health care facilities is provided and clinics are staffed and stocked.

Assure proper safety material, training and information meeting international standards (WBG).

Rates of disease infection are monitored, with special attention to STDs.

Resettlement arrangements are effective and minimize the level of conflict between re-settlers and host population.

10.2 Objectives of monitoring

Environmental monitoring is needed to ensure compliance of the implementation measures and to assess the actual effects of these measures as well as the emerging impacts during project construction and operation phases. Environmental monitoring for this project will be undertaken to meet the following objectives:

To fully comprehend the physical, social and environmental conditions in the project area such as inundation area and project structure and activity area prior to the implementation of the project,

To understand the compliance status of the implementation of mitigation measures and other regulatory standards,

To ensure effectiveness of mitigation measures implemented by contractors as per contractual clauses and obligations,

To check the effectiveness of mitigation and enhancement measures, implemented by the project, and

To verify the accuracy of EIA predictions and assess the emerging and cumulative environmental problems, which could provide timely warning of potential environmental damage.

A more detailed monitoring plan i.e. the EMP summary table will follow details the outlined here provided, thus serving as guidelines. Details are given in the specific monitoring sections. The SEMD will develop detailed monitoring for each program in the EMP as each plan is fully formulated, and will require that contractors adhere to the regime set-up and the recommended international standards.

10.3 Site Inspections

Environmental and Social Management Division (SEMD) of Budhi Gandaki HEP will carry out site inspections prior to construction, during construction and at the end of construction in coordination

with the Contractors. In general, the ‘Initial Inspections’ conducted in the pre-construction phase will brief the Contractors of environmental and social sensitivities in the project area and document pre-project conditions. The ‘Progress Inspections’ of project sites during construction would refer to the compliance monitoring. The ‘Final Inspection’ will be carried out at the end of construction phase which documents that the Contractors have met their contractual obligations with regard to Environmental Contract Clauses.

10.3.1 Initial Inspections

Budhi Gandaki SEMD will monitor the environmental and social condition of various project sites prior to contractor’s mobilization on the project site. It will confirm the location of project sites for temporary and permanent use.

Budhi Gandaki SEMD under the guidance of the Project Director will establish standards for construction and required environmental controls. Sites will be surveyed jointly by Budhi Gandaki SEMD and Contractor’s representative. Photographic record of the sites will be prepared.

Budhi Gandaki SEMD will prepare the project site document.

10.3.2 Progress Inspections

Budhi Gandaki SEMD will prepare environmental and social checklists, reporting procedures etc. soon after the commencement of construction works.

Site inspections will put emphasis on early identification of any environmental and social problems and suitable remedial action.

Budhi Gandaki SEMD will make a regular and frequent monitoring of project sites without prior notification of the contractors. Daily, weekly and monthly site inspections of all works such as vegetation clearance, excavation and spoil disposal activities, blasting, tunneling, chemical storage, drainage and erosion hazards, campsites etc. will be carried out. The Contractors will be notified to take necessary measures to minimize the level of impacts.

Budhi Gandaki SEMD will give the inspection reports to the construction Contractors for action. Any deficiency or inadequacy that is noted during inspection will be immediately drawn to the Contractor’s attention and reported to the Project Director. The Contractors will prepare a monthly site inspection report and submit to BGHEP SEMD.

10.3.3 Final Inspection

Budhi Gandaki SEMD will conduct final inspection of the project sites during at the end of project construction which will determine whether assigned works are completed and necessary mitigation measures are implemented.

Contractor’s obligations and requirements as per the contractual agreement will be verified and deficiencies will be identified. In case of non-compliance, the Contractors will be enforced to implement the remaining works.

Budhi Gandaki SEMD will recommend the compliance of contractor’s works to the Project Director, and it will prepare a ‘Final Inspection Report’ documenting site conditions and compliance with contractual obligations.

10.4 Monitoring Types

Monitoring will be done throughout the project life. Apart from external expert monitoring, an internal monitoring by the project will be done as well as participatory monitoring involving GON or the stakeholders. Below are the main types of monitoring that will be conducted.

10.4.1 Pre-construction Monitoring

The Budhi Gandaki HEP will have the principal responsibility for environmental and social monitoring during the pre-construction phase.

10.4.2 Baseline Monitoring

Data and information will be collected on key physical, biological and social aspects in the direct impacted project area such as inundation area, project structure and activity area and other environmentally sensitive areas, and the data provided by EIA report will be updated. The Budhi Gandaki SEMD will be responsible for baseline monitoring during the pre-construction phase. Physical, biological and social aspects are highlighted.

The primary concern during this phase will be to collect field data to enhance the knowledge of baseline conditions. Focus will be on gathering key physical, biological and sociological information needed to verify and update the data provided by EIA process such as river water quality, air quality in project sites, number of trees to be felled, number of project affected families and their assets etc. Some of the monitoring activities are given below:

10.4.2.1 Physical Aspects

Monitor river water quality and drinking water quality in settlements close to project camps and sites for physical, chemical and biological parameters.

Monitor air quality at the proposed dam and powerhouse sites, batching plant, haul and service road, quarry site, spoil disposal area.

10.4.2.2 Biological Aspects

Pegging of forest sites to be used by contractors.

Counting and marking the trees to be felled from the temporary and permanent sites; District Forest Office (DFO), Community Forest User Groups (CFUG), Leasehold Forest User Group (LFUG) and private owners will jointly count and mark the trees.

Approval from the DFO and CFUG/LFUG for felling the trees from forests.

Monitor the compensation for the felled trees paid by the contractors to the CFUG/LFUG or private owners as well as management of the felled trees.

Population status of threatened and rare species just before clearing forests in inundation area and project construction and activity area.

Monitoring spawning ground and fisheries activity.

10.4.2.3 Social Aspects

Monitor/update detailed information on land, buildings and other housing structures, and biological assets on land to be temporarily or permanently acquired by the project. The project affected people will participate while carrying out such activity.

The Land Acquisition, Compensation, Resettlement and Rehabilitation Plan will be discussed and agreed with the project affected families and other stakeholders.

10.4.3 Construction monitoring

Environmental and social monitoring during project construction will include two major groups of activities:

- Review of the contractor's plans such as
- storage and construction waste management plan,
- domestic waste management plan,
- health and safety plan,
- Emergency medical response unit and other environmental plans.
- Systematic observation to check that contract arrangements by contractors, and other agencies such as government, NGO/CBO or CFUG are in fact complied with, and that emerging impacts are properly mitigated.

10.4.3.1 Compliance Monitoring

Compliance monitoring will be carried out during the construction phase. This is important and will play a bigger role in checking whether recommended mitigation measures and environment management plans have been properly and timely implemented or not. It will determine the overall environmental and social performance of the project.

10.4.3.2 Impact Monitoring

Impact monitoring will examine the effectiveness of the mitigation measures and identify the emerging impacts due to project activities or natural process and develop remedial actions. Impact monitoring will focus on key indicators to assess whether the impacts have been accurately predicted, and whether the mitigation measures are sufficient and effective. The actual impacts caused by the project implementation will be closely monitored during the construction period.

10.4.4 Operational Monitoring

Both compliance and impact monitoring will be carried out during project operation phase. The compliance monitoring will focus on determining the prescribed mitigation and enhancement measures in the operation phase and properly carry out the project. Impacts of activities implemented during construction phase and operation phase will be monitored. However, the monitoring intensity will be much lower compared to the construction phase. Some of the monitoring tasks will be as follows:

Discharge below the dam; 10% of the minimum monthly river flow

Reservoir shore erosion due to peaking operation

Physical stability in and around dam site, powerhouse site and other vulnerable areas

Siren warning system in low flow area and downstream of tailrace outlet

Fish population and biodiversity in reservoir, low flow area and downstream of tailrace outlet

Agriculture production programme such as fruit tree development, intensification in food production and commercial agriculture operation

Socio-economic status of displaced people resettled in another place.

10.5 Monitoring Environmental Program

10.5.1 Physical Environment

For the Physio-chemical Environment, monitoring, the construction section will be involved in slope stabilization mitigation and monitoring according to appropriate measures on the techniques used (see also relevant forest monitoring). In addition, the monitoring of water, air and noise apart from all safety aspects needs to be conducted.

Table 10-1: Physical and Chemical Monitoring Plan

Project phase	Issue	Parameters	Location	Frequency	Responsibility
Construction phase	River water quality	pH, conductivity, turbidity, DO suspended sediments, total phosphorus, PO ₄ ⁻ Total nitrogen, NO ₃ , NH ₄ , Coliform bacteria Mineral oil	Budhi Gandaki river upstream and downstream the Dam site, and Tailrace	Through out construction period, continuous by the SEMD.	Proponent
	Disposal of septic water	Ensure wastewater is treated in accordance with national standards (if not available international standards shall apply).	Work camps, offices	Through out construction period, continuous by the SEMD.	Proponent Main Contractor
	Rehabilitation of borrow areas and temporarily acquired land	Success of revegetation and erosion status/vulnerability	All borrow/pit areas and temporarily acquired land	Through out construction period, continuous by the SEMD.	Proponent Main Contractor
	Soil erosion and siltation	Erosion status/vulnerability	All construction sites and access roads	Through out construction period, continuous by the SEMD.	Proponent Main Contractor
	Spoil disposal	Stability and revegetation success of spoil deposited sites	All spoil disposal areas	Through out construction period, continuous by the SEMD.	Proponent Main Contractor
	Hazardous and non hazardous waste, hazardous materials	Ensure waste and materials are treated in accordance with national standards (if not available international standards shall apply).	Construction site	Through out construction period, continuous by the SEMD.	Proponent Main Contractor
	Air quality	Dust (PM ₁₀), CO, NO ₂ , SO ₂	Dam site, access road, quarry, tunnel, crushing plant.	Through out construction phase: 1 sample every 4 months by the SEMD	Proponent Main Contractor

Project phase	Issue	Parameters	Location	Frequency	Responsibility
	Noise	Noise level	Dam site, access road, quarry, camps, Jagat	Through out construction phase: 1 measurement every 4 months by the SEMD.	Proponent Main Contractor
Operation	Water quality	Temperature, oxygen, pH, turbidity, DO total phosphorus, PO ₄ ⁻ total nitrogen, NO ₃ , NH ₄ , arsenic, iron.	Dudhkoshi River: - upstream the reservoir. -in the reservoir. - downstream the dam, - before the confluence with Sunkoshi River Sunkoshi river: - upstream the DSHEP Powerhouse release; -downstream the DSHEP Powerhouse release.	Four times a year: January, April, July, October	Power plant operator
	Wastewater	Ensure waste is treated in accordance with the stringent between national and international standards.	Hydropower plants, offices, workshops and accommodation area	Regularly in connection with environmental and safety inspections	Power plant operator
	Noise	Noise levels	Hydropower plants	Twice a year	Power plant operator
	Solid waste disposal	Ensure waste is treated in accordance with the stringent between national and international standards.	Hydropower plant, offices, workshops and accommodation area	Regularly in connection with environmental and safety inspections	Power plant operator
	Environmental Minimum Release	Flow released	Downstream the point of compensation flow release	Continuous	Power plant operator
	Soil	Erosion status on revegetation/rehabilitation areas. Riverbanks and reservoir banks erosion.	Power house, workshops, storage areas, outlet from power station and roads. Reservoir.	Regularly in connection with environmental and safety inspections	Power plant operator

10.5.2 Biological Environment

10.5.2.1 Vegetation and Forestry

Monitoring plan in vegetation and forestry is provided below. This includes both compliance and impact monitoring during construction and operation phase.

Table 10-2: Monitoring Plan for Environmental Management for Biological Environment.

Mitigation Measure	Parameters to be monitored	Locations	Measurements	Frequency	Responsibility
COMPLIANCE MONITORING					
Construction Phase					
Forest land lease from MFSC	Permit and approval letters of MFSC	Inundation area and project sites	Review of letters issued	Once in every month after submission of application to the concerned authority	BGHEP ESMD
			Review of government rules & regulations		
Incorporation of environmental mitigations, monitoring and auditing recommendations, and costs	Final project document	BGHEP office	Review of final project document	Following approval of EIA	BGHEP ESMD
	Tender and contract document		Review of tender document & notice	Completion of tender call & during contract	
Payment made for forest land lease	Bank voucher	Project area	Review account files & documents	At the end of first trimester	BGHEP ESMD
	Evidence submitting voucher to DFO				
Approval for vegetation clearance from DoF	Approval letter	Project area	Review of permit letter	Following the submission of application to DoF	BGHEP ESMD
Management of fuel wood depot	Depot	Depots	Review documents	Once in six month	DFO/ BGHEP - BGHEP ESMD
	Books/Register		Register		
Establishment of forest nurseries and seedlings raised	Species, No. and size of seedlings	Nursery sites	Field observations	Once in two months	DFO/BGHEP ESMD
Compensatory plantation of saplings	Plantation site preparation	Project sites	Field investigation (measurements)	monthly assessment of seedling plantation	BGHEP ESMD/ DFO
	Status of fencing		Discussion with local people	Two months before plantation for site preparation	
	Seedlings quality		Review activity completion report	During and after plantation	
	Total area planted		Photographs		
	Survival rate & growth				

Compensation for acquiring private land	Land certificate (red book)	Project area	Review office documents	Following completion of legal formalities	BGHEP ESMD
			Field investigations		CDO
			Field investigations		
Revision and renew of CF/LF	Number renewed	BGHEP office, DFO	Review records	Biannual	BGHEP ESMD/DFO
			Review reports		
			Field investigations		
Arrange fuel wood by purchasing from clear felling areas and private land holders	Quantity of fuel wood purchased	Contractor and labor camp sites	Field observations	Trimester	BGHEP ESMD
Management unit to create and depute someone for invigilation	Quantity of kerosene and LPG purchased		Interview with workforce		
	Commit the no. of offences		Review official records		
Compensatory to illegal cutting and collection of wood	Number of cases	DFO, Project	Review official records (cases)	Trimester	BGHEP ESMD/DFO
	Government revenue		Review reports		
Operation Phase					
Compensatory plantation (replanting and seedling distribution at low scale)	As mentioned above	Various sites	As mentioned above	Trimester	BGHEP ESMD/DFO
Support community forest management through site specific trainings	Number of CF/LF	Project area	Field inspection	December-January every year	DFO/ BGHEP ESMD
	CF area managed		Review reports		
	Forest products		Interview with user		
Revision and renew of CF/LF	Number renewed	Project area	Review records	Biannual	BGHEP ESMD/DFO
			Review reports		
			Field investigations		
Institutional strengthening	Number of users trained	Project area	Review reports	Biannual	BGHEP ESMD/DFO
			Interview with user		

Income generation activity (NTFP)	Number of users trained	Project area	Review reports	Biannual	BGHEP ESMD/DFO
	Number of plants distributed		Interview with user		
	Area planted				
Posters and pamphlets (Awareness Programme)	Number produced and distributed	Project area	Review records	Annual	BGHEP ESMD
High risk area management	Soil conservation measures	Risk areas in the catchment	Site observation	Annual	BGHEP HEP
Catchment conservation	Stakeholders participation level		Reports		
Implementation of natural resource conservation center	Level of understandings		Data records		
Sediment control plots			Interviews		
Orientation training to workforce	Number of activity	Project area	Review report	Annual	v ESMD
			Interview with user		
IMPACT MONITORING					
Compensatory plantation	Actual forest loss	Project areas	GIS, Landsat imagery study	Once in 5 years	BGHEPHEP
	Actual land use change		Field verification		
Reduce number of trees/poles/saplings felling	Actual number of trees felled	Project areas	Records	Twice, during and after construction	BGHEPHEP
	Species types		Field inspection		
	Biomass, volume		Interview		
Catchment conservation	Siltation in the reservoir	Reservoir	Sediment data analysis	Once in five years' time	BGHEP ESMD
		Buffer area			
Forest Management	Forest growing stock and growth	CF/GF/LF	Forest survey and inventory	Five years period	BGHEPHEP/DFO
	Forest products harvest		CF data		
			Reports		
	Forest products sale	CF/LF &	Records of DFO/CF	Five years period	BGHEPHEP

Income generation activity	Income	private land holders	Compare baseline data & information		
	Change in life style				
Dewatering effect on biodiversity	Forest growth and growing stock	Project area	Field data record	Five year's period	BGHEP ESMD/DFO
			Forest inventory		

BGHEP: Budhi Gandaki Hydroelectric Project, BGHEP ESMD: Environment and Social Management/Monitoring Unit

DFO: Divisional Forest Office/r, DSO: District Survey Office,

10.5.2.2 Wildlife and Birds/ Aquatic Ecology

The table below describes the monitoring plan for wildlife and birds.

Table 10-3: Monitoring of wildlife and birds

Parameters	Location	Schedule	Method and frequency	Responsibility
Baseline monitoring				
Population status of threatened and rare species	Forest, CFs, Inundated, project sites	During tree marking during and after tree felling	Regular Observations – 2-3 times a year	Competent authority or consultant.
Clearing forest area	Inundated, project sites		Inspection, measurement	Project, DFO
Types of fishes in the River	Pondage area, low flow zone and down stream of tailrace	Twice a year during construction phase representing spring and autumn season	Cast net or Electrofishing	SEMD/ Project
Impact monitoring				
Incidents of wildlife killing and hunting	Project sites and vicinity forests	Actual loss of number of trees, Wildlife killing, harassing and poaching, Disturbance to wildlife movement	observation twice a year, measurement, inspection	Project, DFO
Fish population and migration in upstream and downstream of the project	River stretches at pondage and downstream of the tailrace	Twice a year representing spring and autumn seasons	Cast net or electrofishing	SEMD/ Project
Compliance monitoring				
Number of trainings conducted	Project construction site, quarry site, access roads	Operation of quarries, borrow pits, spoil disposal, training components, awareness campaigns, poster pamphlets and notice boards,	Inspection, observation	Project, DFO, consultant
Preparation of training manuals developed				

Number and types of poster and pamphlets published and number of notice boards displayed.		enforcement of law, habitat improvement.		
Construction and operation of fish hatchery	Proposed fish hatchery site	Site observation of the construction/ operation	Site observation	SEMD/ project
Production of fingerlings records and it releases in the upstream and downstream	River upstream and downstream of the project	Twices a year when fingerlings are released	Site observation/ review of the records	SEMD/ Project
Status of the fishes population of the fishes in the river down stream and upstream as a result of release of fingerlings	River upstream and downstream of the project	Twices a year when fingerlings are released	Cast net / or Electrofishing	SEMD/ Project

10.5.2.3 Socio-Economic and Cultural Environment

Table summarizes the monitory plan for social, economic and cultural aspects.

Table 10-4: Summary Monitory Plan for Social, Economic and Cultural Environment

Mitigation Measures	Parameters to be monitored	Locations	Measurement	Frequency	Responsibility
Resettlement and Rehabilitation Plan (RRP)					
Direct cost compensation	Compensation payment to affected families as per provision of RAP's entitlement policy	Inundation area	Review of records Field investigation	As proposed in RRP	BGHEP ESMD CDC CDO
Rehabilitation measures for SPAFs	No. of SPAFs engaged by project Living conditions of relocated population	Inundation area Low flow zone Registers of relocated population	Review of records Field investigation	Every 6 months	BGHEP ESMD CDO DADO
Community Infrastructure					
Procurement of connectivity	Changes in existing route Availability of alternative routes Presence of signals and public information boards	Inundation area Project sites	Field investigation Public consultation	Every 6 months	BGHEP ESMD CDO DADO
Replacement and enhancement of	Presence of alternative infrastructure	Inundation area Project sites	Field investigation Public consultation	Every 6 months	BGHEP ESMD CDO DADO

service infrastructure					
Traffic management plan	Presence of Road Information Boards Number of announces (radio, newspaper, etc.) Road accidents statistics	Affected Municipalities	Field investigation Public consultation	Every 6 months	BGHEP ESMD CDO Road Authority
Enhancement and support of selected public services and institutions	Variations in demand for public and social services (schools, health) Variations in cases of detentions and alterations to public order No. of incoming family members demanding school and health services (by rural and urban municipalities)	Affected Municipalities	Public services registers Field investigation Public consultation	Every 6 months	BGHEP ESMD CDO Heads of affected Municipalities
Indigenous Communities Development Plan					
Improvement and enhancement of household assets	Compensation payment to affected indigenous families as per provision of RAP's entitlement policy	Inundation area Low flow zone	Review of records Field investigation Public Consultation	As proposed in Resettlement and Rehabilitation Plan	BGHEP ESMD CDC CDO
Improvement and enhancement of livelihoods and access to natural resources	No. of indigenous families engaged by project Living conditions of relocated population	Inundation area Low flow zone	Review of records Field investigation Public Consultation	Every 6 months	BGHEP ESMD DADO CDO
Promoting social networks and social capital	No. of cultural promotion activities No. of indigenous families participating in cultural events Establishment of new cultural organizations among indigenous population	Inundation area Low flow zone	Review of records Field investigation Public Consultation	Yearly	
Cultural Promotion and Community Relations					
Protection and enhancement of cultural values and religious sites	Identification and register of alternative cremation sites No. of cultural promotion activities No. of PAFs participating in cultural events Establishment of new cultural organizations among indigenous population	Inundation area Low flow zone	Review of records Public Consultation	Yearly	BGHEP ESMD CDO Heads of affected Municipalities

Promotion of community relations and communications	Living conditions among the relocated population No. of conflicts/events between incoming and host population No. of incoming families engaged by project No. of incoming family members demanding school and health services (by VDC) Records of crime in the project area and cause of the crime for impact assessment	Inundation area Low flow zone	Review of records Public Consultation	Yearly	BGHEP ESMD CDO Police Office in affected Municipalities Heads of affected Municipalities
Tourism and Recreation Promotion Plan	Presence of a tourist information center Presence of tourist information board in main routes Identification and signals of alternative routes for tourists during construction period Register of tourist flows in main trekking routes	Inundation area Affected Municipalities	Review of records Public Consultation	Yearly	BGHEP ESMD CDO Heads of affected Municipalities
Landscaping and rehabilitation of highly disturbed areas					
Landscaping and bioengineering measures	Register of implemented measures Pictures of affected sites at different times of year during and after landscaping measures	Project sites in affected Municipalities	Review of records Field investigation	Yearly	BGHEP ESMD CDO Heads of affected Municipalities
Livelihoods Support and Enhancement Plan					
Livelihood support to compensate loss of land and agricultural production	Living conditions of relocated population No. of PAFs with formal job in project	Affected Municipalities Low flow zone	Review of records Field investigation Public Consultation	Yearly	BGHEP ESMD CDO Heads of affected Municipalities
Mitigating impacts on housing and land markets	Register of housing market in main populated areas Register of housing prices in affected Municipalities	Affected Municipalities	Review of records Field investigation Public Consultation	Every 6 months	BGHEP ESMD CDO Heads of affected Municipalities
Enhancing access and functioning of food and other basic commodity markets	Food availability in District headquarters and main markets Food security situation among PAFs	Affected Municipalities	Review of records Field investigation Public Consultation	Every 6 months	BGHEP ESMD CDO Heads of affected Municipalities DADO
Promoting access and	No. of training activities and No. of participants	Affected Municipalities	Review of records	Every 6 months	BGHEP ESMD

sustainable use of natural resources	No. of income-generating businesses started		Field investigation Public Consultation		CDO Heads of affected Municipalities DADO DFO DSCO
Supporting local business and industry initiatives	No. of training activities and No. of participants No. of income-generating businesses started	Affected Municipalities	Review of records Field investigation Public Consultation	Every 6 months	BGHEP ESMD CDO Heads of affected Municipalities DADO

HEALTH AND SANITATION

Drinking Water Supply and Management Plan , Sanitation Enhancement Plan
Community Waste Management Plan, Public Health Support Plan

Support the Environment, Health and Safety enhancement actions of EHSP	Water Quality, waste and sanitation affluent testing Training of health staff	Affected Municipalities	Review of records Field investigation Public Consultation	Every 6 months	BGHEP ESMD CDO Heads of affected Municipalities DADO
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AGRICULTURE

Construction Phase

Non-conventional irrigation plan like Rain water harvesting Irrigation	Use of new irrigation system Number of irrigation plots by new irrigation system	Safeguard buffer area and other program area	Observation, Discussion with local people	Half yearly	BGHEP ESMD
Encourage training for local women	Number of people trained in the area	Interview with locals		Biannual	BGHEP ESMD
Intensification of food crop production plan	Area covered, no. of households involved, increase in cereal grain and other cash crop production	Project area	Household data, discussion with stakeholders	Annual	BGHEP ESMD, DADO
Commercial vegetable and fruit production plan	Area covered, households involved, vegetable growing, fruit trees planted, production and sale, income per household	Selected pockets in project area	Household data, discussion with stakeholders	Annual	BGHEP ESMD, DADO
Commercial poultry and dairy farming plan	Households involved, no. of poultry raised, no. of dairy animal reared, egg, meat and milk production, sale of	Selected pockets in project area	Household data, discussion	Annual	BGHEP ESMD, DLSO

	livestock products, income/household		with stakeholders		
Operation Phase					
Annual monitoring agriculture production program	Household involved, status of production, sale, income/household	Project area, selected pocket areas where agriculture program has been implemented	Household data, discussion with stakeholders	Annual	BGHEP ESMD, DLSO

10.6 Environmental Management and Monitoring Budget

In this chapter an indicative budget is presented for the environmental mitigation, management and monitoring of the BGHEP project impacts, which are presented in the tables below:

Table 10-5: Social and Environmental Management Division/ Unit

SN	Item	Unit Cost	Nos.	C1	C2	C3	C4	C5	O1	O2	O3	Total (USD)	Total (NPR)
1	Personnel Cost												
1.1	SEMD Chief	4,500	1	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	432,000	50,976,000.00
1.2	SEMD Deputy Chief	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.3	Social Expert	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.4	Social Management Assistant	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.5	Greivance Redressal Assistant	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.6	Environment Assistant	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.7	Forestry Assistant	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.8	Wildlife Assistant	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.9	Agriculture Assistant	3,000	1	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	288,000	33,984,000.00
1.10	Secretary	400	1	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	38,400	4,531,200.00
1.11	Accountant	600	1	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	57,600	6,796,800.00
1.12	Driver	300	4	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	115,200	13,593,600.00
Sub-Total 1												2,947,200	347,769,600.00
2	Office and Operating costs												
2.1	Building	50,000	LS	50,000								50,000	5,900,000.00
2.2	Furniture	3,000	LS	3,000								3,000	354,000.00
2.3	Laptops, Printers etc.	10,000	LS	10,000								10,000	1,180,000.00
2.4	Operation	500	1	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	48,000	5,664,000.00
2.5	Travel Cost	50	1	600	600	600	600	600	600	600	600	4,800	566,400.00
2.6	Vehicles	30,000	4	1,440,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	1,818,000	214,524,000.00
2.7	Vehicles operation	1,000	4	48,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	426,000	50,268,000.00
Sub-Total 2												2,359,800	278,456,400.00
Grand Total												5,307,000	626,226,000.00

Table 10-6: Proposed cost of Environmental Management Plan

SN	Mitigation Measures	C1	C2	C3	C4	C5	O1	O2	O3	Total (USD)	Total (NPR)	Remarks
1	Pollution Abatement											
1.1	Air pollution measures and monitoring	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	80,000.00	9,440,000.00	
1.2	Water pollution measures and monitoring	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	80,000.00	9,440,000.00	
1.3	Noise and vibration measures and monitoring	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	80,000.00	9,440,000.00	
1.4	Landfill and waste management - construction and operation	200,000	5,000	5,000	5,000	5,000	1,000	1,000	1,000	223,000.00	26,314,000.00	
Sub-Total 1										463,000.00	54,634,000.00	
2	Slope stability and erosion prevention											
2.1	Top soil conservation/ benching											Part of construction cost
2.1	Slope stability measures											Part of construction cost
2.1	Drainage to prevent erosion	10,000	10,000	10,000						30,000.00	3,540,000.00	
2.1	Spoil disposal site											Part of construction cost
2.1	Stockpiling of materials											Part of construction cost
Sub-Total 2										30,000.00	3,540,000.00	
3	Construction camps and traffic management											
3.1	Coordination with stakeholders											Part of SEMD Budget
3.2	Site clearance											Part of construction cost
3.3	Environmental plan											Part of SEMD Budget
3.4	Guidelines for environment works											Part of SEMD Budget
3.5	Monitoring works	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	80,000.00	9,440,000.00	
Sub-Total 3										80,000.00	9,440,000.00	
4	Terrestrial and ecological Management											

4.1	Marking, removal and stockpiling of Vegetation									15,000.00	1,770,000.00	
4.2	Compensatory plantation									200,000.00	23,600,000.00	
4.3	Consultation with the DFO, MCA, CFUG and MCA FMC										-	Part of SEMD Budget
4.4	Management of plantation area for at least 5 years	10,000	10,000	10,000	10,000	10,000				50,000.00	5,900,000.00	
4.5	Supply LPG and/or Kerosene for cooking purposes.	2,000	2,000	2,000	2,000	2,000				10,000.00	1,180,000.00	
4.6	Cooperation with DFO and MCA on biological conservation	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	80,000.00	9,440,000.00	
4.7	Translocation protected floral species									5,000.00	590,000.00	
4.8	Rescue and rehabilitation centre for wildlife	300,000	10,000	10,000	10,000	10,000	5,000	5,000	5,000	355,000.00	41,890,000.00	
4.9	Fish Hatchery Construction and Operation	500,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	570,000.00	67,260,000.00	
Sub-Total 4										1,285,000.00	151,630,000.00	
5	Public Health and Occupation Safety Management											
5.1	Immediate Health Response Facility/ First Aid Facility at the project sites - establishment and operation	100,000	10,000	10,000	10,000	10,000				140,000.00	16,520,000.00	
5.2	Support local health facility	10,000	10,000	10,000	10,000	10,000	3,000	3,000	3,000	59,000.00	6,962,000.00	
5.3	Clean drinking water	2,000	2,000	2,000	2,000	2,000				10,000.00	1,180,000.00	
5.4	Fencing of sites											Part of construction cost
5.5	Warning signages											10,000
5.6	Insurance and compensation											Part of construction cost
5.7	Warning system on peaking	200,000								200,000.00	23,600,000.00	Part of construction cost
Sub-Total 5										409,000.00	48,262,000.00	
6	Site Rehabilitation Plan											

6.1	Rehabilitation of excavated slopes			50,000	50,000	50,000	50,000	50,000		250,000.00	29,500,000.00	
6.2	Demolition of unnecessary structure					20,000	20,000	20,000		60,000.00	7,080,000.00	
Sub-Total 6										310,000.00	36,580,000.00	
7	Emergency Management Plan											
7.1	Establishment of helipad											Part of construction cost
7.3	Firefighting equipment/trainings/ drills	5,000	5,000	5,000	1,000	1,000	1,000	1,000	1,000	20,000.00	2,360,000.00	
7.4	Installation of siren	5,000								5,000.00	590,000.00	
Sub-Total 7										25,000.00	2,950,000.00	
8	Community Infrastructure Development											
8.1	Alternae Road									-	-	Part of construction cost
Sub-Total 8										-	-	
9	Compensation and Rehabilitation Plan											
9.1	Formation of Compensation Committee									-	-	No cost
9.2	Survey of land and property to be compensated	50,000								50,000.00	5,900,000.00	
9.3	Compensation and rehabilitation	700,000								700,000.00	82,600,000.00	
9.4	Employment opportunity											Part of construction cost
Sub-Total 9										750,000.00	88,500,000.00	
10	Community Support Programme											
10.1	Recruitment of project affected people in the project	50000	50000	50000	50000	50000	50000	50000	50000	400,000.00	47,200,000.00	
10.2	Mobilization of local community in operation of the fish hatchery.	35000	35000	35000	35000	35000	35000	35000	35000	280,000.00	33,040,000.00	
10.3	Mobilization of local community – CFUG and MCA FMC for plantation and management of plantations.	34500	34500	34500	34500	34500	34500	34500	34500	276,000.00	32,568,000.00	

10.4	Agrcultural inputs	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	560,000.00	66,080,000.00	
10.5	Skill training and promoting income generating activities.	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	520,000.00	61,360,000.00	
10.6	Collaborate with MCA in promoting tourism in the area be engaging locals	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	320,000.00	37,760,000.00	
Sub-Total 10										2,356,000.00	278,008,000.00	
Grand Total										5,708,000.00	673,544,000.00	

Note: 1 USD= NPR 118.00

Total CSP= NPR 278,008,000.00 (0.5% of the Total Project Cost)

Total Environmental Cost= NPR 1,299,770,000.00

CHAPTER 11. ENVIRONMENTAL AUDITING

In this EIA, an Environmental Audit (EA) has been proposed to assess the actual environmental impact of the project, the accuracy of impact predictions, the effectiveness of environmental impact mitigation and enhancement measures applied during construction and operation phase, and the functioning of monitoring mechanisms. It is intended that EA should relate actual impacts with predicted impacts, which help in evaluating the accuracy and adequacy of EIA predictions.

The National EIA Guidelines specify that the environmental impact auditing must be carried out by the authoritative government agency with the assistance of other relevant government agencies and non-governmental organization as necessary and results obtained from environmental impact auditing should be made available to the project proponent and concerned agencies. In the context of Nepal, the Ministry of Forest and Environment (MoFE) is the authoritative agency and other concerned government agencies are the Ministry of Energy, Water Resource and Irrigation (MoEWRI), Ministry of Forest and Soil Conservation (MFSC), Ministry of Agriculture, Land Management and Cooperatives (MoALMC) and Ministry of Health and Population (MoHP). Local NGOs and national NGOs may also be entrusted to carry out the task, if they are engaged to do so by the government. IFI requirements are met by the GON requirements for auditing, although formats and report time lines differ among agencies.

11.1 Planning an Environmental Audit

The EIA Guidelines, 1993 has stated the following types of auditing that may be carried out for the national development projects.

Table 11-1: Types of Auditing

SN	Type	Description
1	Decision Point Auditing	It examines the effectiveness of EIA as a decision-making tool.
2	Implementation Auditing	It ensures that conditions of consent have been met.
3	Participatory Auditing	It ensures that stakeholder expectations have been met.
4	Performance Auditing	It studies the work of agencies associated with project management.
5	Predictive Technique Auditing	It examines environmental changes arising from project implementation.
6	Environmental Impact Auditing	It critically examines the methods and approach Assessment Procedure adopted during the environmental impact assessment study.

Not all the audit types mentioned above are required to be implemented in EIA process. At the project approval stage, both project proponent and authorizing agency should make a decision on implementation of one or more audits mentioned above with particular attention given to the project cost-effectiveness and to technical difficulties likely to be encountered. The cost estimation for the task depends on the decision made of the number and types of environmental audits.

Table 11-2: Example of a tentative plan for carrying out environmental audit

Parameter	Location	Method	Source	Indicator
Number of stumps of cut trees in nearby forest	Forest area nearby	Examination of forest	Local people	Number of cut tree stumps increases
Fuel wood trade location of timber depots and fire wood sale in the project area	Project sites	Records	Local People available information	Volume of wood sold increased
Alternative Energy for cooking for labour force	Project sites	Records from the contractors	Local people	Kerosene was provided
Harvesting and trade of medicinal plants	Project sites and the market	Information from local people and market	Local people	Sales of medicinal herbs increased
General condition of forest nearby	Forest near project site	Observation	Information and Local people	Forest condition Growing stock
Number of new houses constructed in the project site	Roadside and at the vicinity of project area	Counting, visual observation	Local people	No of house increased in project area
Number of tea stalls and restaurants established	Project site	Observation and records	Local people	Number of tea stalls and restaurants increased
Riverine forest and diversity	Along Dudhkoshi River in dewater zone	Observation and records	Users and EIA monitoring	General health and species diversity and Growing stock
Forest resources	Compensatory plantations and management areas	Observation, information and records	Users, EIA and EIA monitoring	General health, Species diversity and Growing stock

CHAPTER 12. CONCLUSION AND RECOMMENDATION

The BGHEP is planned along a stretch of the Budhi Gandaki River. The technical feasibility of the project has been performed in the range of 341 MW capacity.

In conclusion, this Environmental Impact Assessment (EIA) Study has been conducted in accordance with the Nepalese regulatory requirements and the international standards including ADB SPS, EPs, IFC PS and associated guidelines. This EIA Study builds on the findings from a number of surveys and studies which allow the identification of the potentially significant impacts considering all Project facilities both during the construction and operation phases. Such impacts have then been assessed in detail as part of this EIA Study. Mitigation measures and monitoring program have been prepared to reduce the potential negative impacts and/ or enhance the potential positive impacts.

The main anticipated impacts of the project include:

- the loss of land and assets of project affected people due to land permanently acquired by the project,
- resettlement and social change,
- changes related to the reservoir and river affecting connectivity, and aquatic life,
- increase in slope instability and erosion,
- loss of forest and habitat fragmentation.

On the basis of this assessment, it is concluded that all potential negative impacts arising from the Project can be effectively managed and mitigated, provided that recommended mitigation measures are implemented and regular monitoring is undertaken. No potentially-insurmountable impacts were identified which would necessitate a fundamental alteration of proposed Project design parameters.

Mitigation and enhancement measures as part of the environmental management plan are proposed to minimize impacts and enhance community wellbeing and economic opportunities through, among others, plans for immediate catchment management, reforestation in the immediate catchment area of the reservoir, fisheries, and the provision of livelihood enhancement support. The measures will help minimize the ecological footprint of the project. Safeguard documents include a Resettlement and Rehabilitation Plan and an Environmental Management Plan guided by a public consultation and disclosure program. An adaptive management process should be adopted to adjust plans according to findings from monitoring, consultations, and audits. The proponent will administer the EMP through the establishment of a Social and Environmental Management Division (SEMD).

In addition, the Site Specific ESMMP shall be developed to detail the key mitigation measures and monitoring plan for such area of works and also to highlight the appropriate implementation of such measures.

The following recommendations shall also be followed:

- to conduct environmental quality monitoring programs (air quality, noise, vibration) during the pre-construction period and construction period to provide essential baseline data. In

addition, it will be of benefit to establish permanent water quality monitoring stations for Budhi Gandaki Basin to regularly monitor the water quality along the Dudhkoshi River prior to and after reservoir inundation;

- the management of the environmental flows downstream of the dam should be implemented and monitored to determine their effectiveness at protecting biodiversity and ecosystem service values downstream. An evaluation and management framework should be prepared to complement the environmental flow regime. An adaptive management framework should also be utilized to amend flow strategies based on water quality and biological data on downstream effects;
- the management of the watershed is a critical component for managing the aquatic habitat and ecosystem services values of the Budhi Gandaki River. A comprehensive watershed management framework is required that has the ability to manage identified risks, propose collaborative efforts with other stakeholder interests and actively engages GoN in administering and managing the values of the watershed. This framework should be developed as the overarching approach to achieving sustainable development in the watershed;
- to include all proposed mitigation measures, monitoring programs, as well as obligations and commitments in relation to environmental preservation and protection in all construction contracts. The involvement of Contractors, especially during the construction period, will help to achieve and maintain environmental preservation and protection. Based on environmental obligations, as addressed in the contract, contractors shall put the environmental management into practice through effective implementation, and manage risks to the environment arising from all construction activities during the construction phase.

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Annex

Annex 1: Project Design

Annex 2: Project License

Annex 3: Approved TOR Annex 4: Focus Group Discussions / Meeting And Public Hearing Report

Annex 5: Recommendation Letters From The Concerned District Offices

Annex 6: Recommendation Letters From Rural Municipality

Annex 7: Declaration And Experts CVs

Annex 8: Forestry- Forest Loss Table

Annex 9: Focus Group Discussions During Field Survey

Annex 10: Publication Of Notice For Public Hearing

Annex 11: List Of Participants In Public Hearing At Jagat Bagar

Annex 12: Detailed Land Description Of 24 Project Affected Household At Chum Numbri Rural Municipality Ward No. 3

Annex 13: Letter To Address The Downstream Impact Of The Project

Annex 14: Landuse Data Of Project Components

Annex 15: Water Balance

Annex 16: Environment Release Table

Annex 17: Energy Calculation

Annex 18: 7 Days Notice And Muchulka