



## NAFRA HYDRO ELECTRIC PROJECT OF 96 MW (2 X 48 MW), ARUNACHAL PRADESH

### Environmental Impact Assessment (EIA) and Environment Management Plan (EMP)

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Executive Summary

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## Executive Summary



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## 1 INTRODUCTION

This EIA study is conducted for Nafra Hydro Electric Project as per the ToR issued by MoEF during the prior-environment clearance. The purpose of Environmental Impact Assessment (EIA) is to assist in the decision making process and to ensure that the project options under consideration are environmentally sound and sustainable.

India needs a great deal of power to sustain its economic growth. The National Electricity Policy (NEP) has set the goal of achieving power for all and annual per capita consumption of electricity to rise to 1000 units by 2012. Nafra Hydro Electric Project is one of the several small hydro electric projects that would contribute to achieve this goal.

## 2 PROJECT DESCRIPTION

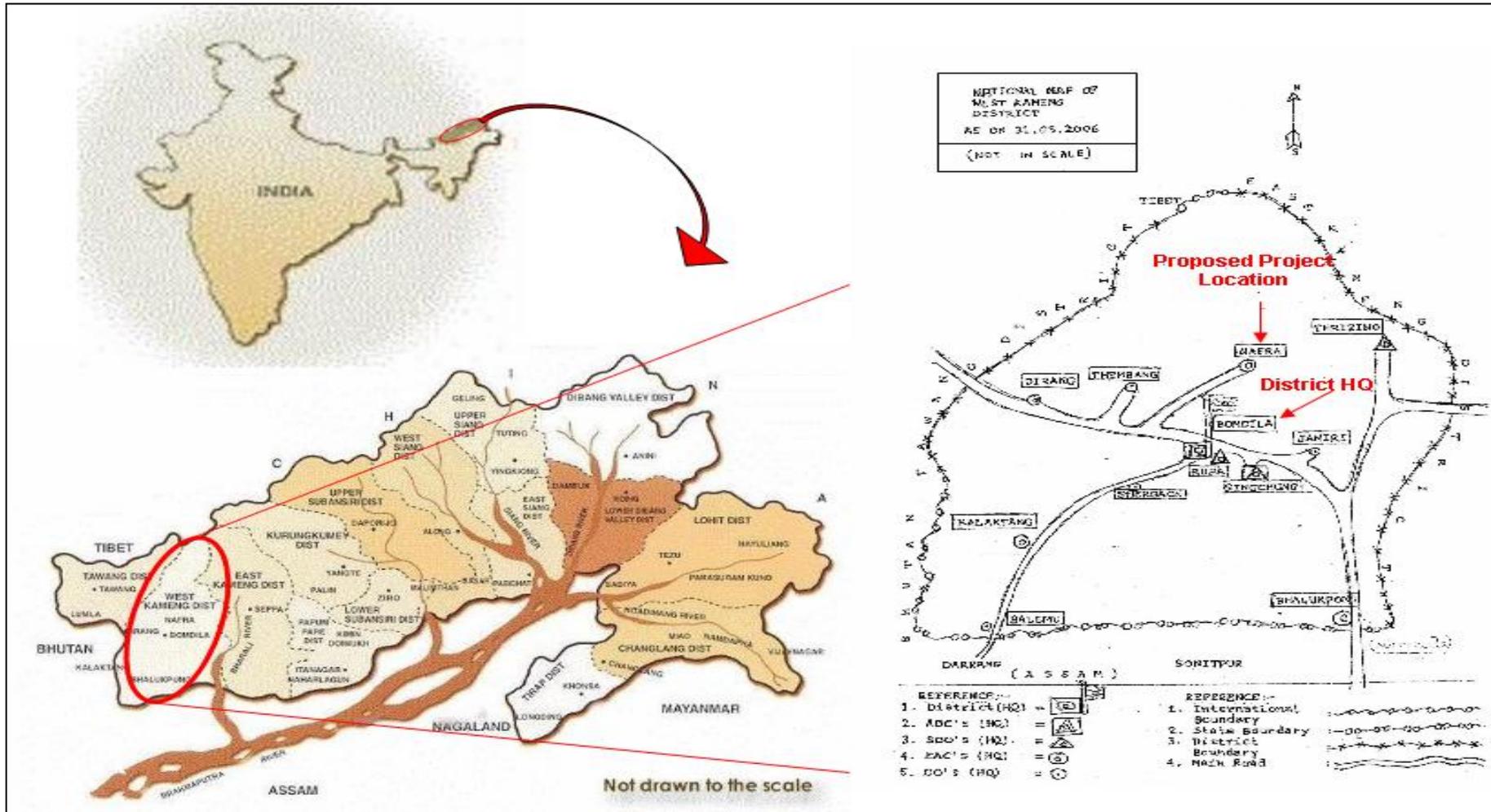
The Nafra Hydro Electric Project is taken up with an objective to exploit the hydro power potential of Bichom River between proposed 125MW Dibbin HEP and ongoing 600 MW Kameng HEP in the Kameng Basin. The project is a run-off-the-river scheme without any seasonal storage (only lean season diurnal pondage) harnessing a gross head of about 184.40 m and design discharge of 61.38 cumec. The project construction includes a 40m high Composite Dam located at Latitude 27° 21' 15.71" N; Longitude 92° 33' 56.66" E where the river bed level is at an elevation of 944m above mean sea level.

The water of river Bichom will be diverted through a tunnel to a surface power house on the right bank of Bichom River. The Power House site is located at Latitude 27° 19' 24.91" N; Longitude 92° 35' 25.25" E where the natural ground elevation is 810m above mean sea level. The installation capacity of 96 MW (2 x 48 MW) will achieve an annual energy generation of 423.95 MU in a 90% dependable year and 491.60 MU in 50% dependable year. The 96 MW power generated at 11 kv at Nafra HEP will be stepped up to 220 kv by unit step up transformers and will be evacuated to the nearest pooling station / sub-station. The civil works of the project will be completed in 36 months.

SEW Nafra Power Corporation Ltd. has signed an MOU with Government of Arunachal Pradesh to develop Nafra Hydro Electric Power Project on Build-Own-Operate-Transfer (BOOT) basis. SEW Nafra Power Corporation Ltd is a special purpose vehicle of SEW Energy Ltd which was established in 2007. Further, SEW Energy Ltd is a wholly owned subsidiary of SEW Infrastructure Ltd, which has 45 years' experience in Hydro Electric project and Dam construction. This parent company has executed over 70 Hydro Electric Projects successfully and has over 40 projects under execution across India

## 3 BASELINE OF EXISTING ENVIRONMENT

It is essential to define the baseline conditions of appropriate environmental parameters which could be significantly affected in order to assess and monitor the impact from time to time. The major categories of parameters determining the baseline environmental conditions are physico-chemical, biological and socio-economic parameters. A study area of 10 km radius of the project area was covered for undertaking the EIA study of the proposed Nafra HEP.



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### 3.1 PHYSICO-CHEMICAL ASPECTS

**Meteorology:** The region has four distinct seasons viz. winter, summer, Monsoon and Post-monsoon. Temperature in the region varies with altitude. Humidity in the region is high throughout the year. The rainfall in the state is amongst the heaviest in the country. The mean annual average rainfall recorded at Bomdila IMD station is 1259.36mm. The range of mean annual average rainfall in four other IMD stations in district West Kameng varies from 2125.05mm to 4834.04mm.

**Geology:** The study area falls within the middle Himalayan tectonic zone, which is known to have multiple thrust faults.. The main rocks which cover the study area and vicinity are a sequence of metamorphic rocks with a dominant E-W strike and large scale folding. The study area is presented by granite, gneisses of the Pre-cambrian age. The geological unit belongs to the Bomdila Group. At the project site this comprises mesocratic, banded and augen gneisses..

**Seismicity and Tectonics:** Arunachal Pradesh is the *cordon sanitaire* between the Indian and the Eurasian plates in North-eastern India. The earthquake activity in this region is due to the Indian plate diving (thrusting) beneath the Eurasian plate and is generally shallow.. As per the 2002 Bureau of Indian Standards (BIS) map, this state also falls in Zone V. Historically, parts of this state have experienced seismic activity greater than **M7.0** & one event of **M8.6** in 1950.

**Soil :** Monitoring and analysis of various parameters (like pH, conductivity, permeability, cation exchange capacity, sodium absorption ratio, water Holding Capacity, Porosity, Nitrogen, Phosphorus, potassium and particle size distribution) has been conducted for 3 seasons (Monsoon, Post-monsoon and Winter). Soil type is heavy silty clay loam in Nafra, light sandy loam in Khellong, and heavy clay loam in Lower Jung respectively.

**Land use and Land Cover:** Land use and land cover mapping of the study area has been carried out by standard methods of analysis, i.e. through remote sensing technique coupled with GIS, followed by ground truthing. Geo-referenced LISS-III Satellite data, survey of India toposheet 83 A/11 has been used for studying the land use & land cover of the study Area. *The study shows Dense Mixed Forest (27.0 %), Pine Forest (31.20 %), Agriculture Land / Settlements (15.30%), Water Bodies (1.80%), Degraded Forest (3.6%) and Shrubs (21 %).*

**Water Quality:** The Nafra Basin is characterized by a bifurcated network of several streams. The proposed project is located in between 125 MW Dibbin H E project and 600MW Kameng HE Project. The water samples from at two sampling locations in the proposed project i.e. upstream of dam site and downstream of power house site at approx 1.00-1.50 km distance were collected for recording the pre-project values. The water quality of study area are classified in B and C class which is fit for outdoor bathing and also could be used for drinking water after conventional treatment and disinfection.

The drinking water samples were collected and compared with drinking water standard. (IS 10,500) It shows that the water quality is within the desirable limit as per IS: 10500 drinking water standards, except for biological parameter. Total Coliform MPN/100ml and Faecal Coliform/100ml were recorded above the recommended limit. Hence; it is recommended that water should be pre treated and disinfected before being used for drinking purpose.

**Ambient Air Quality:** To assess the ambient air quality in the study area, three monitoring station i.e. Nafra Town, Lower Jung Village and Khellong village were taken. The study result shows, the ambient air quality in the project area and its surroundings is free of pollution. The baseline data of ambient air has been generated for SPM, RPM, SO<sub>2</sub>, NO<sub>x</sub> and CO parameters for 3 seasons (Monsoon, Post-monsoon and Winter). The results of ambient air quality in the study area are within the permissible limits as prescribed by CPCB standards.

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During monsoon season; the Suspended particulate matter (SPM) and Respirable Particulate matter (RPM) concentration in the study area varies from 45 to 67  $\mu\text{g}/\text{m}^3$  and 18 to 23  $\mu\text{g}/\text{m}^3$  respectively. The concentration of  $\text{SO}_2$  and  $\text{NO}_x$  varies from 4 to 5  $\mu\text{g}/\text{m}^3$  and 21 to 27  $\mu\text{g}/\text{m}^3$  respectively. CO and HC concentration is below detection limit in the study area. The maximum concentration was found in the Nafra Town followed by Lower jung and Khellong Village.

During Post-monsoon season The Suspended particulate matter (SPM) and Respirable Particulate matter (RPM) concentration in the study area varies from 65 to 100  $\mu\text{g}/\text{m}^3$  and 29 to 44  $\mu\text{g}/\text{m}^3$  respectively. The concentration of  $\text{SO}_2$  and  $\text{NO}_x$  varies from 4 to 5  $\mu\text{g}/\text{m}^3$  and 26 to 33  $\mu\text{g}/\text{m}^3$  respectively. CO and HC concentration is below detection limit in the study area. The maximum concentration was found in the Nafra Town followed by Lower jung and Khellong Village.

During winter season The Suspended particulate matter (SPM) and Respirable Particulate matter (RPM) concentration in the study area varies from 80 to 119  $\mu\text{g}/\text{m}^3$  and 39 to 61  $\mu\text{g}/\text{m}^3$  respectively. The concentration of  $\text{SO}_2$  and  $\text{NO}_x$  varies from 4 to 5  $\mu\text{g}/\text{m}^3$  and 36 to 47  $\mu\text{g}/\text{m}^3$  respectively. CO and HC concentration is below detection limit in the study area. The maximum concentration was found in the Nafra Town followed by Lower jung and Khellong Village. The results are within the stipulated limits as per the CPCB guidelines.

**Noise Environment:** The day and night noise levels have been monitored at three locations during 3 seasons (Monsoon, Post-monsoon and Winter) using sound pressure level meter. Results of ambient noise level monitoring show that  $\text{Leq}$  (day) and  $\text{Leq}$  (night) is within the desired limit (specified by CPCB) at all locations in all seasons.

During monsoon season  $\text{L}_{\text{deq}}$  varies from 42 to 53 dB(A) and  $\text{L}_{\text{neq}}$  varies from 43 to 51 dB(A). The maximum concentration was found in the Nafra Town followed by Lower jung and Khellong Village. The high noise level in night is because of noise created by the insects appearing during monsoon season.

During post monsoon season  $\text{L}_{\text{deq}}$  varies from 44 to 56 dB(A) and  $\text{L}_{\text{neq}}$  varies from 44 to 51 dB(A). The maximum concentration was found in the Nafra Town followed by Lower jung and Khellong Village.

During winter season  $\text{L}_{\text{deq}}$  varies from 45 to 59 dB(A) and  $\text{L}_{\text{neq}}$  varies from 41 to 49 dB(A). The maximum concentration was found in the Nafra Town followed by Lower jung and Khellong Village.

## 3.2 BIOLOGICAL ASPECTS

Arunachal Pradesh has a wide altitudinal range varying from 100m to 7,090m (amsl). There are nine wildlife reserves covering total area of 9,246 km<sup>2</sup>. There are more than 220 species of mammals and more than 500 species of birds recorded in the state. At present, there is no sighting of the wild mammals in the project area except domestic animals, birds, reptiles and butterflies. Secondary literature indicates the presence of number of wild animals in the area in the past. But as per the discussion with the local people and forest department, major animal groups (large mammals) are not available in the study area. No National Park or Sanctuary exists in the vicinity of the project area. The Eagle Nest Wildlife Sanctuary is located in the West Kameng district, but located beyond 10 km radius of the project area.

### 3.2.1 Terrestrial Ecology

Arunachal Pradesh is known for its rich flora & fauna and considered as one of the "Biodiversity Hot Spots" in the world.

**Flora:** The field survey for the ecological studies has been conducted on both banks of the river Bichom, including areas of inundation due to proposed dam construction. The study area falls under

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subtropical forest (*Subtropical Pine Forest & Subtropical Broad-leaved Forest*) with an altitudinal variation ranging from 900m to 1800m in West Kameng district. The Nafra valley area is comparatively dry and sandy, and constituted by well drained soil. Pine (*Pinus roxburghii*; *Pinus wallichiana*) are seen either as pure patches or mixed, and other trees rarely occur in the top canopy. There are very few species of shrubs. But in the locations where the moisture is more, there tends to be an undergrowth of small broad leaf trees mostly like oaks, *Rhododendron*, *Betula*. etc. Other species found in forests are small trees like *Alnus nepalensis*, *Lyonia ovalifolia*, *Betula alnoides*, *Rhododendron arboreum*, *Quercus listerii*, *Q. griffithii*, *Photonia integrifolia*, *Rhus javanica*, *Populus ciliata*.

**Fauna:** The fauna of Arunachal Pradesh is reported to be equally rich. However, local people denied sighting of the referred mammalian fauna. Hunting pressure is very high in the study area; hence the wild life only lives in far off forested areas. In the vicinity of the dam site, there was no direct sighting of any mammal. But it is expected that small nocturnal mammals might be present. The habitat condition for the large sized avifauna is nonexistent, where as only the habitats of small birds exist. The project location has not been under IBA (Important Bird Area), therefore, it is not a sensitive location for birds too.

Amphibia, reptiles and insects were studied within the limitations of this study. Bufonidae, Ranidae and Dicroglossidae families of amphibians were reported. Among reptiles, four lizard species, seven snake species and three skinks were reported. Similarly among insects, short and long horn grass hoppers, mantis, a number of beetles, stone flies, damsel flies, dragon flies, few species of dipteran and ants were reported. A large number of butterflies were reported in the post winter flowering season. There is no site specific or narrow range endemic species in these categories in West Kameng. Hence, no species is restricted due to its very specialized habitat quality and restricted only to the project site.

There is no National Park or Sanctuary in the vicinity. The proposed submergence area is neither potential site for wildlife sanctuary nor offers migration route to any major animal species. The terrestrial fauna covers a wide variety of the taxa from mammals to soil-micro-arthropods. The information of the fauna was gathered (a) primary data (b) secondary information from forest dept, and villagers.

### 3.2.2 Aquatic Ecology

River Bichom is a snow fed stream arising from the high hills of West Kameng district of Arunachal Pradesh. Bichom is a 3<sup>rd</sup> Order River and its flow is dependent on the 1<sup>st</sup> and 2<sup>nd</sup> order streams and thus contributing in shaping the current flow and nutrient composition. There are some streams joining the main Bichom River indicating the contribution of water to the river from other sources. The water current in the river Bichom is 50 cm/ sec or higher, which ecologically is considered to be fast. At this velocity the current will remove all particles less than 5 mm in diameter and will leave behind a stone bottom.

**Phytoplankton:** Phytoplanktons are floating microorganism of the plant kingdom and main producers in the aquatic body. Their distribution depends on the temperature, nutrient supply. Diatoms, flagellates and algae normally constitute the bulk of the phytoplankton. The phytoplankton species found in the slower areas are : *Amphora sp*, *Cocconeis*, *Cymbella*, *Fragillaria*, *Frustulia*, *Navicula*, *Surirella*, *Synedr*, *Cladosphora*, *Spirogyra*, *Ulothrix*, *Rivularia*, *Anabaena*, *Trachyloron*, *Goneochlorises*.

**Zooplankton:** These are consumers and hence heterotrophs and secondary producers. These are important indicator of the health of the aquatic ecosystem. Zooplankton species found in the study area are *Keratella*, *Cypris sp*, and larvae.

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**Fish fauna:** Bichom is one of the largest tributaries of the River Kameng. From Kameng about 73 fish species have been listed (*Nath and Dey, 2000*) while the fish faunal diversity of river Bichom comprises of 27 species belonging to the families Cyprinidae, Psilorhynchidae, Sisiridae, Garrinae (sub family), Cobitidae, Balitoridae, Channidae, Rosborinae. The fish species observed during field survey in the Bichom river are - *Tor tor*, *Tor putitora*, *Labio sp*, *Barilious sp*, *Danio sp*, *Schizotheros sp* of Cyprinidae family and *Balitora sp* of Balitoridae family. The species categorized as endangered (EN) as per available literature (BCPP, 1997) are *Exostomata labiatum*, *Tor tor* and *Tor putitora* out of the total 27 species of the river Bichom, while 9 species are vulnerable (VU) in the lot. The dominant long distant migratory fishes are Snow trout, Mahasheer and Minor carps. The other important fish groups which undertake short migration are *Voemacheilids*, *Glyptothoracids*, *Psilorhynchids*. The migratory phenomenon of the fish species is directly related to its life cycle as the fishes move from one habitat to other for spawning. The breeding migration starts with the onset of monsoon. Even winter migration takes place for the purpose of feeding in most of the migratory fish.

### 3.3 SOCIO-ECONOMIC ASPECTS

The detailed Socio-economic baseline status has been provided in **Social Impact Assessment (SIA) Report as Volume II**.

**Ethnographic Profile:** There are five major tribes in West Kameng District, viz., Monpas, Mijis, Sherdukpens, Akas (Hruss) and Khawa (Gugun). The Nafra town, Khellong and Lower Jung is inhabited by the Sajolang/Miji tribe. The Miji is also known by the name of Sajolang or Damai. Sajolang belongs to the 'mongoloid' ethnic stock. They mostly live in Bichom valley and they are a small community. Sajolangs are mostly agriculturists and they practice shifting cultivation. They as well traditionally engage in hunting and fishing. Basketry is a traditional craft found with the Sajolang men.

**Demographic Profile:** The project is located in Nafra circle, one of the 12 circles in West Kameng district. The population of the Nafra circle is 5818 (Census 2001), out of which 4648 belong to scheduled tribes. There are 26 villages in Nafra Circle, and most of these settlements are small settlements with population even less than 300. The population of Nafra which is the head quarter of the circle is 1407. The other major villages with population more than 300 are Jerigaon, Khoina, Ditchik, Khelong and Longtin.

**Education Profile:** The sample study conducted by the SIA team in November 2008 also included the educational level of the respondent and the family members. The findings on the education level of the population in the impact area are provided in the chart 4.2. The literacy level in Khellong is the lowest among the three at 32.31%. The literacy level of Lower Jung is as high as 72% and that of Nafra is at 59%. The higher education (Beyond School Education) is as low as 6.5% of the total population and just 14% of the total literate population. Khellong village which is located at a higher elevation and has no proper road connectivity has only 2.5% of the total population who have received higher education. Most of the educated (higher education) population lives in Nafra town. 12.33% of the total population in Nafra has received higher education. Not a single person in the impact area is reported to have received technical or vocational education.

**Economic Profile:** Among the districts of Arunachal Pradesh, per capita income of West Kameng district was found to be the highest with Rs 23,897/- at current prices during 2003-04. West Kameng's economy is stronger in the secondary and tertiary sectors, the primary sector activities

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need to get attention to provide strong base and stability to the economy of the district. Agriculture is one of the most popular economic activities in West Kamang district where around 40% of the total workforce is engaged. The presence of cottage industries in the district is quite flimsy. Apart from craft centres, and weaving units, no village and small scale industries are found in the district. The Nafra circle neither has any craft centre of village industries or small scale industries. Hence, there is a need to promote cottage industries in the district.

#### **4 IMPACT PERCEPTION OF LOCAL COMMUNITIES AND MITIGATION PLAN**

The perception of social and economic impact of the local community has been assessed through a structured questionnaire during the SIA study. The overall public opinion on the Nafra Hydro Electric project is positive. A large majority of the people welcome this project. If the results of the opinion survey are summarized, the local people support this project for the following list of benefits that they expect from this project.

1. Employment Opportunity for the local people would increase both during the construction and after commissioning of the project.
2. This would augment family income for most of the people and expand the scope for expansion of trade and business activities.
3. The road and transport facilities for their villages will improve.
4. The availability of reliable supply of electricity for the domestic and industrial use.
5. The availability of water in the reservoir will create possibility of irrigation, fishing, and intensification of agricultural and horticultural activities.

There are certainly a number of apprehensions and concerns of the local people. But, these apprehensions override the developmental benefits that they expect out of this project. The list of apprehensions expressed by the local community is as follows:

1. Reduction in the forest area.
2. Increase in soil erosion.
3. Introduction of new diseases into the region by migrant labors.
4. Increase of mosquito and health hazards connected to them.
5. Increase of crime
6. The reduction in supply of the fish, plants and animals used for food purpose.

Apprehensions expressed by the community are based on their existing knowledge, understanding and limited exposure. Hence, there is a need for a public relation program to educate the local community and thereby ensuring their cooperation in mitigating adverse impacts and enhancing project benefits. The opinion leaders in the community were consulted on these issues, and their concurrence was obtained in deciding social and environment impact mitigation measures.

#### **5 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES**

Based on the project details and the baseline environmental status, potential impacts as a result of construction and operation of the proposed Nafra Hydro Electric Project have been identified. Environmental Impact Assessment for quite a few disciplines is subjective in nature and cannot be quantified. Wherever possible, the impacts have been quantified and otherwise, qualitative assessment has been undertaken. Key Environmental Impacts and Mitigation Measures are discussed as follows :

Parameters	Anticipated Impacts	Management Measures	Implementing Agency
<b>During Project Pre-construction / Construction Phase</b>			
Air Quality	<ul style="list-style-type: none"> <li>Fugitive emissions due to HMP/ crusher operation at site</li> </ul>	<ul style="list-style-type: none"> <li>Commissioning of dust extraction unit on HMP/ crusher in compliance with the statutory guideline given in the NOC by the SPCB</li> </ul>	SEW/ Sub-contractor SEW
Water Quality	<ul style="list-style-type: none"> <li>Water pollution due to disposal of sewerage from labour camp</li> <li>Disposal of effluents with high turbidity from crushers commissioned at various sites and effluents from adits at tunnel</li> </ul>	<ul style="list-style-type: none"> <li>The labour camp shall have septic tank/ soak pit of adequate capacity so that it can function properly for the entire duration of construction phase</li> <li>All justifiable measures will be taken to prevent the wastewater entering directly into river i.e. provision of septic tanks, absorption trenches and settling tanks</li> </ul>	SEW / Project Sub-contractor
Noise	<ul style="list-style-type: none"> <li>Increase in noise levels due to operation of various construction equipments</li> </ul>	<ul style="list-style-type: none"> <li>Noise standard at processing sites, will be strictly enforced as per Govt. of India noise standards.</li> <li>Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure.</li> </ul>	SEW/ Sub-contractor
Land / Soil Environment	<ul style="list-style-type: none"> <li>Soil erosion due to the extraction of construction material from various quarry sites</li> <li>Temporary acquisition of private / forest land for siting of construction equipment and material, waste material, etc.</li> <li>Generation of solid wastes from labour camps / colonies</li> <li>Spillage or leakage of oil</li> </ul>	<ul style="list-style-type: none"> <li>Proper treatment of quarry site, belly benching, Crate walls, re-vegetation and other measures</li> <li>Proper mitigation measures will be adopted during construction and temporary acquired land will be reclaimed after designated use</li> <li>Proper collection and disposal of construction spoils/ solid waste at designated landfill sites</li> <li>Refueling stations will be constructed and maintained so as to prevent spillage or leakage of oil.</li> </ul>	SEW, Sub-contractor and Forest Dept., Bomdila
Terrestrial Ecology	<ul style="list-style-type: none"> <li>Cutting of trees to meet fuel requirements by labour</li> <li>Acquisition of forest area</li> <li>Disturbance to wildlife due to operation of various construction equipment</li> </ul>	<ul style="list-style-type: none"> <li>Adequate supply of kerosene/ LPG for consumption of labour colony so that dependence on firewood for cooking is avoided completely to the extent possible.</li> <li>Compensatory afforestation as per the Forest Conservation Act (1980)</li> <li>Contractual agreements will include penalties for poaching.</li> <li>Proper traffic management and safety measures should be adopted during construction period.</li> </ul>	SEW/ Sub-contractor and Forest Dept.
Aquatic Ecology	<ul style="list-style-type: none"> <li>Marginal decrease in primary productivity due to increased turbidity and lesser light penetration</li> <li>Discharge of domestic waste water from labour camp</li> </ul>	<ul style="list-style-type: none"> <li>Mitigation measures will include appropriate engineering design to minimize increases in suspended solids, including minimizing blasting.</li> <li>All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers</li> </ul>	SEW/ Sub-contractor
Public Health - water related diseases	<ul style="list-style-type: none"> <li>Increased hazards of outbreak of water-borne diseases as a result of lack of sewage treatment and disposal facilities in labour camps</li> </ul>	<ul style="list-style-type: none"> <li>Reservoirs operation, surveillance, insecticide sprays, medical check-ups and development of medical facilities</li> <li>Maintenance of good drainage at overall construction areas to avoid creation of stagnant water bodies.</li> </ul>	SEW and Public Health Dept.

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Parameters	Anticipated Impacts	Management Measures	Implementing Agency
		<ul style="list-style-type: none"> <li>Provision of septic tanks, absorption trenches and settling tanks</li> </ul>	
Socio-economic	<ul style="list-style-type: none"> <li>Acquisition of land and other properties</li> <li>Increase in employment potential</li> </ul>	<ul style="list-style-type: none"> <li>Compensation as per Rehabilitation Plan</li> </ul>	SEW / District Administration
<b>During Project Operation Phase</b>			
Water Resources	<ul style="list-style-type: none"> <li>Reservoir sedimentation</li> </ul>	<ul style="list-style-type: none"> <li>Catchment Area Treatment</li> </ul>	Forest Dept. / SEW
Water Quality	<ul style="list-style-type: none"> <li>Disposal of sewerage from project colonies/ quarters</li> </ul>	<ul style="list-style-type: none"> <li>Commissioning of STP</li> </ul>	SEW
water related diseases	<ul style="list-style-type: none"> <li>Increase in water-related diseases due to creation of suitable habitats for growth of vectors</li> </ul>	<ul style="list-style-type: none"> <li>Reservoirs operation, surveillance, insecticide sprays, medical check-ups and development of medical facilities</li> </ul>	SEW and Public Health Dept.
Aquatic Ecology	<ul style="list-style-type: none"> <li>Reduction in natural flow of river due to diversion of water</li> <li>Natural ecological life will be hampered</li> <li>Expected ecological alterations due to reduction in environmental flow</li> <li>Obstruction in the path of migratory fishes</li> </ul>	<ul style="list-style-type: none"> <li>Adjoining perennial tributaries - Divya Nallah and two more are joining the river Bichom on the left bank, which in turn would contribute to the surface flow and sustain aquatic ecology.</li> <li>The water pool can be created artificially and converted that into natural breeding pools for insects and amphibians</li> <li>Stocking of reservoir and river stretch downstream and upstream of the dam</li> </ul>	SEW/ Fisheries Dept. of A.R.
Socio-economic	<ul style="list-style-type: none"> <li>Increased power generation and greater employment opportunities</li> </ul>	<ul style="list-style-type: none"> <li>12% of the power generated will be provided to the State Government free of cost.</li> <li>Company shall contribute an amount @ one paisa per unit of electricity sold towards local area development fund</li> </ul>	--

## 6 ENVIRONMENT MANAGEMENT PLAN

Based on planned project activities, environmental baseline conditions and impacts assessed in earlier chapters, a set of measures has been suggested to mitigate adverse environmental impacts or to reduce them to acceptable levels during construction and operation phases of the project.

Impact on Environmental Component	Management Plan
Water Pollution	<p><b>During Construction</b></p> <ul style="list-style-type: none"> <li>Treatment of effluent from various sources i.e. HMP/ crushers, labour camps, etc. before discharging into the main stream</li> <li>Construction of settling tank to settle the suspended impurities.</li> </ul> <p><b>During Operation</b></p> <ul style="list-style-type: none"> <li>Commission of suitable treatment facilities to treat the sewage generated from the colony to avoid deterioration of water quality of the receiving water body</li> </ul>
Air Pollution	<p><b>During Construction</b></p> <ul style="list-style-type: none"> <li>Installation of dust extraction unit on HMP/ crusher to control the dust generated while primary crushing the stone aggregates.</li> <li>Stacked fine aggregates should be regularly sprayed with water to prevent the entrainment of fugitive emissions</li> <li>Baseline ambient air monitoring as stipulated in NOC given by SPCB</li> </ul>

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Impact on Environmental Component	Management Plan
Noise Pollution	<p><b>During Construction</b></p> <ul style="list-style-type: none"> <li>• Continuous exposure to noise levels above 90 dB (A) has to be avoided</li> <li>• Exposure period of affected persons should be limited as per CPCB specification</li> <li>• Personal protective measures such as ear muffs or ear plugs to be worn during periods of noise exposure</li> <li>• Equipment and machineries should be maintained regularly</li> <li>• Silencers and mufflers of the individual machineries to be regularly checked</li> <li>• Baseline ambient noise monitoring as stipulated in NOC given by SPCB</li> </ul>
Soil Erosion	<p><b>During Construction</b></p> <ul style="list-style-type: none"> <li>• Selection of proper muck disposal site to avoid muck going into the river</li> <li>• Adoption of soil erosion control measures viz. engineering measures, vegetative measures, reduction in use of fuel wood and management measures</li> </ul>
Terrestrial Ecology	<ul style="list-style-type: none"> <li>• Provision of dedicated grazing lands will help in reducing pressure on forests</li> <li>• Compensatory afforestation has been suggested</li> </ul>
Aquatic Ecology	<ul style="list-style-type: none"> <li>• A minimum flow of during lean season should always be available in the stretch between Dam &amp; TRT discharge point to maintain the aquatic ecology.</li> </ul>
Environmental Management in Road Construction	<p><b>During Construction</b></p> <ul style="list-style-type: none"> <li>• The stripped material should be collected and dumped in the designated muck disposal area which will have retaining walls to prevent the muck to flow down into the river.</li> <li>• After disposal operation is complete at the dump site, dump yard should be contoured and vegetated</li> </ul>
Quarry stabilization and muck disposal plan	<ul style="list-style-type: none"> <li>• The muck disposal sites after dumping should be restored.</li> <li>• Preserving topsoil from the quarry compound should be done by stripping and stacking aside separately at corners.</li> </ul>
Control of Pollution from Labour Camps	<ul style="list-style-type: none"> <li>• Legally mandated provisions will be followed on health, sanitation and appropriate working conditions including accommodation where appropriate for construction worker at camp site.</li> <li>• Provision for solid waste management - facilities for collection, conveyance and disposal of solid waste</li> </ul>
Reservoir & River Fish Management	<p><b>During Operation</b></p> <ul style="list-style-type: none"> <li>• Reservoir and river stretches down stream and upstream of the proposed dam can be stocked with fingerlings</li> </ul>
Public Health	<p><b>During Construction &amp; Operation</b></p> <ul style="list-style-type: none"> <li>• A first-aid post is to be provided near two major construction sites</li> <li>• Monitoring of water samples at a regular interval</li> </ul>
Compensatory Afforestation & Greenbelt Development	<ul style="list-style-type: none"> <li>• Will be prepared in consultation with Forest Department, Bomdila and stipulated guideline given in Catchment Area Treatment Plan</li> </ul>
Social Impact Mitigation	<ul style="list-style-type: none"> <li>• Site selection for constructing Dam and other facilities has been done in such manner which involved minimal acquisition of private land (5.68 %) of the total land requirement.</li> <li>• During design stage extra care has been taken to avoid affecting cultural or religious structures/ public property.</li> <li>• Effort has been made to avoid affecting human settlements.</li> <li>• Management of migrated population and protection of customary privileges and rights of the local community is suggested as part of mitigation plan.</li> <li>• The capacity building of the local institutions for effectively handling this additional responsibility should be taken up for better coordination and administration.</li> <li>• Physical and mental health of the migrated labour population and the local host community should be serviced through providing effective health care and counseling services.</li> </ul>

Total amount to be spent for implementation of Environmental Management Plan (EMP) would be **Rs. 49.74** million. The cost is inclusive of environmental monitoring and exclusive of the cost to be provided as compensation for acquisition of land for the project.

## 7 ENVIRONMENTAL MONITORING PROGRAMME

Monitoring of environmental indicators signal potential problems, facilitate timely implementation of effective remedial measures and allow for validation of assumptions & assessments made in the present study. Environmental Monitoring Programme suggested for the project construction and operation phase is as follows :

Item	Parameters	Frequency	Location
<b>Environmental Monitoring during Construction Phase</b>			
Air quality And Ambient Noise Level	SPM, RPM, SO <sub>2</sub> and NO <sub>x</sub> And Equivalent Noise Level	24 hourly for two alternate days in a month for every quarter during construction period, or as stipulated by SPCB	At 4 locations: <ul style="list-style-type: none"> <li>• Construction Site</li> <li>• Village Khellong</li> <li>• Village Lower Jung</li> <li>• Village Nafra</li> </ul>
Surface Water quality	pH, Temperature, Turbidity, Free Ammonia, Bio-chemical Oxygen Demand (BOD), Dissolved Oxygen, Electrical Conductivity, Boron as B, Sodium Absorption Ratio, Total Coliform Organisms	One sample every quarter till the construction period	<ul style="list-style-type: none"> <li>• At Dam site</li> <li>• At Power House site</li> <li>• Between the tail race discharge point and downstream confluence with Digo river</li> </ul>
Drinking Water quality	Temp, pH, Conductivity, Odour, Taste, Turbidity, Oil & Grease, Total Solids, TSS, TDS, DO, BOD, COD, Total Hardness, Sodium, Potassium, Calcium, Magnesium, Alkalinity, Nitrate, Nitrite, Ammonical-N, Phosphate, Sulphate, Sulphites, Chloride, Fluoride, Lead, Iron, Faecal Coliform and Total Coliform	One sample every quarter till the construction period	<ul style="list-style-type: none"> <li>• 1 sample at labour camp water supply</li> </ul>
Soil Quality	Particle size distribution, Texture, pH, Electrical conductivity, Cation exchange capacity, Sodium Absorption Ratio (SAR), Permeability, Water holding capacity, Porosity, Nitrogen, Potassium, and Phosphorous	One sample in every season for every quarter till the construction period	<ul style="list-style-type: none"> <li>• 1 sample near dam site</li> <li>• 1 sample at muck disposal site</li> <li>• 1 sample at labour camp</li> </ul>
Ecology	Terrestrial and Aquatic	-	Entire Project area
Meteorological aspects	Wind direction, velocity, temperature, humidity, rain		At one of the ambient air quality sampling sites
Public Health	Various health parameters including incidences of water born diseases	Twice a year	Project labour and population of nearby villages
<b>Environmental Monitoring during Operation Phase</b>			
Surface Water Quality	pH, Temperature, Turbidity, Free Ammonia, Bio-chemical Oxygen Demand (BOD), Dissolved Oxygen, Electrical Conductivity, Boron as B, Sodium Absorption Ratio, Total Coliform Organisms	Once in every season	<ul style="list-style-type: none"> <li>▪ Reservoir</li> <li>▪ Between the tail race discharge point and downstream confluence with Digo river</li> </ul>
Drinking Water Quality	Temp, pH, Conductivity, Odour, Taste, Turbidity, Oil & Grease, Total Solids, TSS, TDS, DO, BOD, COD, Total Hardness, Sodium, Potassium, Calcium, Magnesium, Alkalinity, Nitrate, Nitrite, Ammonical-N, Phosphate, Sulphate, Sulphites, Chloride, Fluoride, Lead, Iron, Faecal Coliform and Total Coliform	Twice a year	<ul style="list-style-type: none"> <li>• 1 sample from project colony</li> </ul>
Erosion and	Soil erosion rates and slope stability of	As per CAT plan	River bank of Bichom river

### Executive Summary

Item	Parameters	Frequency	Location
Siltation	embankments of dam, efficacy of soil and conservation measures		
Terrestrial Ecology	Status of afforestation programme of green belt development, changes in migration patterns of the terrestrial fauna	As per CAT plan	Study area
Aquatic Ecology	Status of phytoplankton, zooplankton, benthic life, fish composition, changes in migration patterns of the aquatic fauna species	As per CAT plan	study area

Tentative cost for environmental monitoring will be Rs. 6.94 million.

## 8 SOCIAL IMPACT

The social impact of the project is discussed in the SIA report in Volume II in details and is summarized in the executive summary attached to Volume II. Some of the key social impacts are discussed below.

### 8.1 PROJECT AFFECTED FAMILIES

The affect of the Nafra Hydro Electric Project is limited to 5 families in Khellong, 5 families in Lower Jung. The name of the household heads of these families is provided in the table below.

Name of Villager	Names of Household Heads
Khellong	1. Nikhanju Thriju, 2. Ajin Thriju, 3. Nigee Dajangju, 4. Moloji Dajangju, 5. Norbu Bambiju
Lower Jung	1. Sangchong Longthen, 2. Abul Longthen, 3. Dangsong Longthen, 4. Sanbang Longthen, 5. Lanco Longthen

### 8.2 VULNERABLE GROUPS AMONG PROJECT AFFECTED FAMILY

Vulnerability Category	Remarks/Findings
BPL Families	None of the project affected families belong to Below Poverty Line (BPL) category.
Women Headed Households	The SIA survey did not identify any household headed by woman.
Children and Old People	As the permanent dwelling houses are not affected hence no displacement of these families would take place. Hence, children and old people do not require special attention.
Tribal/SC/ST Population	The local population is comprised of Miji/Sajolang Tribe only. No SC population exists in the project affected area.

### 8.3 IMPACT OF LAND ACQUISITION

Total Land requirement for the Nafra Hydro Electric Project is **74.96 ha**. Total land required for permanent acquisition is **45.04 ha** and for temporary acquisition **29.92 ha**. The total Forest Land to be acquired is **32.12 ha**. Out of this **26.91 ha** will be acquired permanently and **5.21 ha** temporarily for the construction period. Hence, the total forest land constitutes only **42.85%** of the total land required for this project. The total land loss under the possession of the individual families will be only **4.26 ha**, which is only **5.68%** of the total land requirement of this project. In total **42.84 ha** of land required for the Nafra HEP is under collective ownership of the communities. Out of this **18.13 ha** of land (**42%**) under the collective ownership of the community will be acquired permanently. The rest of the total land (**58%**) owned by the community however would be acquired for the construction period only. These patches of lands will be returned back to the community after rehabilitating them appropriately.

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