5. PROJECT IMPACTS

5.1 INTRODUCTION

The PMP EIA (WRC, 2011b; WRC, 2011c) contains a detailed assessment of the potential impacts of the PHD on the environmental conditions of the project area. In the present study, these impacts have been reassessed in context of the updated and newly established or identified baseline conditions. The results of these activities are presented in the ensuing sections.

5.2 PHYSICAL ENVIRONMENT

The potential impacts of the PHD on the physical environment of the project area are described in the following sections. These impacts are summarized in Table 5-1.

5.2.1 Land Use and Land Take

The PHD will require 4,622.9 ha of land, of 2,649 ha is presently under natural vegetation, 143.1 ha under cultivation and 816.3 ha under other landforms (Table 4-2). Out of the total land requirement, 4,479.8 ha will be needed for the reservoir, project structures, permanent facilities and borrow, quarry and spoil disposal sites. Likewise, about 143.1 ha of land will be required for contractors' camps and facilities.

5.2.1.1 Construction Phase

Permanent Land Use Change

Over the 13.5 years construction period, the existing land use and cover in the project area will change gradually as construction on the project components and permanent structures are accomplished. The major land use and cover change in the project area will occur as and after the reservoir is filled. Upon completion of the project, permanent land use change will occur over 4,479.8 ha, comprising 2,539.4 ha under forests, grasslands and bushes, 110.5 ha under cultivation and 816.3 ha under other landforms (Figure 5-1).

Temporary Land Use Change

In the initial stages of construction, about 143.12 ha of land in Chamtada, Dhamkudi, Aptyd and Suryakhal settlements of Pancheshwar VDC will be acquired for the Contractors' camps, offices and labor camps. This land, consisting of 110.5 ha of natural vegetation and 32.6 ha of cultivated fields, will be acquired for the project period only.

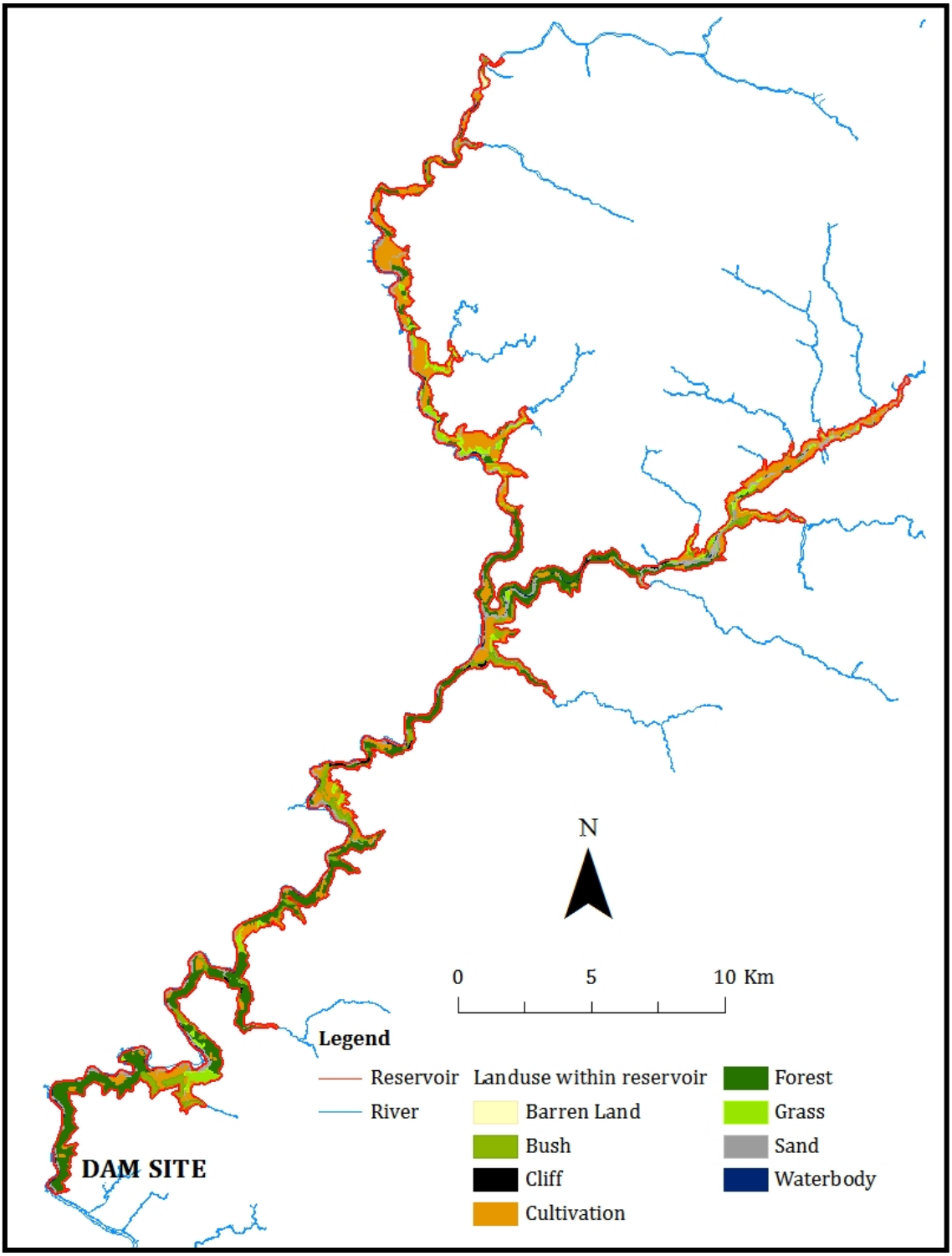

Figure 5-1: Land use to be submerged by PHD reservoir

5.2.1.2 Operation Phase

Upon project completion, all of the temporarily acquired lands (143.1 ha) will be returned to their respective owners, who will have the choice to reinstate these lands to their uses and covers. Borrow, quarry and spoil disposals sites will be rehabilitated with plantation. Thus during the project operation phase, impacts on land use and topography will be insignificant.

5.2.2 Hydrology

5.2.2.1 Construction Phase

During the construction phase, changes in runoff, drainage pattern, river morphology and flow regime are expected to be negligible. However, some changes in these parameters may be witnessed at diversion sites, quarry sites and sites for construction material deposition.

5.2.2.2 Operation Phase

During the operation phase, changes in runoff, drainage pattern, river morphology and flow regime will be significant. The upstream of the dam site will resist direct runoffs, resulting in longer travel times with increase of base flow. The drainage pattern and river morphology under the reservoir may change significantly due to deposition of sediments and water up to the crest level of the spill way. The water level at the upstream side depends upon inlet flow and reservoir regulation. During the process of reservoir filling and impoundment, the downstream water level and flow will be reduced significantly.

5.2.3 Sedimentation

Sedimentation of the reservoir will commence immediately after reservoir impoundment. Studies carried out during preparation of the PMP DPR indicate that the initial reservoir capacity (11.39 million cumecs) will reduce by half in 125 years (EDC, 1995a). The sediment deposition will also result in a fairly large delta formation in the reservoir.

As a result of reservoir sedimentation, water released from the reservoir will be relatively free of sediments. The sediment-free water may result in degradation in the downstream reaches of the Mahakali River.

5.2.4 Land Instability Hazards

5.2.4.1 Preconstruction Phase

During the preconstruction phase, land clearance and site preparation for construction of project facilities will result in removal of forest vegetation, leveling of uplands and possible alteration of the local drainage and storm runoff patterns. As a result, soil erosion will occur, and landslides may occur in critical areas.

Removal of forest vegetation, earthworks and leveling for construction of different roads can cause soil erosion and landslides. Most landslides will occur above the road due to steep slope cuts or weak rock masses, whereas soil erosion will generally takes place below the road levels due to the dumping of mucks at these locations.

5.2.4.2 Construction Phase

During the construction phase, land clearing, earthworks, drilling and blasting will be carried out at all construction sites. These activities can enhance soil erosion, activate old stable landslides and even generate new slides in critical areas. In addition, excavations at borrow sites and quarry sites can disturb their stability, and large landslides or slope failures could be triggered.

5.2.4.3 Operation Phase

The formation of the large reservoir following the damming of the Mahakali River will raise the groundwater levels along the reservoir rim. This, in turn, will saturate the soil and rock mass around the rim. As a result, soil erosion may be enhanced. In addition, dormant landslides in these areas may be reactivated, and new landslides may be triggered in weak rocks or soil masses.

During operation, the reservoir water level will seasonally fluctuate between its normal water level (El. 680 m amsl) and minimum water level (El. 615 m amsl). Although the reservoir

drawdown will be gradual, it may trigger landslides in areas where the geological formations do not permit sufficiently rapid release of pore water pressures.

5.2.5 Reservoir-induced Seismicity

During operation, the reservoir filling, impoundment and subsequent fluctuation of its water level can induce or enhance seismicity. The seismicity depends on the frequency and amplitude of lake-level changes, reservoir dimensions and hydro mechanical properties of the substratum. Longer period water level changes (~ 1 year) are more likely to cause deeper and longer earthquakes. Earthquakes occur at reservoirs where the lake-level changes are comparable to, or a large fraction of, the least depth of water. The seismicity is likely to be more widespread and deeper for a large reservoir. The induced seismicity is observed both beneath the deepest part of the reservoir and in the surrounding areas. It can continue for several years, even decades after impoundment at the reservoir.

The PHD will have an extremely large reservoir that will undergo long-term (seasonal) water level variations amounting to a large fraction (65 m) of the reservoir water depth. In addition, the project area also has several active longitudinal and transverse faults and is characterized by a wide distribution of highly fractured and jointed carbonate rock masses. Thus, the potential for reservoir-induced seismicity in the project area is very high.

During operation, the fluctuation in peaking flows can cause riverbank erosion downstream of the dam site. For reasons mentioned above, the fluctuations may possibly trigger landslides.

5.2.6 Water Quality

5.2.6.1 Construction Phase

Excavation works for construction, drilling and blasting, quarrying and construction of project components and facilities are likely to generate unwanted wastes. Likewise, the generated spoils, trashes, construction-related wastes, oil, paints and other chemicals at different locations of the project area are likely to pollute land and water bodies. In addition, the generation of different forms of waste from labor and office camps, shops, hotels and lodges in the project area is likely to contaminate water bodies and sources of drinking water in and outside the project area. Improper and unsustainable handling and disposal of such wastes may pollute water bodies.

5.2.6.2 Operation Phase

Reservoir impoundment is likely to result in alteration of the thermal regime, reduction in the DO level and reduction in the turbidity level of water downstream of the dam. It is also likely to result in the state of eutrophication of water downstream of the dam.

5.3 BIOLOGICAL ENVIRONMENT

5.3.1 Loss of Habitat, Forest and Vegetation Cover

Forests and agricultural lands dominate the landscape of the project area, with the former covering 65% and the latter covering 32% of this area. The major environmental concern of the project implementation is the permanent loss of wildlife habitat – large forested areas that include prime forests, shrubs and grasslands. An estimated 2,539.4 ha of forests, grasslands and shrubs would be lost. All areas under 680 m amsl will permanently be submerged under water, i.e., different types of forests, shrub lands, grasslands, rocky slopes, riparian belts, boulder banks and fields, sandy banks, Sal forests, Khair Sissoo forests, mixed forests including sandy banks along the riparian zones of the two major river systems that have high conservation significance and are very important habitats for many wildlife species would be lost permanently. This is about 83% of the total forested area of the DIZ

and 6.8% of the total forested area of the project. All the forests along the Mahakali and Chameliya Rivers, which have high conservation significance, will be lost permanently. Furthermore, 115.4 ha forest area will also be lost for project infrastructure development (buildings, campsites, access roads, transmission lines etc.). All standing stock in these areas will be cleared off. Similarly, most of the flood plain areas will disappear, affecting many flood plain dependent species.

All the trees in and around the dam site, quarry sites, campsites, roads and powerhouse will be cleared during the construction phase. The loss of forests, other vegetative cover and wildlife habitats due to site clearance, construction of the dam and other project facilities and services, etc. would cause serious adverse impact on the wildlife of the area – mammals, birds, reptiles and amphibians.

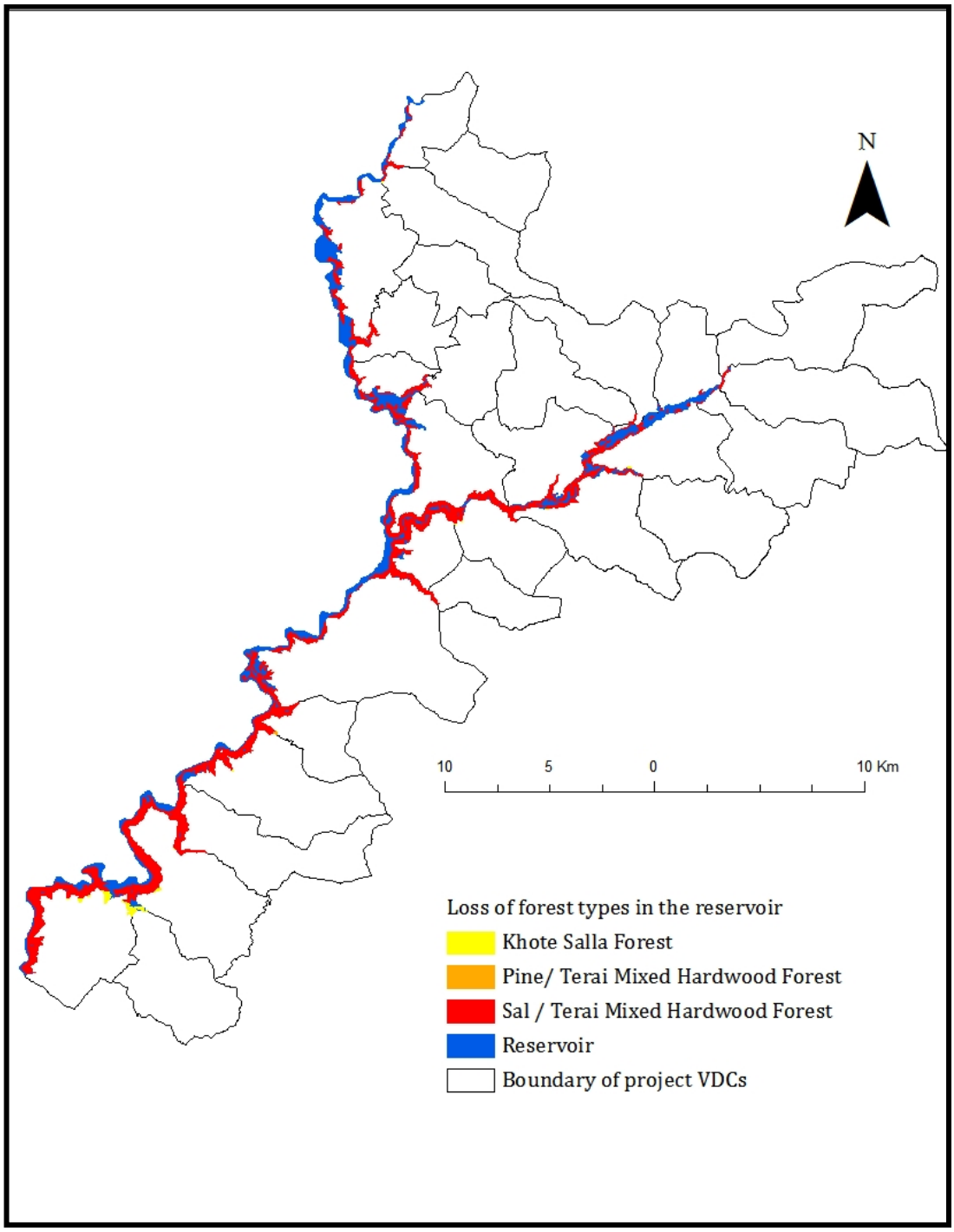

Figure 5-2: Loss of forests due to dam/reservoir construction

5.3.2 Habitat Degradation

Besides permanent loss of a large forest area for the construction of the High Dam and for the construction and establishment of project facilities and services (buildings, campsites, access roads, transmission lines etc.), it is likely that the pressure on the remaining forest land and forest resources would increase simply due to the increasing number of people in the area. The project requires a large number of temporary and permanent construction workers and technical and administrative staff of different levels during site clearance, construction, operation and maintenance. It is estimated that 4,350 workers/staff would be required during construction works including labours, contractor's employees and project staff. Much of the workers would be brought from outside the project area.

The increase in the number of people would increase demand on forest resources as well as increase pressure on forest environment. Also, many people from outside the area will move into the area in search of trade and business prospects (local teashops, restaurants, hotels, vendors, etc.) which may lead to forestland encroachment. The pressure on the remaining forest resources due to increasing demand for fuelwood, timber, fodder, and NTFPs would increase. The dependence on forests for household energy needs, timber, livestock grazing and fodder is already high in the area.

It is also likely that the people clearing forest lands for encroachment, and increasing biotic pressure on forests would increase the chances of intentional and incidental forest fires. Forest fires in such terrain are very difficult to contain and may damage large forest areas. The problem will be more serious during the construction period. Uncontrolled fire is very detrimental to the forest vegetation - loss of forest vegetation and consequently decreases in health of the ecosystem (ecosystem services).

It is also likely that landslides and soil erosion would increase due to increased level of biotic disturbances in the area and as the area is very fragile. This will cause further loss of forests and vegetative cover and degrade the habitat. The chances of landslides and soil erosion would be high mainly during the site clearance and the construction work.

The increase in the number of people (construction workers and other staff, vendors, trade and business prospectors, etc.) and increased biotic pressure on forests, wetlands and grasslands would cause serious changes in habitat characteristics of the area. Pressure on forests would increase due to forest encroachment, illegal timber smuggling, selective felling of trees, fodder, fuelwood and other NTFP collection and forest fires.

Such activities leads to serious habitat degradation - changes in ecosystem, change in ecological processes consequently lead to unhealthy ecosystems which adversely impact on the flora and fauna of the area – species diversity, species abundance and density, species composition and ecosystem diversity.

Loss of habitat, habitat degradation and disturbance are the major causes of threat to wildlife. As food and cover become less available, intra- and inter-species competition becomes high. Some animals develop stress which ultimately may lead to animal mortality and consequently reduction in the population size of the species.

5.3.3 Wildlife Movement/Trans-boundary Migration and Habitat Fragmentation

Loss of forest area, disturbance and degradation of habitats especially during site clearance and construction works and the construction of reservoir with large surface area would fragment the existing habitat affecting local wildlife movement and trans-boundary wildlife migration. Migration of many wildlife species such as Rhesus monkey, Langur monkey, Wild Boar, Goral, and Barking Deer, and many forest and water birds would be disrupted which could adversely impact on wildlife population and species diversity.

Habitat fragmentation and high disturbances during construction works would seriously affect many wildlife species of the area, particularly those species with limited distribution or are very sensitive or have very low tolerance to habitat disturbances. It is possible that some of the species would be locally extinct before the dam is completed. There could be various adverse impacts of the dam on aquatic ecosystem even after the completion of the dam. The blocking of the natural flow of the river and the creation of a large lake alters the ecological conditions of the river - changes in pressure, temperature, oxygen levels and in the chemical and physical characteristics of the water – making the habitat unfavorable to the wildlife of the area.

The physical barriers created during construction works, diversion of river canals, and tunneling would affect many trans-boundary birds like, waterfowl, wader, birds of prey, cranes and passerine birds. It is likely that they might change their migratory route and flyway path. It is also likely that several herpeto-fauna and invertebrates would be lost due to the submersion of their important habitat.

5.3.4 Pollution and Disturbance to Wildlife

Dust and noise pollution especially during site clearance, construction works, mining and quarrying activities would pose serious threat to wildlife. Frequent movement of people, vehicles; continuous use of heavy equipment like loaders, dozers, etc., their leakages and wastes; blasting, drilling, quarrying and other mechanical disturbances; and solid wastes - all impose serious threats to wildlife including several globally threatened and critically endangered species.

Construction activities would also raise the levels of dust in the atmosphere which negatively affects forest vegetation in the region and pollutes the rivers and other water bodies and consequently the health of the ecosystem. The soil, sand and stones required for construction are often mined and quarried from around the actual construction site. Such extraction could have adverse environmental impacts, especially by aggravating dust pollution, wildlife disturbance and destruction of vegetation.

5.3.5 Threat of Invasive/Alien Species

Large number of people moving in to the area for working for the project and in search of new business opportunities could bring new plants and animals along with them intentionally or accidently. The introduction of alien, invasive species could affect various habitats eventually destroying the habitat. Since the ecological characteristics of such species are not very well known, it is likely that they might spread rapidly suppressing local species. Restoration of the habitat in some cases could be very costly.

5.3.6 Modification of Animal Behavior

As wildlife populations are forced to move to new adjacent areas in search of food and cover due to loss of habitat, habitat degradation and disturbances, it is likely that there will be intra- and inter-species competition for food and space. This could cause several animals to behave differently than their normal behavior. The stress developed might sometimes take a heavy toll on their population. For example, some birds might change their nesting, feeding and resting behaviors.

5.3.7 Wildlife Poaching and Illegal Wildlife Trade

As the wildlife habitat would be largely reduced, wildlife would be forced to concentrate in small patches/areas making them more vulnerable to poachers and illegal wildlife traders. It is likely that wildlife poaching would increase as more and more people move in the area (hunting, trapping and poisoning for illegal supply of meat in the local market, and illegal wildlife trade).

The sheer presence of a large human population in the project area - construction workers, vendors and traders would aggravate the unfavorable situation for many wildlife species. Many birds would simply move away from the area never to return again. Fishing activity would increase which would cause decline in fish population consequently the population of aquatic mammals and birds. Similarly the increased solid waste and pollution of the water would threaten aquatic life.

5.3.8 Human Wildlife Conflict

Habitat loss, habitat disturbance and degradation would increase human wildlife conflict in the area. Scarcity of food, water and cover - breeding, nesting, feeding, resting and escape cover would cause wildlife to move in search of better habitat. It is likely that agricultural crop damage, livestock depredation and human attacks by wildlife would increase thus, it would increase human wildlife conflict. It is likely that retaliatory killings and wildlife poaching would also increase.

Although information on transmission of disease or parasites from domestic livestock to wildlife and wildlife to domestic livestock and human is unavailable, transmission of disease could also be a problem. In such case, human wildlife conflict could be serious.

5.3.9 Climate Change

A large number of trees that will be felled affect climate change. Forests play significant role in climate change. Forest trees absorb atmospheric carbon dioxide and increase the carbon content in the soil. The effect of the loss of forest trees on rise in global temperatures may not be noticeable and predictable in the short term. The climatic cycles become uncertain and the weather generally becomes more unpredictable due to global climate change. On long term, global climate change is likely to alter species composition of the forests, affect the landscape, wildlife and agricultural farming practices.

5.3.10 Excessive Fishing Activities

Excessive fishing activities could cause severe depletion of fish species to the extent that it could be difficult to regenerate the population of these species in the reservoir to be created. Heavy fishing by the construction work force, by illegal means, could destroy the fish bio-diversity of the Mahakali River, both upstream and downstream. Illegal fishing could be of any kind, like diverting the river flow, dynamiting, electro-fishing or fish poisoning, which will destroy the fish population of all ages and sizes within its effective zone.

5.3.11 Silt Runoff

The silt produced during construction of the coffer dams upstream and downstream of the main dam and the main dam, quarrying activities and construction of access road will make the river water downstream of the construction site turbid to the extent that the migration of fish upstream and downstream will be blocked. This will disturb their breeding activities and feeding areas.

5.3.12 Use of Explosives

The hazard to fisheries originates from the use of explosives. Blast shocks may cause lethal or sub-lethal damage to fish stocks.

5.3.13 Change in Riverine Habitat

At certain places, the damming could result in changes in aquatic ecology and bio-diversity itself. Change in riverine habitat (lotic to lentic environment) is likely to adversely affect the fish diversity and population of aquatic plants, phytoplankton, aquatic insects and other zooplankton. Long distance migratory fish species will be seriously affected due to damming. The damming could submerge the grazing ground (shallow region of river) of

fish, raise temperature of the reservoir water and change the aquatic fauna, including macro-invertebrates. Coldwater fish like Asla (*Schizothorax spp.*) may not be able to inhabit in such changed reservoir conditions, as they feed on the plankton and micro-organism attached to the substrates like pebbles, boulders of river bottom. Submergence of spawning and rearing area will be critical, as most of spawning and rearing areas are associated with upstream tributaries.

5.3.14 Thermal Stratification Phenomenon

Thermal stratification of reservoir during the warm season can result in de-oxygenation of the hypolimnion. Cool and/or anoxic water discharged from the hypolimnion can severely reduce water quality downstream and negatively impact fish stocks and fisheries.

Low temperature and concentrations of oxygen tend to occur in the hypolimnion when reservoirs stratify. Vertical stratification occurs mainly through the interaction of wind and temperature and creates density gradients that affect water quality. Intensity of the gradient varies latitudinally and is affected by physical characteristics such as reservoir depth, water retention time and water level fluctuation. Oxygen stratification is undesirable because anoxic conditions in the hypolimnion limit habitat availability and can impact water quality throughout the reservoir and downstream.

5.3.15 Increase in Nutrient Load

Phosphorus inputs often come from agricultural sources and municipal effluents. Excessive inputs could result in rapid eutrophication in the PHD reservoir. The consequences of eutrophication are algal blooms, which cause decreased water clarity, wide DO fluctuations and dense littoral beds of aquatic vegetation. Through effects on water physical and chemical characteristics, dense algae blooms make reservoir environment unsuitable for many fish, reducing fish diversity and fish assemblages.

5.3.16 Obstruction in Fish Migration

One of the main negative impacts due to damming is the obstruction of fish migration. In general, most of the fish species migrate upstream for breeding and migrate downstream for rearing. The PHD will produce a barrier effect that will obstruct the migration of economically important fish species like Asla, Sahar, etc.

5.3.17 Loss of Breeding and Rearing Grounds

The PHD will convert the fast flowing river morphology into a large reservoir, submerging many of its large and small tributaries like Pantapali Gad, Baku Gad, Lali Gad of Darchula district, Chameliya River, flowing between Darchula and Baitadi districts and Parmoli Gad and Garma Gad of Baitadi district. The present habitat of all the native fish species will be destroyed by the submersion of these tributaries together with the main river stretch up to the DIZ. The present breeding grounds of economically important coldwater fishes like Asla are found around the confluence area and upstream tributaries. Spawning grounds of Sahar and Katle (*Neolissocheilus hexagonolepis*) are found mainly in the main river stretch, upstream of the PHD site, is expected to be submerged by damming. It could cause serious consequences by losing these economically important fish species from the area upstream of PHD site. However, the marginal areas of the confluences of some of the tributaries from the Nepali side, like Baku Gad, Lali Gad, Chameliya River and its tributaries up to Gokuleshwar, Parmoli Gad, Garma Gad etc., of the reservoir should provide breeding habitats for these fish species. Fishes like Sahar are expected to flourish quite well because of the expanded area of water surface as well as the increase in water depth, which provides more niches for their feeding.

The fish catch composition upstream and downstream of the dam indicates that some of the sub-tropical species like *Labeo sp.*, *Neolissocheilus hexagonolepis, Barilius sp.* and *Bagarius sp.*

could possibly disappear from upstream of the PHD because of the obstruction of their movement during summer. All the three species of the *Barilius sp.* are found up to the confluence of Chameliya River during summer, indicating their upstream migration trend during summer.

5.3.18 Loss of Annual Income

As a result of the PHD construction, the annual income of 435 households, harvesting a total 27,375 kg fish per year, will be lost.

5.3.19 Increased Fish Productivity by Nutrients Load and Water Surface Area

At different places of Mahakali River, damming could increase fish production not only by the increase of water surface and volume but also due to the accumulation of more nutrients due to the increase in water temperature of the reservoir. Increase in water temperature is expected to help increase plankton density and is expected to provide suitable habitat for more fish species of warm water habitat as well, which should help increase fish biomass carrying capacity. Addition of nutrients load from the drainage area should further increase the carrying capacity, making the reservoir water more productive.

The increase in water surface area and volume of water should provide ideal environment for the economically important fish species like Mahaseers (*Tor sp.*) and increase its production. Therefore, the change in aquatic ecology, due to damming in Mahakali River, could possibly help not only in enriching its fish bio-diversity but should also help in increasing its productivity that could help, to a great extent, in the economy of the society around PHD impact area.

5.4 SOCIOECONOMIC AND CULTURAL ENVIRONMENT

5.4.1 Preconstruction Phase

5.4.1.1 Displacement of Residents

The implementation of PHD will require the displacement of 2,943 households with 22,905 populations. It will result in loss of land, psychological stress due to loss of ancestral property, food insecurity and marginalization of affected households. The displacement of a large number of residents of community will potentially disturb the community structure, cohesion and character.

5.4.1.2 Displacement of Cultural and Religious Sites

Project implementation will displace or disrupt religious and cultural sites. People will lose their cultural behavior when they settle in new place. Many of the cultural traits are associated with local environment. Many folk story, song and narratives will disappear along with the displacement of entire village. Many cultural norms and values of the people will disappear due to resettlement in new place. Livelihood is one of the major components of the culture that will be severely affected by the implementation of the PHD.

People will assimilate and acculturate with new culture and place that may lose the traditional culture of the people. Some of them will face the problem of social adjustment and ecological adaptation in new culture. They will lose their technology, art and crafts which were developed centuries ago.

5.4.1.3 Loss of Historical Remains

No written records about the history or origin of this area are available. There are many temples and shrines in the area of the study, but most of them are of recent origin. However, the remains of Uku palace (Sri Mahal) and temple have centuries old history. It is considered belonging to Pal King before the unification of Nepal. Pancheshwar and Dattu

temples are relatively old and many people from Nepal and India come to worship annually. These historical remains will be submerged.

Remains of Uku Palace has archaeological importance that lies in the submerge area of PHD. This place is associated with the emotion of Thakuri Pal and history of ancient Nepal.

5.4.1.4 Displacement of Local Deity

Local deities have important significance for the people of project area. Each clan group has own shrine/ deity for worship. All of the clan members attend *Kul puja* (ancestral worship) annually. All the local deities will be sub-merged. All of these things cannot be replaced in a new location.

Altogether 103 of temples and shrines (69 in Darchula and 34 in Baitadi) will be submerged in PHD. Some of the temples are very old and have internationally (Malika arjun and Saipal of Uku and Jagannath temple of Lali) significant. Many holy places will be submerged. Many of the shrines are historically less significant and many of them were established by erecting stone under the big tress or along with the foot trails within last two three decades. The magnitude of impact is very high.

5.4.1.5 Displacement of Cremation Sites

All of the cremation sites are in the bank of Mahakali River and its tributaries. There are altogether 35 cremation sites in the project area (22 in Darchula and 13 in Baitadi district). People also perform other rituals on the bank of the rivers. People are attached with these sites emotionally.

These sites are not only for the people of DIZ but also by the people of IDIZ and whole region of the project area. These all sites will be submerged into PHD reservoir.

5.4.2 Construction Phase

5.4.2.1 Displacement of Educational and Other Services

Removal of schools and other government offices will take place. 38 schools, 11 post office, 28 government office and 9 health post will be submerged. Some of these community infrastructures are also used by the community living in settlements outside the submerged area. The project will result in an increase in population and result in demands on existing schooling services in IIZ.

The increase in the student population in IIZ results from influx of workers and new comers. Influx of workers and their families, porters and businessmen and their families will create pressures on local schools and other facilities available to the local people. The schools located in the IIZ will suffer from the pressure of students, lack of educational materials, teachers and classrooms.

5.4.2.2 Impacts of Construction Camps and Workers

Influx of workers and their families, porters and businessmen and their families will create the pressures on existing resources and services available to the local people in IIZ. The community character and cohesion may change because of the new values brought by outsiders to the local community.

As a result of project implementation, the population of the project area is expected to grow. This will occur in two ways: i) construction workers and their families, and ii) camp people and other new comers. Contractor requirement of manpower for this purpose of infrastructure planning has been estimated as 8,000 out of this 1,500 would be in the supervisory category and the remaining 6,500 would be laborers similar to the case of owner's personnel. Out of 8,000 half of the personnel would be provided infrastructure facilities on the Indian side and half on the Nepali site.

It is anticipated that 4,500 construction personnel, most from outside of the project area, will be residents at different location of construction camps. Assuming that 25% of the workers will bring families with them with an average family size of five, the population of the construction site area will grow by a total of approximately of 5,500. Similarly, assuming that there will be camps for contractors, consultants and other officials, some of them will bring their families. In addition, there will be shops of new businessmen will increase by another 5,500, for a total increase of another 10,000 people in the whole project area.

5.4.2.3 Women and Disadvantage Groups

Women and disadvantage groups will be affected more compared to male and advantage groups in IIZ during the construction phase. Certain caste and ethnic groups (Dalit, Majhi and women in general) are disadvantaged socially, educationally and economically due to their position in the society. Project implementation can provide both positive and negative impacts for these groups.

Women will participate in the benefits of the project through employment and business related activities. These groups, though may experience some difficulty initially, can benefit from the project by participating in project employment and business opportunities. Meanwhile, the influx of construction workers and new comers may encourage some women to engage in prostitution. With the influx of a large number of construction workers and relative isolation of the camps, there will be demand for prostitution. Some women in the project area view this as an opportunity to earn income.

5.4.3 Changes in Livelihoods, Profession and Income Generation

With commencement of proposed PMP would directly or indirectly affect the existing livelihoods, professions and income generation conditions of the people inhabited in the project affected areas. It is foreseen that the PMP not only affect the existing farming systems in the indirect impact zone but also create increased demand for different types of labors during the construction phase of the project. As a result with this there will be acute shortage of farm labor as most of the members of landless, marginal and small farming households will be attracted towards wage employment in the project construction. Like-wise, the demand for agriculture, livestock and poultry products particularly for fresh vegetables, fruits, milk and milk products, eggs and meat will also increased due to project. The increased demand of these commodities in the project site will increase the prices for these commodities in the local market providing incentives to the local producers. The demand for improved farm production technologies, inputs and services will be very high and various private service providers will move in the project affect areas to capture the new business opportunities. However, due to shortage of farm labor, overall production of high value agricultural commodities will not be increased at local level until and unless a comprehensive agriculture intervention packages is provided to the farming communities of the project affected districts.

5.4.4 Loss of Agricultural Lands and Productivity

The present study reveals that of the total 18,045 ha cultivated lands available in 26 PMP affected 26 VDCs of Baitadi and Darchula districts about 994 ha (5.50% spread over 21 VDCs) is estimated to be completely inudated. Out of total inudated cultivated land about 780 ha (79%) is irrigated low land (*Khet*) and remaining 214 ha (21%) is rain-fed uplands (*Bari*).

Based on the current productivity status of crops both in the irrigated and rain-fed uplands areas of Baitadi and Darchula districts considerable agriculture production will be lost permanently.

5.4.5 Increased Pressure on Local Institutions and Public Services (GOs, NGOs, CBOs)

It has been observed 102 settlements along the Mahakali River basin will be completely inundated by reservoir and number of Agriculture and Livestock Service Centers/Sub-centers established to providing basic extension services to the local farmers will also be either shifted to safer sites or closed down. If these local service providing institutions are not re-located within a reasonable distance, the pressure of service sickers will also increased proportionately in the indirect impact zone.

5.4.6 Increased Pressure on Local Food and Commodity Markets

The EIA study has explicitly mentioned that the proposed PMP has direct impact on the demand and supply of foods and other consumable items in the local markets. The demand for local food will increased primarily due to i) increased influx of estimated work force of about 10,000 people in the project sites, inundation of about 994 ha of productive lands by reservoir, decreased local production of major food crops due to lack of farm labor shortage and decreased productivity of crops due to environmental degradation due construction activities. When the demand for food and other commodities in the local markets increases additional suppliers will also move into the project districts and there are likely chances of dumping of cheap foods and other commodity imported from India and adjoining districts of Nepal discouraging local production.

5.4.7 Increased Vulnerability of Marginal and Disadvantaged Groups

The study shows that despite relatively larger holding size the average productivity of the major agriculture and livestock and poultry is considered very low in the project affected VDCs in both Baitadi and Darchula districts. When the construction activities of project begin, most of the members of these households would naturally be attracted towards wage employment in the project leaving their subsistence farming. Given their size of holding, quality of lands and level of current food security status, majority of these poor, vulnerable groups in the project affected areas will migrate and temporarily settle in and around project construction sites putting more pressure on the physical and other natural resources base in the construction sites and abandoning their limited cultivated lands.In the short-term, they will get employment opportunities and earn competitive wages from construction works but in the long-run majority of them will be further marginalized and eventually displaced from their birth places.

5.4.8 Increase Vulnerability of Locals to Diseases

5.4.8.1 Construction Phase

Water Pollution and Water Borne Diseases

Poor and unhygienic drinking water supply condition could be the cause for incidence of water borne diseases particularly in campsites and in adjoining areas. There is immense possibility of spread of diarrhea and related diseases amongst the workforce and local residents. The magnitude of epidemic of such diseases could be quite high at certain times. Communities located in direct impact zone as well as indirect impact zone could be severely affected from such epidemic. Human health in the community could have substantial affected by water borne diseases such as diarrhea, cholera, dysentery, typhoid etc. Similarly, other infections such as cold cough, pneumonia, skin diseases and infections could prevail due to the water pollution during the construction phase.

Air Pollution

Dusts, particulate matters and smoke generated during the time of construction from project construction sites could increases chances of respiratory diseases and dust allergies. Project staff, laborer and workers could be affected from the air pollution during the

construction of high dam and other relevant engineering structures during period of construction. Dust particles ranging from 1-10 microns could spread air borne infections. Diseases related to dusts and smoke such as asthma, bronchitis, eye irritation, throat and nose irritations etc. could prevail into the communities situated in the direct impact zones during the time of construction.

Noise Pollution

Moving of heavy vehicles from one part to other around project site, use of excavator/ crane work force and blasting activities will create a noisy environment for the community resides in the project site. These activities will produce not only the annoyance but also will cause ill health. The noise of blasting and crouching will create a long lasting effect. The effect of noise exposure will have either Auditory or Non-Auditory effect or both. In the Auditory effect there will be auditory fatigue, deafness and will cause hearing loss. In the Non-Auditory effect there will be interference with speech, annoyance reduction in the efficiency of work and other psychological, physiological changes occur. In addition to this rise in blood pressure and increase of breathing and sweating will occur.

Occupational Injuries

Overall during construction, a substantial number of potential hazards could be created; workers may endure injuries form machinery and equipment, chemical, explosive materials, burns Electrocution, falls, falling objects, dust and vibration during construction activities. During construction phase a substantial number of occupational hazardous will take place. Worker may endure injuries from machinery and equipment, chemicals, explosions, burns, electrocutions, falls, falling objects, and vibration. Silicosis, asthma and bronchitis will create an occupational problem among people involved in project activities. Workers exposed to sound bigger than 90 decibels will have increased risk of noise induced hearing impairment. The construction activities such as blasting, quarrying, heavy vehicular movements are associated with high risk of accidents and injuries for workers as well as surrounding communities.

Sexually Transmitted Diseases (STDs)

There are certain communities who were sex workers and they continue from generation to generation. Around PMP project the hidden sex workers may grab this opportunity to earn extra Income. Concentration of workforce (Laborer to semi-skilled, skilled and high level technicians) could increase the chances of STDs and other communicable diseases. They would put pressure on public water system and generate additional waste and sewage in the locality. A higher rate of STD transmission will be expected if PMP, employees are migrant worker that have previously been working at construction site elsewhere.

Trauma/Accidents

Ergonomics is a scientific approach towards professionalism. Unfortunately in the project professionalism is not followed as they do not have ample time to select right man for right job and the result is obvious mean a lots of job related problems. Accidents at work, particularly in tunnel and other construction sites and on road, due to heavy vehicular movements will come in existence. There could be chemical fumes problem in tunnel construction. It could be fatal in some cases. Trauma is most likely during difficult working conditions. Facture, sprain and dislocation are common problems during working hour. Lack of food availability, working against threshold limit, working under out of region, with different race and different kind of mixed migrant population may lead to trauma and accident during project construction.

Nutrition Deficiency and Health Facilities

The project may experiences scarcity of food supply due to loss of cultivated land and agricultural production. Meager production of food may lead to the variety of nutrition deficiencies and other diseases in the community. The insufficiency in food production in

the community may either lead towards the establishment of new market places for food import from outskirts or lead towards the emigration of the population. Nutrition deficiency could cause health hazard to community, especially to local woman and children. Health hazard may leads to unwanted expense of energy and money for the medical purposes of the community. Unavailability of accessible road, infrastructures and other health-facilities at the project site may make locals vulnerable towards an unexpected life casualty.

Solid Waste Management

Solid waste management could have a major impact upon the community and human resources during project construction at various sites. Inappropriate and unsustainable disposal and direct disposal as well as open defecation by the project staff and laborers at the project site could enhance the possibilities of emergence of various diseases. Open defecation of human excreta both feces and urine at the project site could enhances the possibility of emergence of water borne diseases as well. Diseases such as diarrhea, cholera, dysentery, typhoid etc. could have substantial effect upon human health in the project as well as upon the population at the community level.

5.4.8.2 Operation Phase

Air Borne Diseases

Project site is located in the middle hill region where dust is likely everywhere during the operation of PMP along with its access road. Because of its topographical situation Droplet nuclei, a type of tine partials range from 1-10 microns is likely to spread air borne infection. Diseases such as tuberculosis, influenza, chickenpox, measles, fever and other kind of respiratory diseases are likely to produce significant impact upon public health. Smoke, smog, mist and fumes are the important air pollutants are likely to spread as epidemic around the project areas.

A variety of infection agents like streptococci, viruses and fungus could spread disease like streptococcal and staphylococcal infections, pneumonia and psittacosis.

Sexually Transmitted Diseases (STDs)

The communities surrounding the construction sites are likely to experience socioeconomic changes when the project work starts. High and regular salary of project staffs, per capita buying capacity will make a boom and local business will thrive. These economic developments, being apart from family for a long time will lead towards illegal/elicit relationship. Temptation toward local alcoholism and flow of money and many of this kind of activities will facilitate towards sexuality. The trans boundary migration of local labors and their interaction with local community will provide ample opportunities to transmit sexually transmitted infections as a result AIDS; Syphilis, Gonorrhea and, other sexually infections will be transmitted. These infections will not affect individuals only but the spouse, relatives and other community people as well. There are certain communities there who looks as sex workers and this continues from generation to generation. Around PMP project, the hidden sex workers may grab this opportunity to earn extra Income.

Vector Borne Infestation

Because of high dam and collection of huge amount of stagnant water, insect and arthropod borne diseases will infest workers, staffs and surrounding communities. Most prevalent diseases are Malaria, Filaria, Encephalitis, Kala-azar and Dengue. At the outset, it was believed that there will be no Malaria in the Hilly areas. Likewise other insect, rodent, flea and tick borne cases will come in big numbers. Reservoir area and water body in desanding basin could provide favorable breeding ground for Culex mosquito, increasing chances of malaria in the locality.

Waste Disposal

The waste that will come in the form of excreta, solid\waste like refuse and waste water will be generated in high volume during project operation and will create several public health problems, e.g. fire hazardous, air, water and soil pollution. Insect and rodents borne diseases will come in the form of epidemics, epidemic and sporadic form. In the .absence of toilet facilities, people will defecate either in the open air or on the banks of river and this will ultimately lead to excreta borne diseases.

Pressure upon Existing Health Facilities & Loss of Health Facilities in Reservoir Area

The population influx to the project will lead to an increased demand for all types of health care services. In the absence of proper health care institutions overburden of work will arise and lead to dissatisfaction among the community people that will create negative impact about the project. Overburdening of existing health institution, lack of man power, medicine and medical equipment and provision for quality health services is possible.

Loss of Trans-boundary Crossing Facilities

Reservoir created by PHD project will submerge substantial areas of Dattu, Joljibi and Jhulaghat VDCs. Therefore, existing bridges and road alignments that are used for trans-boundary crossing purposes could be submerged by the reservoir created by the project. This will have direct impact upon the existing transportation situation and the existing infrastructure. In other words, the trans-boundary movement could be halted due to the submergence of all of the existing local infrastructures such as bridges, roads, health institutions, educational institutions and other local infrastructure. The lost health institutions should either be relocated in other suitable locations, although, all loss of existing infrastructure cannot be recovered. The local communities might perhaps be deprived of the existing health facility available at the reservoir area of Dattu, Joljibi and Jhulaghat VDC. However, there could be other means of transportation for trans-boundary purposes. The creation of huge reservoir itself could be the easy means through ships and ferry for navigation purposes and for trans-boundary movement. This means of transportation could be helpful for the people residing in Nepal and traveling to India for health.

Table 5-1: Physical environmental impact assessment matrix

Activities/parameters	Impacts/ issues	Evaluation of impacts		
		Magnitude	Extent	Duration
Pre construction phase				
Construction of project facilities	Disturbances to top soil/ soil erosion	H	Ss	Lt
	Create land instabilities in critical areas	H	L	Mt
Construction phase				
Site clearance, land clearing on slope, earthworks, drilling and blasting at construction sites	Soil erosion	H	Ss	Lt
	Activate old stable landslides	Mo	L	Mt
	Generate new slides in critical areas	Mo	L	Mt
Excavation in borrows and quarry sites	Slope failure	H	Ss	Mt
	Mass movement	H	Ss	Lt
Increased sedimentation in reservoir	Rise of seismicity	H	R	Lt
Water quality and pollution				
Excavation works for construction; drilling and blasting; quarrying activities; construction of service, link and haul roads	Sediment load causing pollution of water bodies	Mo	Ss	Mt
	Pollution of air from dust resulting from excavation works	Mo	Ss	St
Spoil generation, trashes, construction related wastes, oil, paints and other chemicals	Pollution of land and water bodies in the project area	H	Ss	St
Use of heavy machineries, construction equipment and generators, movement of vehicles	Noise pollution and vibration	Mo	Ss	St
Different forms of waste generated from labor and office camps, shops, hotels and lodges in the project area	Solid waste pollution and contamination of water bodies, sources of drinking water	M	Ss	Mt
	Altered thermal regime	H	Ss	Lt
	Reduced levels of dissolved oxygen	H	L	Lt
	Reduced turbidity	H	Ss	Lt
	Increased nutrients	H	Ss	St
Operation phase				
Reservoir formation and water level fluctuation	Rise in gwl	H	L	Lt
	Enhance land instabilities	H	Ss	St
	Generate new slides	H	Ss	St

Activities/parameters	Impacts/ issues	Evaluation of impacts		
		Magnitude	Extent	Duration
Increased sedimentation in reservoir	Rise of seismicity	H	Tb	Lt
	Pollution of water bodies caused by emission of wastes and washing of the vehicles	H	L	St
	Pollution of water due to runoff	Mo	L	Lt

Note:

Magnitude:	M:	Minor	Mo:	Moderate	H:	High/Major	
Extent:	R:	Regional	L:	Local	SS:	Site specific	TB: Transboundary
Duration:	LT:	Long term	MT:	Medium term	ST:	Short term	

Table 5-2: Biological environmental impact assessment matrix

Activities/Parameters	Impacts/ Issues	Evaluation of impacts		
		Magnitude	Extent	Duration
Site clearance				
Fish and aquatic habitat	Loss of breeding and nursery area due to soil erosion and silt runoff	H	R	LT
	Illegal fishing	H	SS	LT
Construction phase				
Fish and aquatic habitat	Breeding place and feeding area	H	SS	LT
	Obstruction of Fish migration	H	R	LT
	Use of explosive is managed	H	SS	ST
	Heavy fishing by construction personnel	H	SS	ST
	Spillage of petrochemical are confined	H	SS	MT
	Waste are effectively managed	H	SS	ST
Forest resources and vegetation	Loss of forest area	H	R	LT
	Effect on resources used by community	H	R	LT
	Effect on forest species	H	R	LT
	Loss of total stock and standing volume	H	SS	LT
	Fire hazard	H	SS	ST
	Impact on vegetation covers and forests	H	R	LT
Wildlife and their habitat	Loss of wild life habitat	H	SS	LT
	Mammalian fauna	H	SS	MT
	Herpeto-fauna	H	SS	MT
	Wildlife movement	H	R	LT
	Human wildlife conflict	H	SS	MT
	Wild life hunting	H	SS	MT
	Terrestrial fauna	H	SS	MT
	Habitat fragmentation	H	L	LT
	Threat of Invasive species	H	L	LT
	Human disturbances to wildlife	H	SS	MT
Avifauna and their habitat	Loss of habitat	H	R	LT
	Disturbance due to sound pollution	H	SS	ST
	Impact due to increased human population	H	SS	ST

Activities/Parameters	Impacts/ Issues	Evaluation of impacts		
		Magnitude	Extent	Duration
	Effect on nesting, feeding and resting	H	SS	MT
Operation phase				
Fish and aquatic habitat	Pollutants, sediments and nutrients from watershed area are appropriately managed	Mo	L	LT
	Thermal stratification phenomenon is minimized	H	R	LT
Forest resources and vegetation	Forest encroachment	H	SS	LT
	Forest fires	H	SS	ST
	Establishment of Buffer zones	H	TB	LT
Wildlife and their habitat	Modification of animal behavior	Mo	TB	LT
	Hunting and poaching	H	SS	LT
	Displacement and loss of wildlife	H	TB	LT
Avifauna and their habitat	Impact on trans-boundary avian movement (due to physical barriers of reservoir)	H	TB	MT

Note:

Magnitude:	M: Minor	Mo: Moderate	H: High/Major				
Extent:	R: Regional	L: Local	SS: Site specific	TB: Transboundary			
Duration:	LT: Long term	MT: Medium term	ST: Short term				

Table 5-3: Social environmental impact assessment matrix

Activities/Parameters	Impacts/ Issues	Evaluation of impacts		
		Magnitude	Extent	Duration
Pre construction phase				
Acquisition of land for PHD facilities construction	Displacement of residents	H	SS	LT
	Displacement of cultural and religious sites	H	SS	LT
	Loss of historical remains	H	SS	LT
	Displacement of local deity	H	SS	MT
	Displacement of cremation site	H	SS	ST
Transportation	Dust, Noise and Vibration	H	L	ST
In migration	Increase population flux	Mo	SS	ST
Construction phase				
Reservoir formation	Inundation of temples, shrine, educational and other services	H	L	LT
Acquisition of land for constructing owner, contractor and labour camps	Pressure on social services, schools, health facilities at IDIZ	H	L	LT
	Threaten to social harmony	H	L	MT
	Social incapability	Mo	R	MT
	Alcoholism, crime and prostitution	H	SS	LT
Transportation	Dust, Noise and Vibration	H	R	LT
	Pressure on social services, schools, health facilities at IIZ	H	R	LT
	Threaten to social harmony	H	R	LT
	Social in-compatibility	H	R	MT
Pancheshwar High Dam and Reservoir	Displacement of residents	H	R	LT
	Lose of land, psychological stress due to loss of ancestral property, food insecurity	H	SS	LT
	Increase of population in IIZ due to influx of a large number of workers	H	SS	MT
	Causes problems of law and order and socio-cultural conflicts with the local community	H	SS	MT
	In IIZ, due to increase in population, increase in pressures on local schools and health facilities	H	SS	MT
	Public safety and security will become a matter of great concern.	H	SS	MT
	Formation and emergence of local pressure and concern groups which may disturb the construction work.	H	L	ST
	Sir Mahal and archaeological site of Uku VDC will submerge	H	SS	LT
	Temples, shrines and cremation sites	H	SS	MT

Activities/Parameters	Impacts/ Issues	Evaluation of impacts		
		Magnitude	Extent	Duration
Impact on women and disadvantage groups	Increases prostitution	Mo	SS	LT
	Sexually Transmitted Disease (STDs)	H	SS	LT
Loss of agricultural and productivity	Agricultural area	H	R	LT
	Livestock	H	SS	ST
	Service infrastructure	H	SS	LT
Agricultural impacts	Loss of cultivated farm land area	H	R	LT
	Loss of agricultural production	H	R	LT
	Loss in horticulture	H	R	LT
	Loss of grazing land and livestock feed resources	H	R	LT
	Enhances nutrition deficiency	H	R	LT
Health impact	Water pollution and water borne diseases	H	R	LT
	Air pollution	Mo	SS	ST
	Noise pollution	Mo	SS	ST
	Occupational injuries	M	SS	ST
	Sexually transmitted diseases (STDs)	H	L	LT
	Trauma / Accidents	Mo	SS	ST
	Nutrition deficiency and health facilities	H	R	ST
	Solid waste management	H	SS	ST
Operation phase				
Agriculture	Forest encroachment for agriculture	H	SS	LT
Health impact	Air borne diseases	Mo	SS	ST
	Sexually transmitted diseases (STDs)	Mo	SS	LT
	Vector borne diseases	Mo	SS	ST
	Waste Disposal	H	SS	ST
	Pressure upon existing and loss of health facilities	H	SS	ST
	Creation of reservoir causing loss of Transboundary crossing facilities	H	TB	LT
Existing community infrastructure and services	Biogas plants and watermills	H	R	LT
	Roads, bridge and communication infrastructures	H	R	LT
	Community institution and facilities	H	SS	LT
	Security services	H	SS	LT

Activities/Parameters	Impacts/ Issues	Evaluation of impacts		
		Magnitude	Extent	Duration
	Educational facilities	H	L	MT
	Service provider	H	SS	MT
	Economic facilities	H	R	MT
	Community assets and households	H	R	LT
	Increased pressure on local institution and public services (GOs, NGOs and CBOs)	H	R	LT

Note:

Magnitude:	M:	Minor	Mo:	Moderate	H:	High/Major	
Extent:	R:	Regional	L:	Local	SS:	Site specific	TB: Trans-boundary
Duration:	LT:	Long term	MT:	Medium term	ST:	Short term	