NORTH EAST ELECTRIC POWER CORPORATION LTD.

COMPREHENSIVE ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR MAWPHU HYDRO ELECTRIC PROJECT (85 MW), STAGE-II, MEGHALAYA

EXECUTIVE SUMMARY

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CONTENTS

CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY REPORT OF CEIA STUDY FOR MAWPHU H.E PROJECT STAGE-II MEGHALAYA

1. INTRODUCTION

The Mawphu HE Project Stage-II is located on river Umiew flowing through East Khasi Hill district of Meghalaya. The Mawphu HE Project Stage-II is a part of a cascade development scheme on Umiew River which is the main drainage in East Khasi Hill district. The river Umiew originates at an elevation of about 1850 m and after running a considerable stretch in Meghalaya, India, enters into Bangladesh to reach Brahmaputra via Surma a major tributary of River Brahmaputra. The river Umiew is joined by number of right bank tributary namely Umkynrem, Umtong and Waisu. Approximately 232m head is available between the dam near Mawphu village and Tail Race Tunnel outlet near Thieddieng village. The project location map is shown in Figure-1.

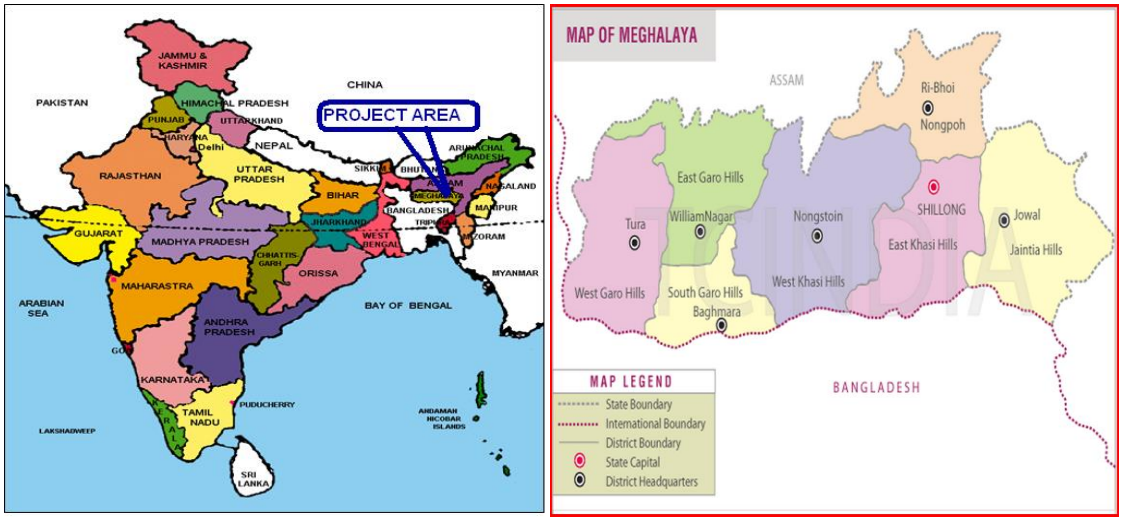

Figure-1: Project Location Map

2. PROJECT PROFILE

Mawphu Hydroelectric Project (Stage – II) is proposed as a run-of-river scheme on the river Umiew in the East Khasi Hills district of Meghalaya. The proposed dam is located at latitude 25°18'32" N and longitude 91°38'19" E at about 2km upstream of Thieddieng village on the right bank. The proposed Power House is located at latitude 25°16'45" N and longitude 91°37'45" E at about 2km downstream of Thieddieng village.

The project envisages the construction of A concrete gravity dam of 51 m high (from the deepest foundation level) and 140 m long (at top) comprising 3 overflow blocks with spillway arrangement of 6 bays , each with radial gate of size 9.0m x 13.70m and 4 non-overflow block and Energy dissipation arrangement is proposed with trajectory bucket. The river diversion arrangement consists of 1 no. diversion tunnel of 7.0 m dia., Horse-shoe shaped and 384 m long, on the left bank with 18 m high upstream coffer dam and 6 m high downstream coffer dam. The Power intake structure is of 16.0 m wide and 17.60 m high on the right bank with an inclined trash rack. The Head Race Tunnel is of 4.80m dia. Horse-shoe shaped and 2.62km long. Restricted orifice type surge shaft is of 10.0 m dia. and 38.35 m high at the end of HRT and main pressure shaft is of 3.50 m dia., 873 m long and branch pressure shaft is of 2.50 m dia. and 32 m long each.

The surface power house is of size 65.84m (L) x 18.0 m (W) x 35.70 m (H) housing two vertical axis Francis turbines each of 42.50 MW installed capacity. The tail race channel is of 10.0m wide and 70.29 m long (including Recovery Bay) to discharge water into the river. The 132kV Gas insulated switchgear installed on the floor above the transformers.

The total cost of the project (including IDC) is Rs. 1042.13 crores. The levellised tariff has been calculated as Rs.6.44. The construction period for the project is 60 months (including pre-construction period).

The key components of the project are:

- A concrete gravity dam of 51 m high (from the deepest foundation level) and 140 m long (at top) comprising 3 overflow blocks with spillway arrangement of 6 bays , each with radial gate of size 9.0m x 13.70m and 4 non-overflow block.
- Energy dissipation arrangement is proposed with trajectory bucket.
- River diversion arrangement consists of 1 no. diversion tunnel of 7.0 m dia., Horse-shoe shaped and 384 m long, on the left bank with 18 m high upstream coffer dam and 6 m high downstream coffer dam.
- Power intake structure is of 16.0 m wide and 17.60 m high on the right bank with an inclined trash rack.
- Head Race Tunnel is of 4.80m dia. Horse-shoe shaped and 2.62km long. Restricted orifice type surge shaft is of 10.0 m dia. and 38.35 m high at the end of HRT
- Main pressure shaft is of 3.50 m dia., 873 m long and branch pressure shaft is of 2.50 m dia. and 32 m long each
- Surface power house is of size 65.84m (L) x 18.0 m (W) x 35.70 m (H) housing two vertical axis Francis turbines each of 42.50 MW installed capacity
- Tail race channel is of 10.0m wide and 70.29 m long (including Recovery Bay) to discharge water into the river
- 132kV Gas insulated switchgear installed on the floor above the transformers

The proposed layout of the project is shown in Figure-2.

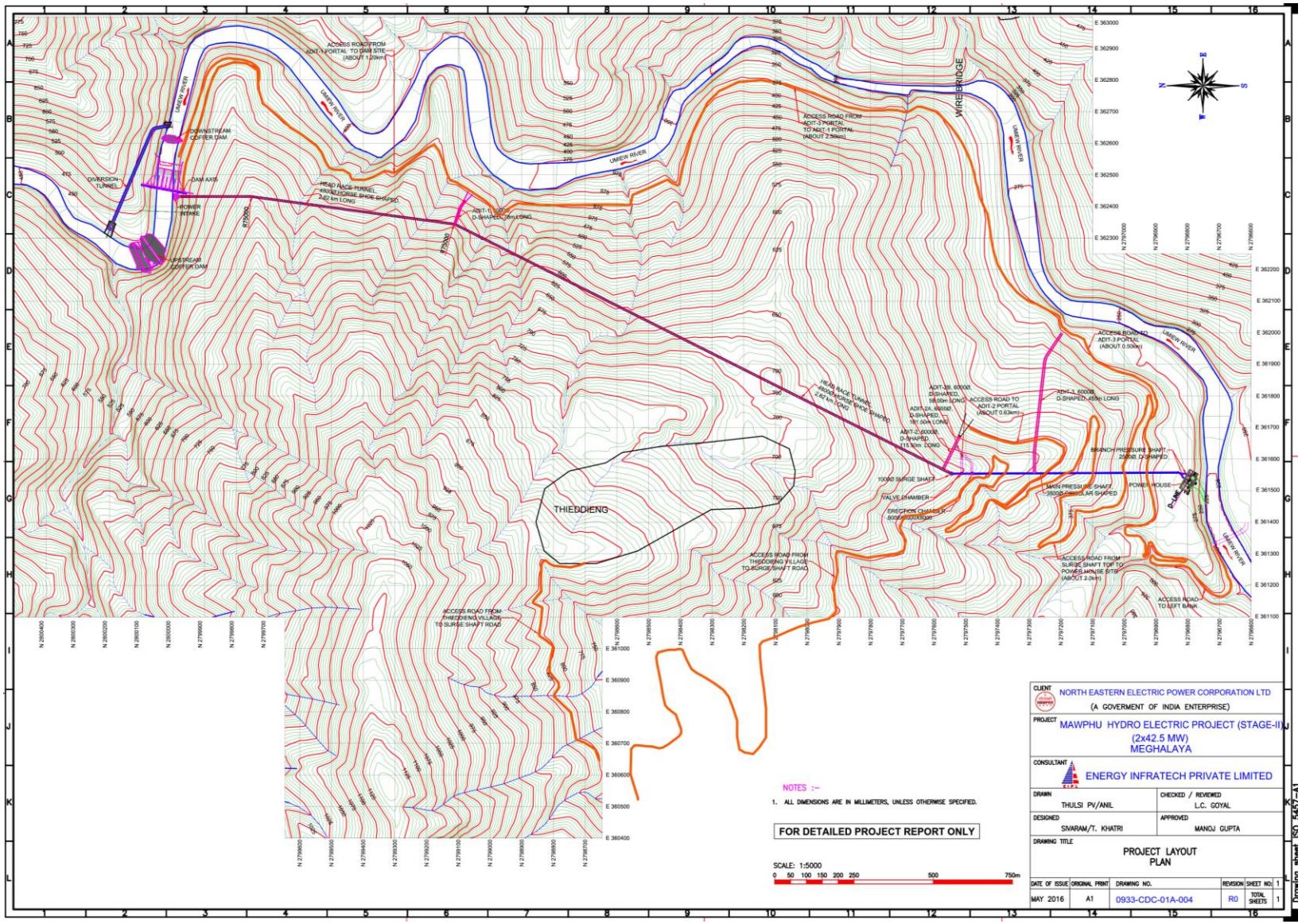

Figure-2: Project layout map of Mawphu HEP (Stage-II)

2.1 Land Requirement

The total land requirement for the project is 110 ha.

Table-1: Details of Land requirement for Mawphu HEP (Stage-II)

Component	Area (Ha)
Residential/Non Residential Area at Dam Site	1.5
Residential/Non Residential Area at PH Site	1.5
Total Area Required For Proposed Roads	17.7
Area proposed for Quarry area	6.5
Area Required for Power House	3.50
Area Required For Adit/Access Tunnels	2.25
Area Required at Surge Shaft Top	2.0
Area Required at Dam complex	9
Area required for HRT	6.20
Submergence area	13.00
Contractor facility/Labour Colony – Adit-1	1
Contractor facilities Area at Dam site	1
Fabrication Yard	1.50
Aggregate Crushing Plant near Dam site	1
Aggregate Crushing Plant near adit-1	1
Aggregate Crushing Plant near PH site	1
Area covering pressure shaft, road to power house, dumping Area for ss, temporary colony for PH And adit-3 alignment (partly)	25
Muck Dumping	
NEAR DAM COMPLEX	5.25
NEAR ADIT-1	2.5
Adit 2	2.0
Adit 3	2.0
Power House (Right Bank)	2
Power House (Left Bank)	1.5
Magazine	
Dam complex	0.1
Between Adit 1 & 2	0.1
Total	**110**

2.2 Access Roads

Motorable road is available up to Mawsynram. Access road from Mawsynram to Thieddieng village is under construction by PWD, Meghalaya. So far, formation cutting for a distance of about 4km has been completed in this stretch. At present, Thieddieng Village is accessed by foot track. Proposed dam site and Power House site can be accessed from Thieddieng Village only by foot paths. Therefore, new approach roads to dam site and Power House are required to be built. About 19 km long approach roads (to all the project components and construction facilities) have been proposed. Five bridges, two permanent bridges of about 100m long and three temporary bridges of about 50m long each have been proposed. In addition, 20 nos. of culverts at nallah crossings have also been proposed. It is proposed to construct the access road to the various project components as given in **Table-2**.

Table-2: Proposed Roads in the Project Area

S.No.	Description	Length (m)
1.	Access Road From Adit-1 Portal To Dam Site	1200
2.	Access Road from Adit-3 portal to Adit-1 portal	2500
3.	Access Road to Adit-3 Portal	500

S.No.	Description	Length (m)
4.	Access Road to Adit-2 Portal	250
5.	Access Road to Surge Shaft	3800
6.	Access Road from Thieddieng Village to Surge Shaft Road	4000
7.	Quarry Roads	6000
	Total	**18250 Approx**

3. STUDY AREA

The study area considered for the CEIA study (Refer Figure-3) is given as below:

- Submergence area
- Area within 10 km of the periphery of the submergence area
- Area to be acquired for siting of various project appurtenances.
- Area within 10 km of various project appurtenances
- Catchment area intercepted at the dam site

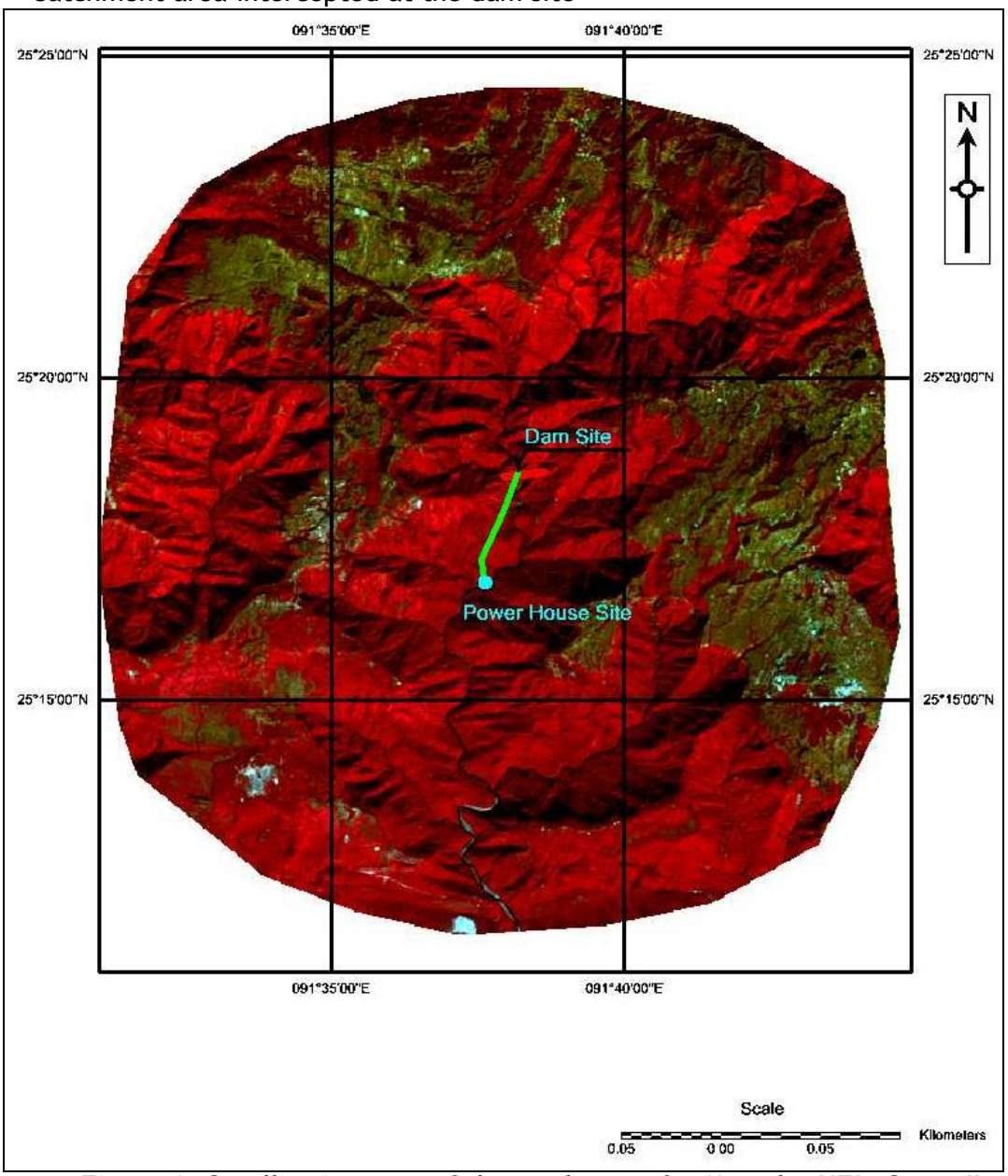

Figure-3: Satellite imagery of the study area for Mawphu HEP, Stage-II

4. ENVIRONMENTAL BASELINE STATUS

The baseline status for the above referred categories has been described in the following sections.

The baseline status has been divided into following three categories:

- Physico-chemical aspects
- Ecological aspects
- Socio-Economic aspects.

The baseline setting for physico-chemical aspects have been covered in this Chapter. The field studies have been conducted for 3 seasons as detailed in **Table-3.**

Table-3: Details of field studies conducted as a part of CEIA studies

Season	Months
Monsoon	August 2014
Winter	December 2014 – January 2015
Summer	April 2015

4.1 Physio-Chemical Aspects

4.1.1 Soils

The pH of soil at various sites lies within neutral range of 7.0 to 7.6.The pH of the soil is in neutral range. The low EC values indicate low salt content. The levels of nutrients indicate that the soil has low to moderate productivity. The continuous washout of nutrients along with runoff as a result of high precipitation and steep slopes can be attributed for this phenomenon

In a hydroelectric project, no significant impact on soil quality is expected barring, soil pollution at local level due to disposal of construction waste. For amelioration of such impacts appropriate management measures are recommended.

4.1.2 Water Quality

The pH level in the study area ranged from 7.3 to 7.7 at various sampling sites covered as a part of the study. The pH level indicates neutral nature of the water, and is within the permissible limit specified for meeting drinking water requirements

The low EC and TDS values indicate the lower concentration of cations and anions. The concentration of TDS level ranged from 96 to 106 mg/l, 92 to 97 mg/l and 87 to 92 mg/l in monsoon, post-monsoon and pre-monsoon seasons respectively, which is much lower than the permissible limit of 500 mg/l specified for drinking water requirements. This is also reflected by the fact that the concentration of most of the cations and anions are well within the permissible limit specified for drinking water requirements.

The total hardness in water samples ranged from 52-76 mg/l in monsoon, 55-61 mg/l in post-monsoon and 50-60 in pre-monsoon seasons respectively. The hardness level in the low calcium and magnesium levels are responsible for soft nature of water. Hardness is caused by divalent metallic cations. The principal hardness causing cations are calcium, magnesium, strontium and ferrous and iron. The low levels of calcium and magnesium are mainly responsible for the soft nature of water.

Alkalinity of water is a measure of its capacity to neutralize acids. The alkalinity of natural water is due primarily because of the salts of weak acids. The alkalinity was found to be higher than the total hardness in all the water sampling stations monitored as a part of the study, which indicates that entire hardness in the water is on account of carbonate hardness and there is no bicarbonate hardness in the water.

Chlorides occur in all natural waters in widely varying concentrations, chlorides is available in natural water, mainly through solvent power of water, which dissolves chlorides from top soil and deeper formations. The chlorides level ranged from 6 to 11 mg/l, which are well below the permissible limit of 200 mg/l, specified for meeting drinking water requirements.

Sulphates ion is one of the major anions occurring in natural water. It is an important parameter because of its cathartic affect, when it is present in higher concentration. The sulphates level at various sampling stations ranged from 3.9 to 5.2 mg/l in various samples monitored for three seasons covered as a part of the study. The sulphates was found to be well below the permissible limit of 200 mg/l specified for drinking water purposes.
The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level. Iron was found to be well below the permissible limit of 1 mg/l specified for drinking water purposes.
The concentration of various heavy metals was found to be well below the permissible limits. Concentration of phenolic compounds and oil & grease as expected in a region with no major sources of water pollution from domestic or industrial sources was observed to be quite low.
The BOD values are well within the permissible limits, which indicate the absence of organic pollution loading. This is mainly due to the low population density and absence of industries in the area. The low COD values also indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load, which enters river Mawphu, stage-II, gets diluted. In fact, even for the minimum flow, there is more than adequate water available for dilution. The heavy metal concentration in the study area is below the permissible limit used for drinking purposes.
Total Coliform count is nil in the study area. It can be concluded that water quality was observed to be quite good, as various parameters are well below the permissible limit specified for meeting domestic requirements.

4.1.3 Ambient Air Quality

The maximum PM_{10} level observed in survey conducted during the post monsoon season was 72.0 $\mu g/m^3$. During field studies, PM_{10} level was observed to be well much below the permissible limit of 100 $\mu g/m^3$, specified for industrial, residential, rural and other areas at various stations covered during the survey.

The SO_2 level was observed to be <5.0 $\mu g/m^3$ at all the sampling locations. The highest NO_2 value observed in post-monsoon season was 13.2 $\mu g/m^3$. The NO_2 level observed at various sampling stations was much lower than the permissible limit of 40 $\mu g/m^3$ for industrial, residential, rural and other areas.

Based on the findings of the ambient air quality survey, conducted for the post-monsoon, winter and summer seasons, it can be concluded that the ambient air quality is quite good in the area.

4.1.4 Noise Environment

The day time equivalent noise level at various sampling stations ranged from 36.4 to 38.1 dB (A) and 36.5 to 37.6 dB (A) in post-monsoon, pre-monsoon and seasons respectively. In monsoon season, the day time equivalent noise level at various sampling stations ranged from 37.3 to 38.1 dB(A) The noise levels were observed to be well within permissible limits specified for residential area.

4.1.5 Land use pattern

The land use pattern of the study area is given in **Table-4**.

Table-4: Landuse pattern of the study area of Mawphu HE Project, Stage-II

S. No	Category	Area(ha)	Area (%)
1	Open Vegetation	8156	17.47
2	Dense Vegetation	22536	48.27
3	Exposed Rocks	3033	6.50
4	Agricultural Land	303	0.65

S. No	Category	Area(ha)	Area (%)
5	River/ Water body	740	1.58
6	Jhum Cultivaiton	4177	8.95
7	Barren Land	7656	16.40
8	Settlements	89	0.19
	Total	**46690**	**100.00**

The major landuse category in the study area of Mawphu HE project is dense vegetation, as it accounts for about 48.27% of the study area followed by open vegetation (17.47%). Jhum Cultivation accounts about 8.95% of the study area. Barren land accounts for about 16.40% of the study area. The area under Agricultural Land is 0.65% of the study area. Settlements account for about 0.19% of the study area. The area under Exposed rocks and water bodies is 6.50% and 1.58% of the study area.

4.2 Ecological Aspects

4.2.1 Vegetation

As per the State Forest Report, published by the Forest Survey of India, the forest cover of Assam is 27,645 sq km which constitute nearly 35.24% of the geographic area and includes very dense, moderately dense and open forest (FSI, 2005). The forest in the state can be divided into six major forest types which are characterised by Tropical Wet Evergreen, Tropical Semi-Evergreen, Tropical Moist Deciduous, Sub-tropical broad-leaved Hill, Sub-tropical Pine and Littoral swamp Forests. The forests observed in the catchment area have been grouped into different forest types following the classification of Kanjilal (1934-40), Champion & Seth (1968), Kataki (1983), Haridasan & Rao (1985), Negi (1989, 1996), and Mudgal & Hajra (1999). The major forest types found in this catchment are given below:

- 2B/C1 *Assam Valley Tropical semi-evergreen forest*
- 2B/C1b *Eastern submontane semi-evergreen forest*
- 8B/C2 *Khasi sub-tropical wet hill forests*
- 9/ C2 *Assam sub-tropical pine forest*
- 11B/C2 *Naga Hills wet temperate forest*

Vegetation Profile / Floristics In The Project Impact Zone

About 158 species of angiosperms including trees, shrubs, climbers and herbs are recorded in the project area during study period. The ground vegetation comprised of ephemeral, annual, and perennial species of grasses, sedges, legumes and non-legume forbs. The study area falls in two zone of East Khasi Hill District where river Umiew river forms boundry i.e. Left bank area along river Umiew falls under Cherapunji zone, whereas area along the righ bank of Umiew falls under Mawsynram. The main project activities will take place along the right bank due to Intake tunnels and power house location. However, forests type is common along both banks of river in the project influenced area. Cherapunji and Mawsynram platue are the highest hill range of Meghalaya. The details are given in **Table-5**.

Table-5: Different life forms of the plant species recorded in various seasons from study area.

Plant Species	No. of Species	Percentage of Species
Trees	41	25.95
Shrubs	40	25.32
Climbers	19	12.02
Herbs	47	29.75
Ferns	11	06.96
Total	**158**	**100.00**

4.2.2 Fauna

A total of 29 species from 15 families of mammals could be confirmed from the influence area of Mawphu H.E. project of Meghalaya. The entire study area is located in the range of Mawsynram – Cherrapunjee plateau of Meghalay and is one of the heavy rains shed area in the world. Family Soricidae is represented by 3 species, all these species are common and widely distributed. The available information on Shrew is not much from the study and adjacent areas, therefore, the presence of many other species of shrews are anticipated from the study area. Indigenous people are aware of shrews but not up to the specific level.

Primates comprise of 3 species, of which *Macaca assamensis* is widely distributed while other species have their restricted distribution. Felidae includes 1 species, i.e. Jungle cat, which is common and widely distributed in Indian sub continent, however, is highly restricted in the area occupancy.

Family Canidae is represented Jackal (*Canis aureus)* is generally sighted by people in the close vicinity of the proposed component areas. It inhabits open place.

Herpestidae includes *Herpestes urva* and *Herpestes edwardsii* (Mongoose). They dwells open places near settlement. Both species are common and widely distributed. Local people are familiar with the presence of Mongoose in the vicinity of proposed project. Each of the family Mustelidae and Hystricidae comprises of a single species. Both species are common in distribution.

In the Artiodactyla, the area is inhabited by 2 species belonging to family Cervidae. Both species (Barking Deer and Sambar) are common and widely distributed. The Barking dear is occasionally spotted in the area by its call. Sambar inhabits dense forests.

Various species of Rodents (Squirrels, Rats and Mice) are reported from the study area. These species are found mostly in bamboo forests and settlement areas. People are familiar to many species of squirrels, rats and mice and other fauna, however, the presence of only 4 species could be confirmed from this area.

4.2.3 Avifauna

Out of 85 species of birds present in the zone of influence of Mawphu project, a total of 73 have been considered as 'least concerned' of IUCN redlist. As per the Schedule list of IWPA (1972) a total of 81 species are included in the Schedule IV. Only 2 species are Schedule I,including one is *Polyplectron bicalcaratum* (Grey Peacock Pheasant) and Oriental Pied Hornbill.

4.2.4 Fish Communities & Status

The major ichthyofaunal information from Meghalya commences with Sen (2000, 2003), which reported a total of 165 species from 85, genera, 31 families and 9 orders. The geographical variation in the form of hills, plateaus and plains provide a fair scope of rich ichthyofaunal diversity in Meghalaya including Khasi hills.

Likewise, other states and areas of India, fish fauna of Meghalaya including the study area has been facing substantial threats due to faulty fishing methods, water pollution, degradation of natural habitat due to deforestation, soil erosion, and river regulation. Though, the surroundings of Mawphu H.E. projected is nor experienced of these factors so far, but cannot be denied to be affected by these activities, especially river regulation and its ancillary activities in future. The baseline data on fish and fisheries from the area under discussion would be helpful in predicting the likely impacts of projects and understanding of mitigation measures.

4.3 Socio-Economic Aspects

4.3.1 Demographic profile

The total number of Project Affected Families are 49 as per the survey conducted where about 263 Families resides. Maximum number of families follow Christianity followed by others and Christanity.Almost all the families are Schedule Tribes.The ratio of male and

female population observed in the area as per the survey conducted is 45.25% females to 54.75% males. The married and unmarried population ratio is 49.43% to 50.57%.The 92.78% of the population is literate. As per the survey conducted 57.03% of the persons are economically engaged whereas 42.97% of the persons are not economically engaged.

5. PREDCTION OF IMAPCTS

5.1 Impacts on Water Environment

5.1.1 Water quality

a) Construction phase

Sewage from labour camps/colonies

The project construction is likely to last for a period of 5 years. The peak labour strength likely to be employed during project construction phase is about 800 workers and 200 technical staff. The increase in the population as a result of migration of labour population during construction phase is expected to be of the order of 4000. Considering per capita water supply as 70 lpcd, the domestic water requirement has been estimated as 0.28 mld. Considering sewage generation as 80% of the total water supplied, quantum of sewage generation is expected to be 0.22 mld

Effluent from crushers

During construction phase, at least one crusher will be commissioned at the quarry site by the contractor involved in construction activities. It is proposed only crushed material would be brought at construction site. A total quantity of 49 m^3/hr of effluent is expected to be generated from various crushers.

Pollution due to muck disposal

The major impact on the water quality arises when the muck is disposed along the river bank. The project authorities have identified suitable muck disposal sites which are located near the river channel. The muck will essentially come from the road-building activity, tunneling and other excavation works. The unsorted waste going into the river channel will greatly contribute to the turbidity of water continuously for long time periods. The high turbidity is known to reduce the photosynthetic efficiency of primary producers in the river and as a result, the biological productivity will be greatly reduced. Therefore, prolonged turbid conditions would have negative impact on the aquatic life.

b) Operation phase

Effluent from project colony

During project operation phase, due to absence of any large-scale construction activity, the cause and source of water pollution will be much different. Since, only a small number of O&M staff will reside in the area in a well-designed colony with sewage treatment plant and other infrastructure facilities, the problems of water pollution due to disposal of sewage are not anticipated. In the operation phase, about 50 families (total population of 200) will be residing in the project colony. About 0.03 mld of sewage will be generated. The total BOD loading will be order of 11 kg/day.

Impacts on reservoir water quality

The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. Phytoplankton productivity can supersaturate the euphotic zone with oxygen before contributing to the accommodation of organic matter in the sediments. Enrichment of impounded water with organic and inorganic nutrients will be the main water quality problem immediately on commencement of the operation.

Eutrophication risks

Another significant impact observed in the reservoir is the problem of eutrophication, which occurs mainly due to the disposal of nutrient rich effluents from the agricultural fields. However, in the present case, fertilizer use in the project area is negligible, hence,

the runoff at present does not contain significant amount of nutrients. Even in the post-project phase, use of fertilizers in the project catchment area is not expected to rise significantly. Thus, in project operation phase, problems of eutrophication, which is primarily caused by enrichment of nutrients in water, are not anticipated.

5.1.2 Impacts on Hydrologic Regime

The proposed Mawphu hydroelectric project, stage – II envisage of reservoir up to its live storage capacity, which would then be used for peaking power. The filling up of reservoir for peaking power operations can lead to drying up of river downstream of dam site, especially in non-monsoon seasons. The impact is most severe in lean season. This can lead to significant adverse impacts on downstream riverine ecology. To mitigate the adverse impacts, Environmental flows shall be released for maintaining the aquatic ecology and water quality of river.

It is proposed to release Environmental Flows for sustenance of Aquatic Ecology. The details are given in **Table-6**.

Table-6: Summary of Environmental Flows to be released in various seasons

Season	Avg. inflow (m^3/s)	% of Inflow	Avg. EF to the downstream(m^3/s)
Lean (December to March)	4.23	20	0.85
Non-Monsoon Non-Lean (October-November, April-May)	28.8 24.43	25	7.20 6.11
Monsoon (June- September)	46.28	30	13.89

5.2 Impacts on Air Environment

Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted as a result of combustion of diesel is SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming that all the equipment are operating at a common point, is quite low, i.e. of the order of less than 1 $\mu g/m^3$. Hence, no major impact is anticipated on this account on ambient air quality.

Emissions from crushers

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher each is likely to be commissioned near proposed quarries for dam and power house. During crushing operations, fugitive emissions comprising mainly the suspended particulate will be generated. Since, there are no major settlements close to the crusher sites for dam and power house, hence, no major adverse impacts on this account are anticipated. However, during the layout design, care should be taken to ensure that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone (say about 2 km on the wind direction) of the crushers.

Fugitive Emissions from various sources

During construction phase, there will be increased vehicular movement. Lot of construction material like sand, fine aggregate are stored at various sites, during the project construction phase. Normally, due to blowing of winds, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on this account are generally, insignificant in nature.

Blasting Operations
Blasting will result in vibration, which shall propagate through the rocks to various degrees and may cause loosening of rocks/boulders. The overall impact due to blasting operations will be restricted well below the surface and no major impacts are envisaged at the ground level. During tunneling operations, dust will be generated during blasting. Ventilation system will be provided with dust handling system to capture and generated dust. The dust will settle on vegetation, in the predominant down wind direction. Appropriate control measures have been recommended to minimize the adverse impacts on this account.

Pollution due to increased vehicular movement
During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Similarly, these will be increased traffic movement on account of disposal of muck or construction waste at the dumping site. The maximum increase in vehicle is expected to 50 vehicles per hour. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. Similarly, marginal increase in Hydrocarbons, SO_2 and NOx levels are anticipated for a short duration.

Dust emission from muck disposal
The loading and unloading of muck is one of the source of dust generation. Since, muck will be mainly in form of small rock pieces, stone, etc., with very little dust particles. Significant amount of dust is not expected to be generated on this account. Thus, adverse impacts due to dust generation during muck disposal are not expected.

5.3 Impacts on Noise Environment
The operation of construction equipment is likely to have insignificant impact on the ambient noise level. The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it is recommended that exposure period of affected persons be limited as per the maximum exposure period specified by Occupational Safety and Health Administration (OSHA).

5.4 Impacts on Land Environment
The major impacts anticipated on land environment during construction are as follows:

Quarrying operations
The quarrying operations are semi-mechanized in nature. Normally, in a hilly terrain like Arunachal Pradesh, quarrying is normally done by cutting a face of the hill. A permanent scar is likely to be left, once quarrying activities are over. With the passage of time, the rock from the exposed face of the quarry under the action of wind and other erosion forces, get slowly weathered and after some time, they become a potential source of landslide. Thus it is necessary to implement appropriate slope stabilization measures to prevent the possibility of soil erosion and landslides in the quarry sites.

Operation of construction equipment
During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earthmovers, rock bolters, etc. The siting of this construction equipment would require significant amount of space. Similarly, space will be required for storing of various other construction equipment. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storage of quarried material before crushing, crushed material, cement, rubble, etc. Efforts shall be made for proper siting of these facilities. Efforts must be made to locate equipments in such a way

that the adverse impacts on environment are minimal, i.e. to locate the construction equipment, so that impacts on human and faunal population are minimal.

Muck disposal

The quantum of muck generated in the proposed project shall be of the order of 10.64 lakh m^3, and considering a swelling factor of 1.5, the quantum of muck to be handled is 15.95 m^3. About 50% of muck shall be utilized and remaining 50%, i.e. about 7.98 lakh m^3 shall be disposed at designated muck disposal area. In the proposed project, muck generation is envisaged during excavation of project components such as Coffer dam, Diversion tunnel, Dam, Power house, TRT, Adits, Surge shaft, Pressure shaft etc. worked out.

Changes in landuse

The total land required for the project is 110.0 ha. A part of this land is required for labour camps, quarry sites, muck disposal, storage of construction material, siting of construction equipment, which will be required temporarily and returned once the construction phase is over. Permanent acquisition of land is required for dam axis, submergence area, project colony, etc..

Impacts due to roads

A total road network of 18.25 km is proposed to be constructed as a part of the project. The details are given in **Table-7**.

Table-7: Project Major Road Network

S.No.	Description	Length (m)
1.	Access Road From Adit-1 Portal To Dam Site	1200
2.	Access Road from Adit-3 portal to Adit-1 portal	2500
3.	Access Road to Adit-3 Portal	500
4.	Access Road to Adit-2 Portal	250
5.	Access Road to Surge Shaft	3800
6.	Access Road from Thieddieng Village to Surge Shaft Road	4000
7.	Quarry Roads	6000
	Total	**18250**

5.5 Impacts on Biological Environment

a) Construction phase

5.5.1 Impacts on Terrestrial flora

Increased human interferences

The direct impact of construction activity of any water resource project in a Himalayan terrain is generally limited in the vicinity of the construction sites only. As mentioned earlier, a large population (4,000) including technical staff, workers and other group of people are likely to congregate in the area during the project construction phase.

Diversion of forest land

During project construction phase, land will be required for location of construction equipment, storage of construction material, muck disposal, widening of existing roads and construction of new project roads. The total land requirement for the project is 110 ha out of which 22 ha land is forest land.

5.5.2 Impacts on Terrestrial fauna

Disturbance to wildlife

The total land required for the project is 110 ha of which about 13 ha comes under submergence, (including river bed). Based on the field survey and interaction with locals, it was confirmed that no major wildlife is reported in the proposed submergence area. It would be worthwhile to mention here that most of the submergence lies within the gorge portion. Thus, creation of a reservoir due to the proposed project is not expected to cause

any significant adverse impact on wildlife movement. The project area and its surroundings are not reported to serve as habitat for wildlife nor do they lie on any known migratory route. During the construction phase, accessibility to area will lead to influx of workers and the people associated with the allied activities from outside will also increase. Increase in human interference could have an impact on terrestrial ecosystem. The other major impact could be the blasting to be carried out during construction phase. This impact needs to be mitigated by adopting controlled blasting and strict surveillance regime and the same is proposed to be used in the project. This will reduce the noise level and vibrations due to blasting to a great extent.

Impacts on avi-fauna

The project area and its surroundings are quite rich in avi-fauna. However, water birds are not very common in the area. The main reason for this phenomenon is that water birds generally require quiescent or slow moving water environment. However, in the proposed project area and its surroundings due to terrain conditions, water flow is swift, which does not provide suitable habitat for the growth of water birds. With the damming of the river, a reservoir of an area of about 13.0 ha will be created, with quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds. This is expected to increase the avi-faunal population of the area.

5.5.3 Aquatic Flora

a) Construction phase

During construction phase wastewater mostly from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. Around 0.56 mld of water is required for the workers during the peak construction phase out of which 80% (i.e. about 0.45 mld) will be discharged back to the river as wastes, more or less as a point sources from various congregation sites where workers will reside. The lowest minimum flow during lean season for 90 % dependable year is about 2.44 cumec. However, sufficient water for dilution will be available in Mawphu, stage-II to keep the DO of the river to significantly high levels.

b) Operation phase

The completion of Mawphu, stage-II hydroelectric Project would bring about significant changes in the riverine ecology, as the river transforms from a fast-flowing water system to a quiescent lacustrine environment. Such an alteration of the habitat would bring changes in physical, chemical and biotic life. Among the biotic communities, certain species can survive the transitional phase and can adopt to the changed riverine habitat. There are other species amongst the biotic communities, which, however, for varied reasons related to feeding and reproductive characteristics cannot acclimatize to the changed environment, and may disappear in the early years of impoundment of water. The micro-biotic organisms especially diatoms, blue-green and green algae before the operation of project, have their habitats beneath boulders, stones, fallen logs along the river, where depth is such that light penetration can take place. But with the damming of river, these organisms may perish as a result of increase in depth.

5.5.4 Impacts on Aquatic Fauna

a) Construction phase

Impacts due to extraction of construction material

It is proposed to extract construction material from borrow areas in the river bed. The extraction of construction material may affect the river water quality due to increase in the turbidity levels.

Impacts due to discharge of sewage from labour camp/colony

The proposed hydro-power project envisages construction of a project colony. The labour camp and colonies are proposed close to project site. This would result in emergence of

domestic waste water which is usually discharged into the river. However, it is proposed to commission appropriate units for treatment of domestic sewage before its disposal in to the river.

(b) Operation Phase

Impacts due to damming of river

The damming of river Mawphu, stage-II will result in creation of 13 ha of submergence area. The dam will change the fast flowing river to a quiscent lacustrine environment. The creation of a pond will bring about a number of alterations in physical, abiotic and biotic parameters both in upstream and downstream directions of the proposed dam site. The micro and macro benthic biota is likely to be most severely affected as a result of the proposed project.

Impacts on Fish Migration

The obstruction created by the dam would hinder migration of species especially the Mahseers (from downstream to upper reaches) and *Schizothorax* sp. (from upper reaches to the lower reaches). These fishes undertake annual migration for feeding and breeding. Therefore, fish migration path may be obstructed due to high dam and fishes are expected to congregate below the dam wall. Under this situation poaching activities may increase in the area. Most of the species will shift to the section of the river where they find favourable environment for breeding. Since the dam is 40 m high, construction of fish ladders is not feasible in the proposed dam. However, it is proposed that the artificial seed production in hatchery may be adopted which can be stocked in the river stretches downstream and upstream of the proposed dam.

The *Schizothorax* species are steno-thermal. During winter months, they migrate from upper reaches to near flood plains in search of suitable feeding and breeding grounds. The sampling in river Mawphu, stage-II both on upstream and downstream of the proposed dam site for macro-benthic life gave 5 units/sq.m. of fry of *Schizothorax* sp. This observation further strengthens the fact that *Schizothorax* sp. migrate during winter months. With the onset of summer season, these species migrates upstream. These species from henceforth would congregate in the reservoir. It is expected that in due course of time these species will adapt themselves to the changed habitat.

5.6 Downstream Impacts

The discharge for 90% dependable year and number of hours of peaking available in the proposed Mawphu, stage-II hydroelectric project is also given in **Table-8**

Table-8: Number of hours of peaking available in 90% dependable year for Mawphu, stage-II hydroelectric project

Month	TD	90% Dependable Year Discharge (m^3/s)	Rated dischrage (cumec)	Time available for peaking power (hrs.)
May	I	29.91	40.81	17.59
	II	36.97	40.81	21.74
	III	61.51	40.81	24.00
Jun	I	34.48	40.81	20.28
	II	58.95	40.81	24.00
	III	64.63	40.81	24.00
Jul	I	49.87	40.81	24.00
	II	29.44	40.81	17.31
	III	44.98	40.81	24.00
Aug	I	42.85	40.81	24.00
	II	53.39	40.81	24.00

Month	TD	90% Dependable Year Discharge (m^3/s)	Rated dischrage (cumec)	Time available for peaking power (hrs.)
	III	42	40.81	24.00
Sep	I	44.84	40.81	24.00
	II	49.4	40.81	24.00
	III	40.56	40.81	23.85
Oct	I	54	40.81	24.00
	II	53.94	40.81	24.00
	III	38.39	40.81	22.58
Nov	I	11.8	40.81	6.94
	II	8.13	40.81	4.78
	III	6.53	40.81	3.84
Dec	I	5.72	40.81	3.36
	II	6.44	40.81	3.79
	III	4.53	40.81	2.66
Jan	I	4.25	40.81	2.50
	II	4.9	40.81	2.88
	III	3.71	40.81	2.18
Feb	I	3.42	40.81	2.01
	II	3.23	40.81	1.90
	III	2.55	40.81	1.50
Mar	I	3.23	40.81	1.90
	II	4.01	40.81	2.36
	III	4.73	40.81	2.78
Apr	I	4.69	40.81	2.76
	II	4.42	40.81	2.60
	III	9.06	40.81	5.33

Source: DPR

It can be seen from **Table-8** that number of hours for which peaking power will be available, in 90% dependable year shall range from 17.31 to 24 hours in the monsoon season from June to September. In the months of October-November and April- May, peaking will be available for a period of 3.84 to 24 hours and 2.60 to 24.00 hours respectively.

In lean season, from December to March, peaking will be available for a period of 1.5 to 3.79 hours in 90% dependable year. It can be observed that in lean season, river water will be stored for a period of 20.21 to 22.5 hours. The spills from Mawphu, stage-II hydroelectric project in 90% dependable year is given in **Table-9.**

Table-9: Spills from Mawphu, stage-II hydroelectric project during peaking operations in Mawphu, stage-II HEP for 90% dependable year

Month		Discharge in 90% Dependable year (cumec)	Rated dischrage (cumec)	Spill from reservoir
May	I	29.91	40.81	
	II	36.97	40.81	
	III	61.51	40.81	20.7
Jun	I	34.48	40.81	
	II	58.95	40.81	18.14
	III	64.63	40.81	23.82
Jul	I	49.87	40.81	9.06
	II	29.44	40.81	
	III	44.98	40.81	4.17

Month		Discharge in 90% Dependable year (cumec)	Rated dischrage (cumec)	Spill from reservoir
Aug	I	42.85	40.81	2.04
	II	53.39	40.81	12.58
	III	42	40.81	1.19
Sep	I	44.84	40.81	4.03
	II	49.4	40.81	8.59
	III	40.56	40.81	
Oct	I	54	40.81	13.19
	II	53.94	40.81	13.13
	III	38.39	40.81	
Nov	I	11.8	40.81	
	II	8.13	40.81	
	III	6.53	40.81	
Dec	I	5.72	40.81	
	II	6.44	40.81	
	III	4.53	40.81	
Jan	I	4.25	40.81	
	II	4.9	40.81	
	III	3.71	40.81	
Feb	I	3.42	40.81	
	II	3.23	40.81	
	III	2.55	40.81	
Mar	I	3.23	40.81	
	II	4.01	40.81	
	III	4.73	40.81	
Apr	I	4.69	40.81	
	II	4.42	40.81	
	III	9.06	40.81	

5.7 Impacts on Socio-Economic Environment

a) Construction Phase

Employment opportunities

The construction of the proposed project would invariably create a number of direct employment opportunities. However, indirect employment opportunities would also be generated which would provide great impetus to the economy of the local area. Various types of businesses, such as shops, food-stalls, tea stalls, restaurants, workshops, etc. would invariably come-up, which would be run by the more entrepreneurial local residents. Besides, a variety of suppliers, traders, transporters, service providers, etc., are also likely to concentrate here and likely to benefit immensely, as demand for almost all types of goods and services will increase significantly. The business community as a whole would be benefited. The locals would also avail these opportunities arising from the project and increase their income levels.

Improved business opportunities

Improved access facilities in the project area

Improvement in infrastructure

The availability of infrastructure is generally a problem during the initial construction phase. Though the construction workers would be willing to pay for certain facilities like

health, education, etc., the facilities itself are often not made available timely and of the desired quality. The adequacy of water supply, sewage treatment, housing etc. should, therefore, be ensured before and adequate measures would be taken at the very start of the project.

Increased incidence of vector-borne diseases due to excavations
Impacts on public health due to inadequate facilities in labour camps

b) Operation Phase

Impacts due to acquisition of land and homesteads
One of the most important and negative impact due to the commissioning of the project would be that a number of families could be displaced from their lands, and economic activity. As per the assessment, a total of 74 PAF's would be losing land in varying proportions.

6. ENVIRONMENTAL MANAGEMENT PLAN

6.1 Compensatory Afforestation and Biodiversity Conservation Plan

The land to be acquired for the project including submergence area and other project appurtenances is about 110 ha. Only 22 ha is forest land. Thus, a total of (22*2) 44 ha of land needs to be afforested. The afforestation work is to be done by the State Forest Department. The afforestation work is to be done by the Forest Department. Local species shall be preferred for plantation under compensatory afforestation. In addition, following measures are also recommended:

- Afforestation
- Soil stabilization measures & improving water regime,
- Promote use of non-conventional energy so as to reduce pressure on natural resources,
- Sustenance of Livelihoods
- Establishment of botanical gardens for conservation and propagation of RET species.
- Control of grazing & implementation of anti poaching measures, etc.
- Peoples participation in the biodiversity conservation programmes
- Community development initiatives
- Training & Publicity Programmes

6.2 Public Health Delivery System

A population of about 4000 is likely to congregate during the construction phase. The labour population will be concentrated at two or three sites. It is recommended that a dispensary should be developed during project construction phase itself, so that it can serve the labour population migrating in the area as well as the local population.

A first-aid post is to be provided at each of the major construction sites, so that workers are immediately attended to in case of an injury or accident.

6.3 Management of Muck Disposal Sites

The muck would be piled at an angle of repose at the proposed dumping sites. For stabilization of dumped materials various engineering and phyto-remedial measures are being proposed. The overall idea is to enhance/maintain aesthetic view in the surrounding area of the project in post construction period & avoid contamination of any land or water resource due to muck disposal. Suitable retaining walls shall be constructed to develop

terraces so as to support the muck on vertical slope and for optimum space utilization. The muck disposal sites should be reclaimed with vegetation.

6.4 Restoration Plan for Quarry Areas

The quarry slopes after excavation of the construction material needs to be stabilized. It is suggested that quarry slopes should be maintained at a slope 1:1. The slope should then be covered with topsoil of at least 30 cm. It is suggested that for stabilization, grass, herbs & shrubs should be grown over these slopes. Afforestation with suitable plant species of high ecological and economic value along with turfing by suitable grass species can be undertaken over the two quarry sites after providing required slope and laying top soil over the slopes.

6.5 Landscaping and Restoration of Construction Areas

After completion of all the construction activity, the construction sites and other temporary settlements would be removed and area covered with the top soil to support the growth of plant species. These plant species which grow first are considered ecological pioneers and would initiate the process of succession and colonization. Areas close to colony and suitable areas will be landscaped to develop children parks, gardens, etc.

6.6 Environmental Management in Road Construction

The approach roads will have to be constructed as a part of the proposed project. Steeply sloping banks are liable to landslides, which can largely be controlled by provision of suitable drainage. Landslides are proposed to be stabilized by several methods i.e. engineering or bio-engineering measures alone or a combination of these.

6.7 Greenbelt Development

It is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc. This will be carried out in consultation with the State Forest Department.

6.8 Solid Waste Management

As per the requirements of the Municipal Solid Waste (Solid Waste Management & Handling) Rules 2000, land filling would be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall be done following proper norms and landfill sites shall meet the specifications as given in these rules.

6.9 Control of Air Pollution

The air pollution is basically generated due to primary crushing and fugitive dust from the heap of crushed material. The various crushers need to be provided with cyclones to control the dust generated while primary crushing the stone aggregates. It should be mandatory for the contractor involved in crushing activities to install cyclone in the crusher.

6.10 Measures for Noise Control

In a water resource projects, the impacts on ambient noise levels are expected only during the project construction phase, due to earth moving machinery, etc. Likewise, noise due to quarrying, blasting, vehicular movement will have some adverse impacts on the ambient noise levels in the area

Workers operating in high noise should be provided with effective personal protective measures such as ear muffs or ear plugs to be worn during periods of exposure.

6.11 Water Pollution Control

Construction phase

During construction phase of the proposed project, crushers are likely to operate at major construction sites. The effluent generated from crushers will have high suspended solids. It is proposed to provide settling tanks for treatment of effluent from various crushers.

During tunneling work, the ground water flows into the tunnel along with construction water which is used for various works like drilling, shotcreting etc. The effluent thus generated in the tunnel contains high suspended solids. It is proposed to construct a settling tank to settle the suspended impurities.

6.12 Fish Management

a) It is proposed to release Environmental Flows for sustenance of Aquatic Ecology.

The details are given in **Table-10**.

Table-10: Summary of Environmental Flows to be released in various seasons

Season	Avg. inflow (m^3/s)	% of Inflow	Avg. EF to the downstream(m^3/s)
Lean (December to March)	4.23	20	0.85
Non-Monsoon Non-Lean (October-November, April-May)	28.8 24.43	25	7.20 6.11
Monsoon (June- September)	46.28	30	13.89

7. CATCHMENT AREA TREATMENT (CAT) PLAN

Silt Yield Index (SYI) method has been used to prioritize sub-watershed in a catchment area for treatment. The area under high erosion category has to be treated by the project proponents, which accounts for about 56.89% of the total free draining catchment area. The details are given in Table-11.

Table-11: Area under different erosion categories

Category	Area (ha)	Area (Percentage)
Low	4007	12.52
Medium	9789	30.59
High	18204	56.89
Total	**32000**	**100.00**

A CAT Plan comprising of following measures is proposed:

- Gap Plantation
- Afforestation
- Nursery development and maintenance of nursery
- Vegetative fencing
- Check Dams

8. RESETTLEMENT AND REHABILITATION PLAN

The provisions of the "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013" have been taken into consideration, and the best option has been recommended for preparation of Rehabilitation Plan for the PAFs.

8.1 Measures for Rehabilitation

The compensation for acquisition of private land would be paid to the respective land owners/ land titleholders within the provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. In the

proposed project, no homesteads are being acquired, thus, no resettlement is required and only rehabilitation plan is being suggested.
The details of the provisions for the implementation of Rehabilitation Plan at the site are given as follows:

- Compensation for Land acquisition as per the provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013
- One-time financial assistance of a minimum of Rs. 25,000/- to each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition
- One person from each affected family shall be offered necessary training facilities for development of entrepreneurship, technical and professional skills for self-employment.
- For families losing land under canal network, Compensation for Land acquisition as per the provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 shall be given.

8.2 Budget

A total budget of Rs. 1033.72 lakh would be required for implementation of R&R Plan. The details are given in Table-12.

Table-12: Budgetary estimate for implementation of R&R Plan

S. No.	Components of R&R	Cost (Rs. lakh)
1.	Compensation for Land	475.02
2.	Grant to Rural Artisans	18.50
3.	Annuity payment	355.20
4.	Grant for construction of Cattle shed or petty shop	185.0
	Total	**1033.72 lakh say 10.3 crore**

9. LOCAL AREA DEVELOPMENT PLAN

It is proposed to upgrade the infrastructure in various schools in the project area and its vicinity. The following activities are proposed under LADP activities:

- Educational facilities
- Healthcare facilities
- Community Toilets

A sum of Rs. 450.0 lakh shall be spent by the Project Proponent for implementation of various measures outlined in Local Area Development Plan as per details outlined in Table-13.

Table-13: Budget for Local Area Development Plan

S. No.	Items	Budget (Rs. lakh)
1	Construction/Up-gradation schools in Study Area	185.0
2	Improvement of Public Health Facility	130.0
3	Construction of community Toilets	135.0
	Total	**450.0**

10. DISASTER MANAGEMENT PLAN

The following measures have been suggested as a part of the Disaster Management Plan:

- Dam Safety and Maintenance Manual
- Emergency Action Plan (EAP)
- Administration and Procedural Aspects
- Preventive Action
- Communication System
- Notifications
- Evacuations Plans and Evacuation Team
- Public Awareness for Disaster Mitigation
- Management after receding of Flood Water

11. SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

An Environmental Monitoring Programme should be undertaken during construction and operation phase of the project. The details of environmental monitoring programme are given in Tables - 14 and 15 respectively.

TABLE-14: Summary of Environmental Monitoring Programme during Project Construction Phase

S. No.	Item	Parameters	Frequency	Location
1.	Effluent from septic tanks	pH, BOD, COD, TSS, TDS	Once every month	Before and after treatment from each septic tank
2.	Water-related diseases	Identification of water related diseases, adequacy of local vector control and curative measure, etc.	Three times a year	Labour camps and colonies
3.	Noise	Equivalent noise level (L_{eq})	Once in three months	At major construction sites.
4.	Air quality	$PM_{2.5}$, $PM_{10,}$ SO_2 and NO_2	Once every season	At major construction sites
5.	Meteorological aspects	Wind direction & velocity temperature humidity, rain	Once every season	At one of the ambient air quality sampling sites

Table-15: Summary of Environmental Monitoring Programme during Project Operation Phase

S. No.	Items	Parameters	Frequency	Location
1.	Water	pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO. COD, BOD, Iron, Zinc, Manganese	Thrice a year	• 1 km upstream of dam site • Water spread area • 1, 3 and 4km downstream of dam site
2.	Effluent from septic tank	pH, BOD, COD, TSS, TDS	Once every week	• Before and after treatment from

S. No.	Items	Parameters	Frequency	Location
				septic tank
3.	Soils	pH, EC, texture, organic matter	Once in a year	Catchment area
4.	Ecology	Status of afforestation programmess of green belt development	Once in 2 years	• -
5.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Three times a year	• Villages adjacent to project sites
6.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once a year	• 1 km upstream of dam site • Water spread area • 1, 3 and 4 km downstream of dam site
7.	Landuse	Landuse pattern using satellite data	Once in a year	Catchment area

12. COST ESTIMATES

12.1 Cost for Implementing Environmental Management Plan

The total amount to be spent for implementation of Environmental Management Plan (EMP) is Rs. 46.10 crore. The details are given in Table-16.

Table-16: Cost for Implementing Environmental Management Plan

S. No.	Item	Cost (Rs. crore)
1.	Catchment Area Treatment	13.32
2.	Compensatory Afforestation	0.67
3.	Bio-diversity conservation Plan	2.05
4.	Greenbelt development	0.30
5.	Fisheries Management	2.61
6.	Public health delivery system	1.00
7.	Environmental Management in labour camps	2.23
8.	Muck disposal Plan	2.19
9.	Restoration and Landscaping of construction sites	1.00
10.	Air pollution Control	0.50
11.	Noise control measures	0.25
12.	Water pollution control	0.10
13	Energy Conservation measures	0.20
14.	Disaster Management Plan	0.80
15.	Rehabilitation Plan	10.33
16.	Local Area Development Plan	4.50
17.	Tribal Development Plan	2.26
18.	Monitoring & Evaluation of R&R Plan	0.15
19.	Environmental Monitoring during construction phase	1.50

S. No.	Item	Cost (Rs. crore)
20.	Purchase of Meteorological equipment	0.10
21.	Purchase of noise meter	0.015
	Total	**46.075 Say Rs. 46.10 crore**

12.2 Cost for Implementing Environmental Monitoring Programme

The cost required for implementation of the Environmental Monitoring Programme is of the order of Rs.1.50 crore @ Rs.24.6 lakh/year. A 10% annual price increase may be considered for every year. The construction period for estimation of cost for implementation of Environmental Monitoring programme during construction phase has been taken as 5 years. The details are given in **Table-17.** The cost required for implementation of the Environmental Monitoring Programme at operation phase is of the order of Rs.21.8 lakh/year. The details are given in **Table-18.**

Table-17: Cost for Implementing Environmental Monitoring Programme during construction phase

S. No	Item	Cost (Rs. lakh/year)	Total cost for construction period of 5 years with 10% escalation per year (Rs. lakh)
1	Water quality	4.8	29.28
2	Air quality	5.8	35.36
3	Ecology	11.0	67.21
4	Incidence of water-related diseases	3.0	18.33
	Total	**24.6**	**150.18 Say Rs. 1.50 crore**

Table-18: Cost for Implementing Environmental Monitoring Programme during operation phase

S. No	Item	Cost (Rs. lakh/year)
1	Water quality	5.6
2	Ecology	7.0
3.	Soils	1.2
4	Incidence of water related diseases	3.0
5	Land use pattern	5.0
	Total	**21.8**